



Technical Appendix

Specifications for the
RADIO SYSTEM UPGRADE

Specification No. 90222

Technical Appendix to Specification No. 90222
Table of Contents

Section 1. Proposed City Radio System Design 1-4

Section 2. Radio System Performance Requirements.....28

Section 3. Dispatch Workstations31

Section 4. Interconnect Systems43

Section 5. Mobile Equipment50

Section 6. Portable Equipment.....58

Section 7. Control Station Equipment65

Section 8. Backup Power Systems.....71

Section 9. Installation and Service Requirements74

Section 10. Management and Training83

Section 11. Project Schedule84

Section 12. Delivery and Storage of Materials85

Section 13. Acceptance Tests86

Section 14. Warranty90

Section 15. Preventive Maintenance.....91

Section 16. System Documentation92

Technical Appendix to Specification No. 90222

List of Tables

Table 1	Planned Primary City Radio Systems	5
Table 2	Planned Backup Radio Systems	5
Table 3	Additional Equipment (Supply Only)	10
Table 4	Special Operational Requirements	11
Table 5	User Equipment and Accessories	13
Table 6	Vehicular Chargers	13
Table 7	Distribution of Fire Equipment	14
Table 8	Control Station Equipment	15
Table 9	Dispatch Center Radio Equipment	16
Table 10	Backup Power Run Times	26
Table 11	City Leased Circuits	43
Table 12	South Hill <> Fire Station 2 Fiber	43
Table 13	South Hill <> Fire Station 3 Fiber	43
Table 14	South Hill <> Fire Station 1 Fiber	44
Table 15A	Mobile Radio Transmitter Technical Specification – Police	55
Table 15A	Mobile Radio Transmitter Technical Specification – Police	55
Table 16A	Mobile Radio Receiver Technical Specification – Public Works/Utilities	55
Table 16B	Mobile Radio Receiver Technical Specification – Public Works/Utilities	56
Table 17A	VHF Mobile Radio Transmitter Technical Specification	56
Table 17B	VHF Mobile Radio Receiver Technical Specification	56
Table 18A	UHF Portable Radio Transmitter Technical Specification	
	Police and Public Works / Utilities	62
Table 18B	UHF Portable Radio Receiver Technical Specification	
	Police and Public Works / Utilities	62
Table 19A	VHF Portable Radio Transmitter Technical Specification – Fire	62
Table 19B	VHF Portable Radio Receiver Technical Specification – Fire	63
Table 20A	Control Station UHF Transmitter Specification	66
Table 20A	Control Station UHF Receiver Specification	66
Table 21A	Control Station VHF Transmitter Specification	66
Table 21B	Control Station VHF Receiver Specification	66
Table 22	Dispatch Center Radio Antenna Assignments	69
Table 24	Minimum Schedule Components	84

TECHNICAL PROPOSAL REQUIREMENTS

The proposer should submit product documentation, system diagrams showing placement of all equipment and address the following system features in their proposal.

Section 1. PROPOSED CITY RADIO SYSTEM DESIGN

Radio System Design Plan

Applicable Departments

The following City departments and divisions plan to operate on the new radio systems:

- Community Development, Building Safety Division
- Fire
- Police
- Utilities
- Finance and Information Technology
- Parks and Recreation
- Public Works

System Design Plan

The design plan for the new networks incorporates the following types of channels:

- A. Analog Wideband Channels – These channels generally utilize Police (460 MHz) and Fire (150 MHz) conventional frequencies that must maintain wideband analog mode for interoperability. Network equipment shall also be capable of narrowband analog and Project 25 digital conventional operation in the future. Stations need not be equipped for digital operation at this time. As these channels will continue to operate on their existing frequencies and wideband mode, it will eliminate the need for surrounding agencies to reprogram their vehicular and portable radios in the near term.
- B. Analog Narrowband Channels – These channels are primarily for use by Public Works and Utilities, or are citywide common channels. These channels shall initially operate in narrowband analog mode, as they are not required to be interoperable with outside agencies. Network equipment shall also be capable of wideband analog (for spare parts commonality with other channels), and Project 25 digital conventional operation in the future. Stations need not be equipped for digital operation at this time.
- C. Digital Narrowband – These channels are primarily used by law enforcement, where repeated encryption is anticipated, or where digital conventional talkgroup capability is anticipated or desired (when possible).

The following table summarizes the existing and planned channel configuration per this RFP.

Table 1 - Planned Primary City Radio Systems (not all City Channels are shown in this table)¹

<i>Department</i>	<i>Existing Channels</i>	<i>Planned Conventional Channels</i>	<i>Planned Channel Mode</i>	<i>Mobile Receive Frequency</i>	<i>Mobile Transmit Frequency</i>	<i>Baseline Transmitter Sites</i>	<i>Baseline Receiver Sites</i>
City Fire	SLOFD CTTAC	SLOFD CTTAC CTTAC 2 (NEW)	Analog Wide Analog Wide Analog Wide	155.145 154.310 155.025	154.205 154.310 155.025	South Hill	South Hill Fire Station #2 Fire Station #3
City Police	PD GREEN	PD GREEN PD TAC 2 (NEW)	Analog Wide Digital Narrow ²	460.3750 453.2875	465.3750 458.2875		
Public Works (others)	PUB WORKS	PUB WORKS 1 PUB WORKS 2 (NEW)	Analog Narrow Analog Narrow	453.4125 453.6125	458.4125 458.6125		
Utilities	PUB WORKS	UTILITIES (NEW)	Analog Narrow	453.7125	458.7125		
All Departments (150 MHz)	(none)	CITYWIDE COMMON (NEW)	Analog Narrow	155.955	159.075		
All Departments (450 MHz)	(none)	CITYWIDE COMMON (NEW)	Analog Narrow	453.8750	458.8750		

¹ Some radios on this channel would be equipped with voice encryption; all radios would operate digitally.

Table 2 - Planned Backup Radio Systems

<i>Department</i>	<i>Existing Channels</i>	<i>Planned Conventional Channels</i>	<i>Planned Channel Mode</i>	<i>Mobile Receive Frequency</i>	<i>Mobile Transmit Frequency</i>	<i>Baseline Transmitter Sites</i>	<i>Baseline Receiver Sites</i>
City Fire	(none)	SLOFD B/U	Analog Wide	155.145	154.205	919 Palm St.	919 Palm St.
City Police	(none)	PD GREEN B/U	Analog Wide	460.3750	465.3750		
Public Works / Util.	(none)	PUB WORKS / UTIL 1 B/U	Analog Narrow	453.4125	458.4125		

The plan incorporates a new Citywide Common Channel on each radio band. This new channel will be programmed into all City radios. Both the VHF and UHF side would be permanently tied together to allow all departments to communicate with each other and dispatch when needed.

Primary radio repeaters shall be installed at the City's current primary site on South Hill. Remote receivers shall be installed at Fire Station 2 and Fire Station 3. Comparators and dispatch electronics shall be installed in the new Dispatch Center Equipment Room within the new Dispatch Center located on Fire Station 1 property.

Nine new dispatch workstations shall be installed at the new dispatch center located on Fire Station 1 property.

Wideband channels will eventually be switched to 12.5 kHz narrowband operation before 2013. Thus, this equipment should be capable of narrowband analog or digital conventional operation per this Specification upon installation to simplify the future transition.

To fill gaps in talk-out (downlink) coverage in areas near these fire stations, proposers shall provide an option for talk-out improvement at each fire station.

155.955 MHz is the current repeater transmit frequency in use by Public Works. This channel must only be activated after these users have relocated to their new channels. The current plan is to relocate all the users on the 155.955 MHz Public Works channel to the new UHF channels once they have been tested and are operational. This will then free-up this channel.

A more detailed list of site characteristics, including geographical coordinates and elevation data, is shown in Exhibits 3 and 4 to this Appendix.

Other City Channels

The following other channels and stations are part of this RFP:

- Backup Channels – Stations on these channels consist of stand-alone repeaters (no remote receivers) primarily for backup to South Hill. These shall operate on the same frequency and transmit CTCSS codes as the primary stations, but will have a different receive input CTCSS code. They can be activated by field units or dispatch using a different access code.
- Wide-Area Channels – Two new stations shall be supplied (only) to replace the existing Fire and Police stations at Tassajera Peak. The Police station is a stand-alone repeater. The Fire station is configured as a base station, and connected to a 450 MHz link to the existing dispatch center. Both stations shall be equipped with a method to activate and deactivate them. Antennas, backup power and link equipment shall be reused. Installation and testing of the supplied equipment, and realignment of the link antenna to the new dispatch center shall be quoted separately.

System Technology

Digital offerings shall conform to APCO Project 25 standards. A Project 25 Phase I-compliant system ensures that any manufacturer's compliant subscriber radios have access to the services described in the TIA 102-series documents, involving other systems, across system boundaries, backward compatibility, etc., regardless of system infrastructure.

To ensure both multi-source procurement and interoperability with existing and future Project 25 Phase I systems and equipment, all fixed network equipment and selected subscribers shall be capable of the following mandatory Primary Conventional Services (see Exhibit 5):

- Project 25 Common Air Interface (CAI)
- Required Project 25 Voice Call Features
- Electronic Serial Number (ESN; subscriber)

Additionally, the following Standard Options are also being considered and must be quoted separately:

- AES Voice Encryption³
- Group Voice Call
- Individual Voice Call
- Selective Squelch
- System Call
- Radio Unit Monitoring
- Emergency Alarm
- Radio Unit Inhibit* / Disable
- Radio Unit Uninhibit* / Re-enable
- Talking Party Identification
- Subscriber Priority Channel Scan (Voice)⁴

While only certain channels will operate in digital mode, it is desirable that most of the repeater and remote receiver components be generally interchangeable with the proposed analog stations to the extent possible.

All user equipment (i.e. mobile, portable, base and control station equipment), with the exception of the fixed infrastructure, shall be capable of analog FM wideband and narrowband operation on a per-channel basis to promote interoperability.

Modulation Types and Channel Bandwidth

Designated user equipment (i.e. mobile, portable, base and control station equipment) shall be equipped to operate using the following access method, bandwidth and modulation, on a per-channel basis to promote interoperability:

- Conventional 25 kHz (16 & 20K0) wideband FM (analog)
- Conventional 12.5 kHz (11K3) narrowband FM (analog)
- Conventional 12.5 kHz (8K1) narrowband Project 25 Phase 1 CAI

Changes to user equipment bandwidth and modulation mode shall be made automatically via user channel selection. Operation on any of these modes shall not require hardware, software and/or firmware changes for the life of the equipment.

Audio levels of analog wideband and analog narrowband messages heard from subscriber radio speakers as well as from dispatch workstations shall be identical and not vary by channel.

² Designated radios and infrastructure.

³ May not be a current documented Project 25 feature.

New System Design

The South Hill repeater site and the Fire Station 2 and Fire Station 3 remote receiver sites shall utilize existing, City-owned, single-mode dark fiber to connect to the new central Site at Fire Station 1. Central control equipment such as comparators shall be located in a new equipment room at Fire Station 1 (referred to as the Dispatch Center Equipment Room).

The contractor must provide adequate multiplex or routing equipment in order to interface to the City single-mode fiber at all locations. The City shall be responsible for providing single-mode fiber to a backboard termination point in equipment shelters or rooms.

The Fire Station 1 Dispatch Center Equipment Room shall house the Central Dispatch Workstation Electronics (which will initially support nine dispatch workstations; 12 total future), and well as various auxiliary receivers, control and base stations that support the dispatch center. Fire Station 1 will also be equipped with an 80' self-supporting tower to support all antenna systems associated with dispatch. The contractor shall be responsible for antennas, transmission lines, outdoor cable support hardware (clamps, etc.) and outdoor lightning protection hardware associated with the antenna system at Fire Station 1.

The City shall provide immediate and long-term backup power at Fire Station 1 consisting of a generator and UPS, including the number of outlets required by the contractor. Thus, all hardware at this site shall operate on 120 VAC.

The Contractor shall provide space-efficient DC battery float systems equipped with modular rectifiers at all remote sites. All major site equipment items shall operate from the DC source, or be provided with an inverter operating from this source. UPS systems to support equipment incapable of DC operation shall be considered only when necessary. In all cases, DC, inverter and UPS system shall be rack-mounted in 19" or 23" EIA racks.

Citywide Common Channel Interconnection

The connection between the 150 MHz and 450 MHz citywide channels shall be driven from the opposing channel's carrier-operated-switch (COS) signal, or other fast-switching circuit(s). Connections shall not employ voice-operated PTT circuits. Voice message truncation (loss of portions of the message) due to call setup times, such as the sum of hardware, tone signaling, and coded squelch decode times, shall not exceed 400 milliseconds. In some cases, this may require the use of voice delay circuits to ensure this requirement is met. Contractors must demonstrate a representative link during factory testing to verify conformance.

Redundancy and Single Point Failures

Contractors shall minimize single points of failure that would disable or significantly degrade more than a single channel for any particular department. Any redundant or parallel equipment shall be capable of automatic and manual switching.

System Features

While most of the conventional channels will initially operate in analog mode, it is desirable that the repeater, remote receivers and comparator components be capable of digital operation simply by reprogramming. While it would be desirable to have the conventional system be capable of automatic dual-mode operation (automatic detection and switching to analog or digital mode, depending on a users uplink signal), such operation is not required.

System Manager Workstation

A System Manager Workstation (SMW) shall be provided in the Dispatch Center Equipment Room located on Fire Station 1 property for use by system technicians.

Ideally, SMW access should be provided via a standard Windows-based web browser application (Internet Explorer, Firefox etc.) via an IP based network.

The SMW shall provide access to and visibility over the following functions:

- Individual Radio Enable/Disable (if provided)
- Real-time comparator display
- Alarm status of all repeater stations and external sensors / alarms
- Alarm status of all workstations
- Ability to set privileges for remote access to SWM
- Maintenance, alignment and control of simulcast subsystem (if applicable)

SMWs shall provide a graphical user interface and on-line help database. Units shall be interfaced to the radio systems through a standard Ethernet or other common interface protocol.

SMW's shall be network devices and utilize standard Ethernet LAN connections.

Secure Wide Area Network (WAN) Access of SMW Server

Contractor shall provide secure root access to SMW functionality over the City's existing LAN/WAN using a secure encrypted VPN package for maintenance personnel. All login and password information for remote access shall be fully encrypted. Contractor shall provide VPN packages to the City and assist with installation on three computers. Proposer shall describe how this will operate over the City's network.

System Failure Modes

- A. Removal of Inoperative Resource. In the event a resource becomes inoperative (i.e., repeater receiver, transmitter or connection circuit), the radio network shall detect such failure and provide indication (an alarm) of the defective equipment, channel or circuit to the SMW. The system shall continue to operate using the remaining operating equipment.
- B. Local Repeater Fallback. In the event that a comparator, or connection between the comparators and a repeater fail, a selected repeater (per channel) shall operate using its local receiver. Recovery shall be automatic. SMWs and dispatch workstations shall receive an indication when the system enters and exits this condition.
- C. All processors, devices, and on-line and background functions in the City radio system shall be monitored for fatal and recoverable errors. All errors shall be recorded for later review by maintenance personnel and shall be included in the error statistics displays and reports provided by the System Manager's software. Each type of error for each device (for example memory access violation, device reply time-out, or message checksum error) shall be recorded separately and stored for diagnostic review.

Fire Station Alerting

Fire station alerting shall be performed on the SLOFD channel. The current system uses DTMF codes to activate systems at each station. Proposers shall indicate how the new system will support this existing signaling method, or propose an alternate signaling method.

Control stations for fire station alerting are included in the Control Station Equipment quantities in this Section.

It is the intent of the City that contractor shall provide an interface between the new Dispatch Center radio control equipment/system and the new (to be determined) Fire Station Alerting System. Although this new Fire Station Alerting System has not been identified yet, it is believed that one of the following contractors will be granted the competitive bid:

- Locution Systems, Inc.
- Zetron, Inc.
- ComTech Communications
- West Net, Inc.
- Motorola (RTU-based technology)

It is the intent to bring on-line the new Dispatch Center, the new Radio System and the new Fire Station Alerting System at the same time. The contractor shall allocate resources to support these efforts as needed.

Conventional Backup Repeaters

The 919 Palm Street (downtown) site shall house the conventional PD GREEN B/U, SLOFD B/U and PUB WORKS / UTIL 1 B/U repeaters. The VHF station shall be equipped with a duplexer and single antenna. The UHF stations shall utilize an expandable combiner and multicoupler arrangement and use two antennas for possible future expansion. As with other remote sites, contractor shall provide a DC battery float system equipped with space-efficient modular rectifiers.

While these stations shall be operated separately from the primary systems, City-owned dark single-mode fiber shall be used to connect to Fire Station 1 for monitoring purposes.

Additional Equipment

The contractor shall furnish the following additional stations. Installation and testing shall be separately quoted as Option "ADDEQUIP". Equipment shall comply with specifications herein for the Station Type listed.

Table 3 – Additional Equipment (Supply Only)

<i>Config.</i>	<i>Site</i>	<i>Planned Use</i>
Repeater	Cuesta Peak	PD TAC (453/458.7500 MHz)
Base	Tassajera	CTTAC (154.3100 MHz)

Special Operational Requirements

Among the special system requirements detailed in this Section are:

Table 4 – Special Operational Requirements

<i>Name</i>	<i>Special Requirement</i>
CHP	Link to California Highway Patrol
ENCRYPT	Voice Encryption (for quantity. indicated; fixed and user)
TRANS3	Talk-Out Enhancement for Fire Station 3 (end-to-end)
TRANS2	Talk-Out Enhancement for Fire Station 2 (add/delete to TRANS3)
FACMUT	Factory Mutual Certification

The City reserves the right to decline any or all the Options specified herein. However, these requirements will be considered as part of the proposal evaluation.

CHP – Link to California Highway Patrol

Contractors shall propose a method and cost to link a conventional CHP VHF low-band channel, through a contractor-provided control station to one of the police channels. Performance shall be equivalent to that specified for Citywide Common Channel Interconnection noted elsewhere.

Contractor may quote a dispatcher-enabled link arrangement, or a more innovative approach (preferred). The control station for this link would be located in the Dispatch Center Equipment Room at Fire Station 1.

ENCRYPT – Voice Encryption

The City requires digital voice encryption to eliminate eavesdropping and interception of tactical movements, sensitive information and other ongoing investigations work. It is not anticipated that day-to-day communications will be encrypted. Under this requirement, all police vehicular and portable radios would be equipped with voice encryption capability, as well as all dispatch workstations. Encryption would be possible on the digital PD TAC2 channel. Encryption is required on all over-the-air transmissions. Additionally, encryption shall also operate on a unit-to-unit (repeater talkaround and direct) basis as well.

One key loader will be provided in the Dispatch Equipment Room.

To ensure compatibility with future networks of other manufacturers or other agencies, the City requires AES (Advanced Encryption Standard) approved FIPS (Federal Information Processing Standard) standard. Proposers will address the following AES on Project 25 systems is described in ANSI/TIA/EIA-102.AAAD (2002), titled “Project 25 - Block Encryption Protocol.”

Contractors shall indicate the following in their proposals:

- Compliance with AES on Project 25 systems as described in ANSI/TIA/EIA-102.AAAD (2002), titled “Project 25 - Block Encryption Protocol.”

- Whether the proposed product would be compatible with the City of Santa Maria Police Department's current law enforcement encryption method (given keys were known). Santa Maria currently operates a conventional UHF digital system provided by Motorola.
- Provide details on Project 25 compliance and the type of encryption proposed.
- How many different keys can user equipment hold?

TRANS3 – Talk-Out Coverage Improvement Near Fire Station 3

Field users are experiencing poor reception in the areas surrounding, and south of, Fire Station 3 on both UHF and VHF. This is primarily caused by massive terrain blockage between South Hill and these areas. Transmitters placed at Fire Station 3 would improve talk-out coverage to a significant extent.

Due to limited frequency availability and limitations associated with a transmitter-steering approach, simulcast is the preferred method to enhance coverage in this area.

There can be significant areas of signal overlap between South Hill and Fire Station 3. Therefore, contractors are required to use appropriate technology to minimize interference.

TRANS2 – Talk-Out Coverage Improvement Near Fire Station 2 (add/delete to TRANS3)

Users are experiencing poor reception in the areas surrounding, and northwest of, Fire Station 2 on both UHF and VHF. Additionally, Fire has taken over responsibility for coverage of the Cal Poly State University campus. Coverage problems here are primarily caused by terrain undulations between South Hill and these locations.

This requirement is identical to TRANS3 above. However, for the purposes of pricing this requirement, proposers shall assume that the TRANS3 subsystem has already been installed, and that common equipment at South Hill could be simply expanded to support this site.

One significant limitation is the estimated fiber run distance between South Hill and Fire Station 2 is over 25,000 feet.

FACMUT – Factory Mutual Certification

The City may require some Fire portable radios to be rated intrinsically safe through Factory Mutual certification. Proposers shall quote this certification option here (portable and battery costs to be shown separately is applicable).

User Equipment and Accessories

The following includes 5% spare equipment. Charger definitions are included in the Portable Radio Section. Single Unit and Gang refer to desktop (fixed, non-vehicular) battery chargers.

Table 5 - User Equipment and Accessories

	<i>Subscriber Equipment</i>		<i>Portable Radio Accessories</i>				
	Vehicular	Portable	Extra Batt.	Belt Holder	Speaker/Mic.	Single Unit	6-pos. Gang
Fire Department (VHF) (Note 1)	29	58	58	58	35	7	5
Fire Department (UHF) (Note 2)	7	1					
Police Department (UHF)	38	79	33	79	33	13	3
Pub. Wks./Util. (UHF)	104	42	11	10	10	7	2
Totals	178	180	102	147	78	27	10

Note 1: Fire vehicular radio quantities above refer to the total number of control heads required for Qty. 21 vehicles. Thus, Fire radio transceiver quantities can be reduced if radios are capable of multiple control heads.

Note 2: Some fire apparatus and vehicles will be equipped with a UHF radio to allow simultaneous reception of police and fire communications.

All Fire portable radios are to be rated intrinsically safe through Factory Mutual certification. Fire Belt Holders are swivel type. Selected Fire portable radios are to be rated intrinsically safe through Factory Mutual certification (see Option FACMUT). Fire belt holders are D-type swivels (require the radio case to be inserted upside down and swung into place).

Table 6 – Vehicular Chargers

	<i>Vehicular Charging Equipment</i>	
	Single-Unit Vehicular Rapid Chargers	Single-Unit Vehicular Cup Chargers
Fire Dept. Vehicles	49	49

Desktop Battery Analyzer / Exerciser/Dischargers – Quantity 6

Table 7 – Distribution of Fire Equipment

Vehicle Name/#	Headsets	Vehicular Radios	Portable Radios	Single-Unit Vehicular Rapid Chargers	Single-Unit Vehicular Cup Chargers	UHF Vehicular Radio	UHF Portable Radio
Truck 1 - F203	5	2	5	5	5		
Eng 2 - F110	4	2	4	4	4		
Eng 3 - F112	4	2	4	4	4	1	
Eng 4 - F109	4	2	4	4	4		
Eng 5 - F108	4	2	4	4	4		
Eng 6 - F114		2	4	4	4		
OES Eng -F111		1	4	4	4		
Patrol 1 - F320		1	2	2	2		
BC Veh. - F314		2	2	2	2	2	
Back-Up BC-F427		1	1	1	1		
Chief 1 - F425		1	1	1	1	1	
TO Veh. -F317		1	1	1	1		
Squad 1 - F318		1	2	3	3	2	1
Brown - F419		1	1	1	1		
Ferguson - F420		1	1	1	1		
Fire Marshal - F421		1	1	1	1		
Madden - F422		1	1	1	1	1	
Admin - F424		1	0	0	0		
Boyle - F426		1	1	1	1		
Dugger - F319		1	1	1	1		
New Truck 2009		2	4	4	4		
Bike Medics			2				
Other:							
Interns			3				
Radio Cache			5				
Totals	21	29	58	49	49	7	1

Fire Vehicular Headsets

Proposers shall provide interface and assure that new vehicle radio systems work with existing David Clark Series 3800 headset systems on five apparatus (one truck and four fire engines).

Proposers shall also provide for one fire engine (E-6) equipment and installation for a David Clark Headset radio and intercom system, series 3800 that includes 2 PTT stations, 2 remote stations, and four H7042 (or equivalent) headsets. All cabling, including radio interface to be included.

Proposers shall provide an additional 21 David Clark H7042 (or equivalent) headsets (per Table 7 – Distribution of Fire Equipment). These headsets to be compatible with existing series 3800 vehicle radio/intercom systems.

Proposers shall provide 2 David Clark U3800 Master Control Stations, 2 U3817 Remote Headset Stations, and 2 U3813 Radio Interface Headset Stations with PTT.

Control Station Equipment

Spare Control Station equipment is shown separately in the following table. Remote and control station placement details are provided in the Technical Appendix, Exhibit 1. Control station equipment shown below at Fire Station 1 is not associated with those serving the dispatch center workstations or the network.

Table 8 - Control Station Equipment

<i>Location</i>	<i>Remotes</i>	<i>Base/Control Stations</i>	<i>Comments</i>
City Hall	3	1	UHF
Public Works 919 Palm	1		
Parking 1260-B Chorro	1		
Fire Sta. 1	17	3	2 VHF; 1 UHF
Fire Sta. 2	5	1	VHF
Fire Sta. 3	4	1	VHF
Fire Sta. 4	5	1	VHF
Corp Yard Offices	4	1	UHF
Utilities Department	3	1	UHF
Subtotal:	43	9	
Spare Equipment	3	1	
Total:	46	10	

Dispatch Center Radio Equipment

The disposition of dispatch center radio equipment is described below. All equipment shall be equipped with new antennas and transmission line. Equipment must be connected to 120 VAC backup power. Some equipment is new.

Table 9 – Dispatch Center Radio Equipment

<i>Radio Manuf.</i>	<i>Model</i>	<i>Use</i>	<i>Action</i>	<i>Replacement Station Type</i>
UHF				
Motorola	GM300	SLOPD Green Main Radio	Replace	Control Station Type C(D,M)
Motorola	GM300	SLOPD Green hot standby	Replace	Control Station Type C(D,M)
Motorola	GM300	White monitor	Replace	Control Station Type C
Motorola	GM300	Medcom 2 monitor	Replace	Control Station Type C
Motorola	GM300	TAC	Replace	Control Station Type C
Motorola	GM300	OES Law	Replace	Control Station Type C
Motorola	GM300	S.O. Blue monitor	Replace	Control Station Type C
Motorola	GM300	Cal Poly Gold	Replace	Control Station Type C(M)
Motorola	MSF5000	Orange net Link	Replace	Control Station Type A
Motorola	MSF5000	S.O. Yellow	Replace	Control Station Type A
Motorola	MSF5000	S.O. Red	Replace	Control Station Type A
VHF				
Motorola	GM300	Fire City Net Main Radio	Replace	Control Station Type C
Motorola	GM300	Fire TAC Net Alternate	Replace	Control Station Type A
Motorola	GM300	County Fire	Replace	Control Station Type C
Motorola	GM300	VHF Spare	Replace	Control Station Type C(M)
Motorola	Maxtrac	CHP Monitor (Low Band)	Replace	Control Station Type B
Motorola	GM300	VHF Spare	Discard	N/A
Motorola	MSR2000	City Fire Reverse	Replace	Control Station Type A
Motorola	MSR2000	Public Works	Replace (w/UHF)	Control Station Type C
Motorola	MSR2000	Fire White 1 154.28 MHz	Replace	Control Station Type A

(D) Digital capable.

(M) Multi-channel; channel can be selected from console screens if desired

Type definitions are listed in the Control Station Equipment Section.

Repeaters and Base Stations

The following sections describe the requirements and specifications for conventional repeater base stations and associated equipment.

Repeater and Base Station Specifications

The following specifications apply to conventional repeaters and stations. The City desires interchangeable hardware among conventional all stations to the extent possible.

- A. Repeater transmitters and receivers shall comply with Part 90 of the FCC Rules and Regulations. Transmitters shall conform to EIA-152-C standards and specifications through 470 MHz. Receiver equipment shall conform to EIA-204-D to 470 MHz and meet Class A specifications
- B. Digital stations shall be digitally interfaced to multiplex or other backhaul circuits either on a per-circuit (for circuit-switched connections) or on a broadband basis (packet-switched). Broadband connectivity is preferred.

- C. Conventional repeaters site shall be equipped with an automatic station identifier, to transmit the FCC call sign using a pre-recorded digital voice circuit or Morse code, at intervals of not more than 30 minutes, in accordance with FCC rules. Identification shall be sent without coded squelch encoding. The identifier shall be "polite," such that it begins during an interruption in radio traffic, and, if interrupted, resets, and attempts to send again, until which time the complete message has been sent.
- D. Conventional repeaters shall be equipped with an "in-cabinet-repeat" option that shall cause them to operate as stand-alone repeaters upon loss of the comparator or leased-lines.
- E. Conventional repeater receivers and transmitters shall be capable of operating on existing 25 kHz channels (20K0 emission designator) or 12.5 kHz channels (11K3 emission designator) through programmable software changes. No hardware or firmware changes shall be required to change between bandwidths.
- F. Conventional repeaters shall be programmable to encode and decode any combination of 37 EIA CTCSS and 83 standard DCS codes. Receivers shall be capable of operating on any of three different CTCSS and/or DCS codes simultaneously.
- G. Transmitters shall employ a means of encoding a coded squelch "phase-reversal," or a digital turn-off code to eliminate the noise burst at the end of transmissions that would otherwise be heard by mobiles. Repeater receivers shall also be equipped with circuitry to detect a coded squelch "phase-reversal," or a digital turn-off code from a mobile.
- H. Each repeater shall be equipped with a local speaker and volume control to monitor all on-channel signals.
- I. Repeaters shall be equipped with contact outputs indicating malfunctions in transmitter output power, synthesizer condition, AC and battery power supply status.
- J. Transmitter and receiver modules shall be interchangeable between repeaters without requiring tuning.
- K. Transmitters shall be equipped with the highest frequency tolerance option available.
- L. Transmitters and receivers shall be programmable in consecutive 2.5 and 7.5 kHz (VHF) or 12.5 kHz (UHF) steps, to allow operation on all interoperability channels.
- M. Equipment shall operate continuously within full specifications between -30 to +60 C and 5% to 90% RH EIA (50 C).
- N. Repeaters shall be equipped for external DC battery float operation unless specified otherwise.
- O. Transmitters shall be equipped with a power reduction circuit that will reduce transmitter power by at least 3dB when operating solely on battery power. This function will be activated by a signal from the charger system or other external connection. As a minimum, a maintenance port shall provide the following controls and functions for local operations:
 - 1. Transmitter keying and modulation
 - 2. Local receiver audio volume
 - 3. Receiver squelch control

4. Coded squelch encode and decode disable switch (affecting local and console)
5. Coded squelch decode disable switch (affecting local speaker only)
6. Repeater disable
7. Transmitter disable - effective in all modes of operation
8. Line input/output disable switch for testing purposes
9. Local control functions that could cause service interruptions shall be equipped with visual indicators.
10. Received BER indication and digital pattern generation for transmitter.

UHF Transmitter Specifications

Repeater transmit powers shall be selected to meet the licensed ERPs shown in the Appendix, using the antenna and combiner types specified herein.

RF power output, watts (EIA Continuous)	100
Frequency range (MHz)	450-470
Frequency Spread (MHz)	20

UHF Receiver Specifications

Frequency range (MHz)	450-470
Analog Sensitivity, 12 dB SINAD (dBm)	-116
Digital Sensitivity, 5% BER (DAQ 3.0) (dBm)	-116
Selectivity, EIA, @ 25 kHz bandwidth (analog)	-85 dB
@ 12.5 kHz bandwidth (analog)	-75 dB
@ 12.5 kHz bandwidth (digital)	-60 dB
Intermodulation immunity, EIA SINAD, @ 12.5 kHz BW	-80 dB
Spurious and image rejection	-100 dB
Frequency Spread (MHz)	20

VHF Transmitter Specifications

Repeater transmitter set points shall be selected to meet the licensed ERPs shown in the Exhibit 3, Site Data, using the antenna and combiner types specified herein.

RF power output, watts (EIA Continuous)	100
Frequency range (MHz)	150-174
Frequency Spread (MHz)	20

VHF Receiver Specifications

Frequency range (MHz)	150-174
Analog Sensitivity, 12 dB SINAD (dBm)	-116
Digital Sensitivity, 5% BER (DAQ 3.0) (dBm)	-116
Selectivity, EIA, @ 25 kHz bandwidth (analog)	-85 dB
@ 12.5 kHz bandwidth (analog)	-80 dB
@ 12.5 kHz bandwidth (digital)	-60 dB
Intermodulation immunity, EIA SINAD, @ 12.5 kHz BW	-80 dB
Spurious and image rejection	-90 dB
Frequency Spread (MHz)	20
Frequency range (MHz)	150-174
Analog Sensitivity, 12 dB SINAD	0.35 μ V
Digital Sensitivity, 12 dB SINAD	0.35 μ V
Selectivity, EIA, @ 25 kHz bandwidth	-85 dB
@ 12.5 kHz bandwidth	-80 dB
Intermodulation immunity, EIA SINAD, @ 12.5 kHz BW	-75 dB
Spurious and image rejection	-90 dB

Comparator Equipment

A comparator for each radio channel shall be provided to accept and compare the received audio from the multiple repeater and remote receivers. Selected audio shall be sent to the consoles and associated transmitters.

- A. Each channel shall be equipped with 25% spare comparator ports for future expansion.
- B. The comparators shall monitor all receiver port for continuity, and automatically adjust for changes in analog line level for analog connections.
- C. On any transmission, the comparators shall make an initial comparison and selection within 50 milliseconds, and subsequent changes in selection within one millisecond.
- D. Analog comparators shall differentiate between a weak signal with a high signal-to-noise ratio, and a strong signal with a low signal-to-noise ratio, and choose the former. Analog comparators shall change receiver selections on detecting a signal-to-noise differential of 2 dB or greater. Digital comparators shall use a “majority vote” or BER-based selection for signal reconstruction and output.
- E. Controls shall be provided to allow manual override of receiver selection, and the disabling of any receiver port at the comparator.
- F. Indicators and controls shall be provided at the comparator to display the status and to allow loudspeaker monitoring of each receiver port.
- G. Analog comparators shall be capable of operation with a standard 3002-type line or T1 line circuit cards from each receiver.

- H. Comparator shall be capable of storing basic statistical data such as count and duration that a particular receiver was selected; number of receiver or line failures, etc. Such data shall be available on a port using a PC.
- I. Comparator shall be capable of applying a user-defined weighting value or prioritization function to prefer certain receivers above others.
- J. Comparators shall be equipped for DC battery float operation unless specified otherwise.

Tower Top Preamplifiers

Tower-top preamplifiers/filters will not be used.

Antenna Systems

Antennas

The selection and design of antennas, transmitter combiners, and receiver multicouplers will be the responsibility of the contractor, but shall comply with the following specifications:

- A. Each antenna shall be equipped with a dedicated transmission line to the combiner or multicoupler equipment.
- B. All antennas shall be mounted to minimize the pattern distortion effects caused by tower members, transmission lines, other antennas, and other objects located near the antenna.
- C. Receive antennas shall be plumbed and mounted vertically above the transmit antennas as space on the towers permits.
- D. Antennas shall meet or exceed the requirements of Part I of EIA-329-A. Separate transmit and receive antennas shall be provided unless otherwise specified.
- E. Multiple-feed antennas for transmitters (having separate elements inside one antenna radome) may be used to minimize tower loading and allow more space for other antennas.
- F. Antennas shall be high quality, ruggedized models, designed for long-term, high-reliability performance under high wind conditions, and for minimal generation of passive intermodulation.
- G. Repeater sites shall use Decibel Products DB-408, DB-420 or approved equivalent antennas.

Transmission Lines

- A. Andrew LDF5-50A, 7/8 inch Heliac® cable shall be used for the major portions of the cable runs. Outdoor cable runs shall be continuous lengths, unless cable lengths exceed the maximum length supplied by the manufacturer. The manufacturers' minimum bending radius shall not be exceeded during installation.
- B. Andrew FSJ4-50B, 1/2 inch super-flex Heliac® cable shall be used in short lengths where greater flexibility is necessary. This includes each antenna and connection to all equipment.
- C. All cables shall be terminated in N-type connectors unless equipment requires otherwise. Connectors shall be constructed of non-ferrous materials, and shall have gold plated inner conductors and silver-plated bodies. Andrew Model LDF5-P, premium performance, Type N male and female connectors shall be used for all transmission line connections.

- D. Easiacx cable cutting tool, Andrews Model 222951, shall be used to terminate all cables. For replacement blades, use Andrews Model 222954 blade kit (5 per kit).
- E. Antenna connectors shall be weatherproofed, using Andrew type 221213 weatherproofing kit or approved equivalent. Butyl-rubber tape shall be applied liberally to the antenna connector and 3M Scotchcoat® shall be applied liberally over the butyl-rubber tape.
- F. Cable selection shall minimize transmission losses to less than 10% of total transmitter power; this shall include connector losses.
- G. Transmission lines shall be secured through standard cable hangers attached to channel supports or "Unistrut" as appropriate. All cables shall be dressed appropriately, and run parallel to each other.
- H. Antenna transmission lines shall be grounded just prior to entering the facility.
- I. When required, six-opening feed-through panels shall be provided at repeater sites, if the existing is filled to capacity. Feed-throughs shall be similar to Andrew model 48940-6. Wall feed-through boots shall be sized for the correct cable OD. Feed-through panels, boots and unused ports shall be sealed to prevent moisture and dust intrusion.
- J. Each transmission line shall be protected from lightning and static discharges with an appropriate Transient Voltage Surge Suppression ("TVSS") device designed with a voltage-handling capability to support the number of transmitters anticipated, plus one future. The TVSS device shall conform to all of the requirements shown elsewhere in this Specification. These devices shall be connected to the facility grounding system as described elsewhere in this specification.
- K. TVSS units shall be mounted to contractor-provided copper cage assemblies that shall be installed at transmission line entry ports. This cage shall both ground and support TVSS units. TVSS units shall be mounted in the cage in such a fashion as to permit easy disconnection of cables to/from external antennas for testing.

Antenna Support Structures

Details of antenna mounting shall be determined by the contractor, as required by the availability of support structures at each site and the contractor's specific design, and in coordination with the City's Project Manager.

All contractor-provided hardware shall be the highest-quality stainless steel or galvanized. Antenna brackets shall be Andrews/Decibel Products models or engineer-approved equal.

Cable Support Structures

The City shall provide all indoor and outdoor cable support structures unless otherwise noted. This includes cable trays, ladders and "Unistrut" where application. However, contractor is required to provide cable support and standoff brackets, etc., as applicable, which will mount to City-provided supports. All contractor-provided hardware shall be the highest-quality stainless steel or galvanized. Hardware shall be Andrews/Decibel Products models or engineer-approved equal.

Fire Station 1 Tower Antenna System

- A. The contractor shall supply and install all antennas, mounting brackets and hardware, transmission lines, connectors, TVSS devices and other hardware on the new FS#1

- tower. Specific models are listed in Technical Appendix, Exhibit 3, the FS#1 Tower Construction List. The tower and conduit will be installed by others.
- B. Transmission line TVSS devices will be Polyphaser models or approved equal. Device models are listed in the Exhibits.
 - C. Two Polyphaser CU-SPGP Copper Single Point Ground Panels or approved equivalent will be supplied and installed in the Equipment Room. Alternate methods of grounding the TVSS devices may be proposed.
 - D. All UHF and VHF antennas will be secured to the tower using galvanized or stainless steel hardware. The antennas will be offset from the tower face by no more than 6 feet and no less than 3 feet. The antennas will be attached to locate the feed connector at the elevation listed on the Tower Construction List. The antennas will be oriented in the direction indicated on the Tower Construction List.
 - E. Each transmission line and waveguide will be grounded at the antenna end and at the bottom of the tower. The grounding kits will be Andrew type 241088 or equal. The ground kits at the antenna end will be attached to one of the tower members or legs through a clamp. The ground kits at the bottom end will be attached to the ground bar at the bottom of the tower.
 - F. The transmission lines in the Equipment Room will be terminated in similar (male or female) N-type connectors. Cables will terminate on the TVSS devices listed in the Tower Construction List.
 - G. Each TVSS device will be mounted to one of two Polyphaser CU-SPGP ground panels. These panels will be wall-mounted above the conduit stub-outs, at approximately 4 feet above the floor. Each panel will be separately grounded to the ground buss bar will using the copper straps supplied with the ground panel.
 - H. The antenna end of the transmission lines will be terminated in a suitable connector. All transmission line connectors will be type 'N', except as dictated by the connector supplied with antennas.
 - I. Short jumper cables (~36") will be used to interconnect the antenna(s) to the top end of the transmission line. Jumper cables will be installed with some service slack.
 - J. The installer will exercise great care to avoid damage to the transmission lines and waveguide during installation and termination. Any damage to the transmission lines during installation will result in the line being removed and replaced.
 - K. Installation will conform to the following:
 - The manufacturers' minimum bending radius will not be exceeded during installation.

- All cables will be dressed appropriately, and run parallel to each other.
 - Cable runs will be continuous lengths, unless cable lengths exceed the maximum length supplied by the manufacturer.
 - No coaxial connector adaptors will be used. All connectors will be selected to mate with one another.
 - Multiple cable runs will not be bundled together but rather, will be strung and supported adjacent to each other.
- L. Installers will ensure that each transmission line and antenna is tested and properly documented. Test frequency range will be at least +/- 5% of antenna center frequency. If the test results show any indication of transmission line damage or anomaly, the affected component line will be removed and replaced.
- M. Each end of each transmission line will be fitted with a brass identification tag. These tags will be securely attached to the cable. The tags will be engraved with the antenna model, frequency range, center frequency, height, and azimuth and center frequency return loss (or VSWR) at installation.
- N. The results of the tests will be provided to the Owner for review and approval prior to completion of work. Documents will be provided in printed and electronic form (Adobe PDF). Document will indicate antenna system tested (e.g., TX 1, TX 2, RX1, etc.), test type, and critical test details (e.g., with jumper, terminated with precision load, terminated with open/short, or terminated with antenna).
- O. The following tests will be conducted:
- Test 1 – Jumper Insertion Loss and Return Loss. All jumpers should be physically inspected and tested for return loss and insertion loss. All antenna system jumpers will be tested prior to their installation.
 - Test 2 - Antenna Return Loss. The antenna will be tested for return loss and frequency bandwidth prior to installation.
 - Test 3 – Transmission Line System Insertion Loss (Cable Loss). Insertion loss measurements will be performed on each antenna line (i.e., main transmission line, jumpers, and lightning suppressor). Cable loss is equal to the return loss (dB) of a cable while terminated with an open or short, divided by two.
 - Test 4 – Transmission Line System Return Loss. The return loss of the transmission line system will be measured while it is terminated at the top of the tower with the jumper and a precision load.
 - Test 5 - Complete Antenna System Return Loss. The return loss of the entire antenna system will be measured (lightning suppressor, transmission line, jumper and antenna).

Transmitter Combiners - Repeaters

- A. The selection and design of transmitter combining equipment and arrangements will be the responsibility of the Contractor, but shall comply with the following specifications in this Section.
- B. All combiners shall be cavity-type and be expandable in the future with the simple addition of additional ports (isolator, low-pass filter, cavity and cable) into a common assembly. Each combiner shall be expandable by at least one port at current minimum channel separations without major disruption.
- C. Combiners shall be equipped with RF sample ports for service and maintenance purposes (approximately -40 dBc).
- D. Each combiner port shall be labeled with an identification tag indicating center tune frequency and loss at installation. Labels shall be permanent and not hand written.
- E. South Hill Site UHF: Two three-channel UHF transmitter combiners shall be provided and connected to separate antennas to minimize losses. The spare channel port shall be tuned to the existing PD GREEN channel frequency for use during the transition to the new network (this will allow removal of the existing PD GREEN antenna and minimize interference in the interim).
- F. South Hill Site VHF: A single expandable VHF combiner shall be provided. However, once the combiner and antenna has been installed, the existing non-Public Safety transmitter shall be placed on this combiner to minimize interference at the site.
- G. Isolator loads shall be sized to protect against damage to the associated transmitter (and isolator) in case of a combiner, transmission line or antenna failure that results in 100% reflection of the incident transmitter power from the associated transmitter. Low-pass filters shall be installed following isolators to reduce third-order products.
- H. Interconnections shall use flexible, low-loss cable. Combiners shall be rack-mounted in all cases.
- I. The transmitter combiner technical specifications are:

Frequency range	150-174 MHz / 450-470 MHz
Minimum isolation, Tx-Tx	64 dB
Minimum isolation, Ant-Tx	50 dB
Maximum insertion loss, per channel	3.0 dB
Maximum continuous power input, per channel	125 W (minimum)
Input impedance	50 Ohms
Maximum input VSWR, all ports	1.25:1
Minimum channel separation	As determined by planned frequencies
Temperature range	-30 to +60 C
Connectors	Type N female

Receiver Multicouplers

- A. The selection and design of receiver multicoupling equipment and arrangements will be the responsibility of the contractor, but shall comply with the following specifications in this Section.
- B. Multicoupler systems shall be designed to limit receiver degradation from City or other collocated transmitters to no greater than 1 dB. The contractor may be required to supply additional band-pass filters to reduce interference from nearby transmitters.
- C. Multicouplers shall be supplied with at least one unused (spare) port, terminated in a 50-Ohm load.
- D. Interconnections shall use flexible, low-loss, hard-line-type cable.
- E. The multi-coupler shall have a visual power supply failure alarm indicator.
- F. The multicoupler technical specifications are as follows:

Frequency range	150-174 MHz & 450-470 MHz
Power requirement	DC
Maximum system noise figure, including bandpass filter(s)	5.0 dB
3rd-order intercept point	+42 dBm
Minimum 1 dB compression point	+21 dBm
Minimum system gain	1.0 dB
Minimum Rx-Rx isolation	20 dB
Absolute intermodulation suppression	-120 dBm, with two -35 dBm input signals
Temperature range	-30 to +60 C
Impedance	50 Ohms
Antenna input Received output connector	Type N female
Maximum input/output VSWR	1.5:1

Duplexers

All required station duplexers shall be band-pass type and equipped with N-type connectors. All stations equipped with duplexers shall also be equipped with dual-stage isolators and low-pass filters on the transmitter inputs. Load shall be sized to dissipate 100% reflected power without damage.

Combiners or multicouplers equipped with duplexers do not require isolators or low-pass filters.

GPS Receiver Antennas

Antennas for GPS receivers (if required) and antenna mounting arrangements shall be determined by the contractor and coordinated with City Project Manager. Installation, cable and grounding shall conform to the overall requirements for station antennas.

System Time Clock

The contractor shall configure all provided subsystems and devices to operate using a common, redundant network timeserver (provided by the City; NTP or NTP2 protocol), which will provide a single source “fixed time” standard. The timeserver will be a Spectracom NetClock® Time Server (Model 9383). This includes the following major subsystems and components:

- A. Radio system components
- B. Dispatch Workstation sub-system
- C. System Management Workstations
- D. Interconnection sub-system (multiplexers and/or routers, managed switches)

Proposer shall describe how all components are synchronized.

Backup Power Systems

All essential site equipment shall be powered by a DC battery power supply furnished by the Contractor. Systems shall include batteries, battery racks, float-type battery chargers, DC load centers and rack distribution/fuse panels. A battery backup system is not required at Fire Station 1, as a City-provided UPS will support this site.

48 VDC systems are preferred unless a significant portion of equipment is not capable of this supply voltage. All power systems shall utilize the same voltage. Battery system shall provide the following run times following loss of commercial or generator power. Duty-cycles represent percent of time for maximum current consumption and do not include quiescent (standby) periods. Quiescent periods must be considered in overall run time.

Table 10 – Backup Power Run Times

<i>Site</i>	<i>Required Run Time</i>	<i>Load Assumptions</i>	<i>Load Duty Cycle</i>
South Hill	4 hours	Voice stations Other equipment	30% 100%
Fire Station 2	2 hours	Receivers Voice Stations TRANS2 Other equipment	100% 30% 100%
Fire Station 3	2 hours	Receivers Voice Stations TRANS3 Other equipment	100% 30% 100%
919 Palm	2 hours	Voice stations Other equipment	30% 100%

Equipment Housing

All fixed-site radio equipment shall be mounted in EIA-standard, 19-inch, open-faced racks, with accessibility to both the front and rear. Back-up power racks may be 23". The mounting racks shall have durable corrosion-resistant finishes, shall be earthquake-braced for Seismic Zone 4, and shall be separately grounded to the equipment room ground system.

Section 2. RADIO SYSTEM PERFORMANCE REQUIREMENTS

This Section describes system performance requirements for the new radio networks or specific subsystems. The acceptance test procedures required to demonstrate compliance with the performance requirements here are contained in other Sections of the Specification.

Radio Coverage

- A. The City has selected repeater and receiver sites based on experience of reliable performance with regard to signal strength and building penetration. The Contractor shall be responsible for meeting a communications reliability level specified herein at 95% of locations served by the proposed sites, in narrowband digital mode.
- B. At the City's Option, this will be confirmed through outdoor signal strength measurements (to ensure enough margin exists for predicted indoor coverage) and BER measurements (for overall outdoor coverage and simulcast overlap). The contractor shall be contractually bound to meet this requirement in the areas shown on their submittals.
- C. The contractor shall be responsible for the actual effectiveness of propagation coverage of the radio system, including both the voice quality and the signal level achieved. Contractors shall submit verifiable coverage prediction maps showing anticipated coverage performance given the sites proposed herein.
- D. The required City Service coverage areas are shown in the Appendix. All areas should be combined and treated as one contiguous area. A geo-coded form is also available from the City upon request.

Radio Site Selection

The Proposal shall include all proposed primary conventional radio sites, including the new transmitters defined in Special Operation Requirements TRANS3 and TRANS2.

Basis of Coverage Design

The above goal is based on the following design criteria:

1. Transmit powers and receiver sensitivity as described in the Specifications
2. Delivered Audio Quality (DAQ) of 3.4, equivalent to a Bit Error Rate (BER) of 2%.
3. DAQ criterion of 3.4 is described in TSB-88B as "Speech understandable with repetition only rarely required. Some Noise/Distortion." The above criteria conform to the approach described in the most recent version of TIA TSB-88B, Wireless Communications Systems; Performance in Noise and Interference – Limited Situations; Recommended Methods for Technology – Independent Modeling, Simulation and Verification.
4. UHF (450-470 MHz) coverage predictions are based on the following:

- Indoor coverage assumed using – 8dB for residential/light industrial structure attenuation
 - Vehicle-mounted mobile radio with a -1 dBd gain antenna at 6 feet AGL
 - Portable radio mounted at the user's waist level (3' AGL), with a helical antenna (–17.2 dB median body plus antenna loss).
5. VHF (150-174 MHz) coverage predictions are based on the following:
- Indoor coverage assumed using – 12dB for residential/light industrial structure attenuation
 - Vehicle-mounted mobile radio with a -1 dBd gain antenna at 6 feet AGL
 - Portable radio mounted at the user's head level (6' AGL), with a helical antenna (– 11.3 dB median body plus antenna loss).

Link Budget Analysis

- A. Service coverage maps shall be provided for the following, for both bands:
- Mobile radio talk-in
 - Mobile radio talk-out
 - Portable radio talk-in
 - Portable radio talk-out
- B. Maps shall be based on 95% reliability and use the lowest tier equipment proposed by the contractor, using the antennas and conditions specified herein.
- C. The contractor shall indicate if their assumptions differ from those specified in the Basis of Coverage Design section above.
- D. Coverage maps shall be provided using City's desired Coverage Area boundary.

Radio System Availability

This section identifies the equipment and functions required for the City radio system to be considered available.

The City radio system shall include any and all equipment and subsystems provided by the contractors, regardless of manufacturer. It shall not include reused equipment, or equipment of facilities that the City provides to the contractor (i.e., City fiber, shelters, commercial and City-provided backup power).

The City radio system shall have a total calculated availability, including functional availability and hardware availability of 99.5%. That is, the ratio of system availability over the total measurement period shall be equal to or greater than 0.995.

System Unavailability

Unavailability is defined as the cumulative sum of all of the following:

- A. One or more channels are functionally inoperative.

- B. One or more dispatch workstations lose access to more than 10% of conventional channels (channels provided by the contractor).
- C. Condition of local repeater fallback operation.
- D. Greater than 5% of mobiles, 5% of portables or 5% of control stations become functionally inoperative.

The contractor shall propose an adequate but accelerated measurement period that will demonstrate conformance with this requirement.

Nuisance Malfunctions and Failures

Nuisance problems are recurring operational or functional problems that cause systems or equipment not to provide the degree of reliability necessary for City operations, or cause the City to assign significant resources (City or outside contractor staff) to resolve on three or more occasions, on similar models of equipment. Such problems may not reach the unavailability threshold described earlier.

Such problems can be caused by software, firmware, or hardware that is faulty or improperly engineered, or manufactured.

Contractor shall be responsible for resolving such problems promptly in a jointly agreeable manner. Such problems will be considered as part of the basis for final contractor payment.

Interference

The contractor shall be responsible for basic diagnosis of all interference that degrades the performance of its own or others equipment. The contractor shall be responsible for its resolution if the equipment supplied under this contract is found to be the source of such interference. If the contractor's equipment is limited to contributing to such interference, the contractor shall assist with identifying the source of its contribution and make all necessary changes or modifications to reduce its susceptibility and impact.

Interference in this case is defined as a degradation of effective receiver performance by 1 dB or greater. Interference includes Passive Intermodulation (PIM) interference, which must be kept 10 dB below the noise floor of all co-located receivers.

Section 3. DISPATCH WORKSTATIONS

It is the intent of this section to describe a state-of-the-art color-display-based radio communications workstation that is user friendly, which will incorporate radio, signaling and other ancillary functions and controls in a manner that will provide simple and efficient operation to the dispatchers.

General

The new radio control equipment will include nine (9) identical workstations, with the capability of expanding to an additional 3 workstations in the future. All workstations shall be installed in the new Dispatch Center located on Fire Station 1 property. Workstations shall be functionally identical.

The City's goal is to have all CPU's located in the Dispatch Center Equipment Room to reduce space, heat load and noise. The contractor shall propose such an arrangement unless a major workstation redesign becomes necessary.

Central electronics shall be installed in the Dispatch Center Equipment Room. The City shall provide floor space for rack-mounted equipment and cable raceways, ladder rack or conduits necessary to connect workstations to the central electronics.

The City shall provide 120 VAC backup power supplied from a UPS and generator.

Auxiliary radio equipment associated with the dispatch workstation system is more completely described in Section 3, City Radio System.

Workstation Features

- A. Workstations will be PC-based utilizing a 19-inch (diagonal measurement) or larger, full color LCD screen, with operator functions that can be controlled by either a touch-screen or by a mouse. QWERTY keyboard control shall be optional. Use of Blade PC's is strongly desired.
- B. The following table describes the current channel designations on the existing workstations. New workstations shall be capable of these channels plus a 50% overall growth in the number of channel resources. Actual assignment shall be made later in the project.

<i>Police Channels</i>	<i>Fire Channels</i>	<i>City Services Channels</i>
<ul style="list-style-type: none">• PD Green• PD TAC• CO RED• SO Yellow• PD White (CLEMARS)• Orange Net• Sheriff Blue (rec.-only)• CHP (rec. only)	<ul style="list-style-type: none">• SLOFD (City Net)• CTTAC (City TAC)• County Net• State White Fire 1• OES Fire• MEDCOM (rec. only)	<ul style="list-style-type: none">• Public Works

- C. New workstations shall be capable of the following functions including a 25% growth:

Auxiliary Radio Controls

- Primary FD repeater on
- Back-up FD Repeater
- Primary PW repeater on
- Back-up PW Repeater
- Marker (Code 33) Signal
- Alert “3” Signal
- 3 other misc. alert tones

Paging / Alerting Controls

- Pagers
- Fire Station 1
- Fire Station 2
- Fire Station 3
- Fire Station 4
- All-Call
- Cal Fire

Paging (cont.)

- Cuesta On
- Cuesta Off

Other Controls:

- Gate Enter
- Gate Exit
- Gate Power
- Traffic Signal
- 32 other misc. inputs and outputs

D. New workstation auxiliary controls shall be capable of the following:

1. Inputs must be configurable for momentary and latching.
2. Inputs must be configurable to sound an alarm and display a message on the LCD at specific position(s)
3. Outputs shall be capable of Form A, B & C type operation.

E. Contractors shall provide a site license for all positions, resources, and features

F. Each radio control position will be PC-based with common Central Control Electronics (CCE). The minimum acceptable workstation will include:

1. The processor shall be Intel or AMD processor or equivalent operating at or above 3 GHz with Microsoft Windows XP Professional; more advanced processors are acceptable; more advanced operating systems will be considered. The operating software for the workstations shall be supported by its manufacture at time of system delivery.
2. FAT32 or NTFS file system
3. 2 GB of RAM, expandable to 4 GB
4. 250 GB SATA hard disk drive, floppy disk drive; CDRW/DVD-W, 44X
5. One serial, four USB 2.0 ports
6. 100MB/1GB Ethernet Network interface Card
7. DVI and VGA analog outputs
8. LCD monitor, 19-inch (diagonal) viewing area, 0.25 mm (min.) dot pitch; video monitor must have an anti-reflective coating, low radiation, emission and energy characteristics; tilt and swivel base
9. LCD must be fully compliant with ANSI standards
10. Radio control boot-up time shall not exceed 90 seconds; time shall be measured from the PC power turn-on until the radio control software is available for use by the operator.

11. Operating system shall be capable of receiving a network-based halt and shutdown command issued from a central backup power system. Contractor shall work with the backup power provider to install, configure and test this functionality.
 12. BIOS and motherboard shall be capable of automatically restarting (powering-up) after an unplanned, or forced shutdown by a remote backup power system.
- G. Radio workstations shall be equipped with separate and independent radio and telephone volume controls for each headset (total of 4 controls per position). Telephone talk-out mute will be automatic when transmitting on the radio.
 - H. A heavy-duty, non-skid dual foot switch with a non-skid base for monitor and PTT shall be provided.
 - I. Zone public-address capability shall be provided on each position to the following locations. Contractor shall provide balanced, line-level outputs in the Dispatch Center Equipment Room.
 1. Fire Station 1 (three separate zones plus all zones)
 2. 1042 Walnut, Police Dept. (two separate zones plus all zones)
 3. 1016 Walnut (two separate zones plus all zones)

Central Control Electronics (CCE) Design

The proposed central electronics shall be equipped for the following:

- A. Common mounting hardware, software and firmware, with provision for expansion to twelve positions in the future.
- B. A communications port, which will provide complete testing and diagnostics of audio paths to and from the system central controller, through a laptop PC (not provided). This includes:
 1. Listing of all alarms over a 24-hour period, categorized by major and minor alarm
 2. Current status of all interconnected or subordinate systems
- C. All radio control programming shall be performed via a laptop PC or via a position. Radio control programming data shall be stored on non-volatile storage devices, and shall not require PROM or EPROM replacement for changes made to the basic operational features. Programming of the central electronics equipment shall not disable or degrade any radio control position.
- D. The proposed workstations shall utilize an integral 100BaseT Ethernet LAN to convey all voice and signaling information among each other, and with the central electronics equipment. Voice signaling may utilize TCP/IP or UDP type protocols on the LAN.
- E. The 100BaseT LAN shall permit software and screen updates to be configured from any position, or from the CCE. Two spare Ethernet ports shall be provided near the CCE for connection to a laptop.
- F. Workstations shall be capable of relocation anywhere on the Workstation LAN without the need for additional audio and signaling cables or other connectivity, for full operation. This will permit the City to place workstations anywhere at a future time if the Workstation LAN is extended elsewhere (City responsibility).

- G. Voice and signaling interfaces to communications networks and auxiliary radio equipment shall be digital unless interfacing to existing or contractor-provided analog equipment.
- H. Interconnection of the central electronics to leased telephone lines or other media shall be accomplished through standard 66-type punch-down blocks and bridging clips, to enable technicians to isolate each sub-system for troubleshooting.
- I. Audio output to the logging recorder shall not contain control tones. The sum of all noise shall be 40dB below the average audio level.
- J. Voice truncation, between the dispatcher's operation of the PTT switch, and audio output from a field radio unit, and between a radio unit keying the microphone and audio output at the dispatcher position, shall not exceed 400 milliseconds.
- K. The system shall allow operating parameters, including those for paging, to be programmed or reconfigured from a remote location on the City's LAN, using a password, through Ethernet equipped personal computer (PC).
- L. System must be sufficiently redundant that there is no single point of failure.
- M. System logging will be to a log file that automatically archives old logs based on file size and/or date. Log files shall be printable by a designated supervisor's workstation. Log write errors shall result in a visual and audible alarm to the workstations. Contractors shall describe size constraints on log files and how they can be automatically archived.
- N. All base station interfaces shall utilize tone remote controls with standard tone keying protocols commonly in use by Motorola or Tyco. The workstations shall be capable of operation with the Contractor's latest digital radio system offerings.

Operational Features

Each proposed dispatch radio control shall be equipped with the following features:

- A. All workstations shall provide an alert tone generator with multiple tone combinations, and associated momentary switch depiction for urgent messages.
- B. Failure of a hard disk drive shall not affect the operation of the system, its screens, or any active configuration files.
- C. Workstation channel icons shall be capable of displaying eight-character, user "aliases" derived from emergency button activation from field units and from PTT-ID. Up to 24 aliases shall be stored in history for immediate access.
- D. Capability for full-duplex operation between dispatcher and radio units shall be provided, with dispatcher priority.
- E. A restricted channel-alerting marker (Code 33) tone shall be provided which will automatically send a tone (or digital equivalent) on any combination of channels at a programmable interval and duration during events requiring restricted channel use. The interval shall be adjustable from one second to ten seconds; the duration adjustable from 250 milliseconds to two seconds; the frequency of the tone adjustable from 700 to 1,000 Hz. Enabling and disabling the tone shall be performed with a single-action from the screen display. A flashing icon or screen depiction shall indicate an enabled and active status. The dispatcher or mobile/portable user shall immediately override and disable the tone during

transmission. All dispatchers and field units shall have priority over this tone under all conditions.

- F. An inter-position intercom shall be provided that allows selective calling between all positions within a dispatch center. The intercom shall include provision to interconnect other future remote locations on the Workstation LAN.
- G. Each radio control position shall provide the following functions or displays as a minimum requirement:
 - 1. A 24-hour digital clock
 - 2. A digital or analog VU meter
 - 3. Separate select, unselect and monitor speakers and volume controls
 - 4. An electronic transmit interlock so that no more than one dispatcher can simultaneously transmit on a channel
 - 5. Automatic muting between headsets having the same channel selected
 - 6. Upon depressing any PTT, the transmitted telephone audio shall be muted not less than 60 dB.
 - 7. Display icons or screen depictions to indicate PTT, COS/Busy, Enable/Disable, and all other utility functions
 - 8. An output to record headset audio (transmit and receive) of each position
 - 9. Selectable muting or reduction in volume levels of select, unselect and monitor speakers during a PTT
 - 10. "Select", "Unselect" and monitor controls for the selection or de-selection of audio channels
 - 11. "Instant Transmit" control providing instant push-to-talk capability for the selected, unselected and monitor audio channel
 - 12. "Volume Control" indicator for each audio channel
 - 13. "Selected Site" indicator for each audio channel will display the site selection of inbound audio traffic.
 - 14. "Mute" control to mute any channel
- H. A "simul-select" or "all-call" function shall be provided to enable a dispatcher to simultaneously transmit on any combination of channels. The all-call initiator's PTT shall override all other radio control PTTs.
- I. A "patching" function shall be provided to enable a dispatcher to patch any combination of channels. A "macro" function shall allow the selection of preset choices through a single icon. Patches between radio channels or talkgroups shall not employ VOX circuits to activate PTTs. PTTs shall be driven from the opposing channel's COS signal, or other fast-switching circuit(s). Patched channels shall meet maximum delay requirements specified in Central Control Electronics (CCE) Design above.

- J. An internal adjustable "squelch" or muting control shall be provided to reduce background noise of idle channels and amplifier "white-noise" in each headset and speaker. Muting shall reduce noise to a minimum of 60 dB below reference level.
- K. An adjustable compression point for transmit audio on each position shall be provided. Expansion of audio during pauses in speech shall not cause a perceptible increase in background noise.
- L. A single-action mute control for each unselected channel shall be provided. Muting a specific channel from one position shall not mute the same channel at other radio control positions.
- M. Each channel shall be equipped with an adjustable threshold control at which the (carrier-operated-switch) COS/BUSY display that will light, or unmute received audio.
- N. All positions will be capable of accessing the building's public address system.
- O. The contractor's radio workstation shall come with an instant recall recorder function.
- P. If the offering does not come with an existing instant recall recorder, provisions to control an existing City GUI-based digital instant-recall recorder (Plant CML Vesta) shall be an integral part of each radio control. It shall have the following features:
 - 1. Capable of three separate audio channels
 - 2. Capable of simultaneous record and playback
 - 3. Controls shall be integrated into the radio control panel
 - 4. Recorder status shall be displayed on the LCD
 - 5. It shall be possible to route the playback audio to the selected, unselected, monitor or a dedicated recorder speaker
 - 6. Time stamped messages
 - 7. Capable of controlling this function on a per-position basis.

Headsets

Both wired and wireless headset access shall be provided for each supplied position.

- A. A single spare headset jack shall be provided at each radio control position, which will be used as backup. Jacks shall be standard dual 1/4" types (RJ-327 type plug). Insertion of a headset plug into a jack shall automatically mute the select speaker at that position. A manual override for this feature shall be provided. Workstations shall have a technician-adjustable side-tone level. Headsets shall operate primarily with radio and intercom systems as selected by the dispatcher and with telephone systems based on off-hook status of the associated telephone instrument.
- B. Headset jacks shall function as 6-wire, with capability of push-to-talk on the headset cord. They shall be also compatible with a 4-wire headset.
- C. Each position will be equipped with a wireless headset adaptor or base station. This will allow the City to eliminate the headset cords and provide better mobility in the dispatch

center and surrounding area. Each position will operate independently, using a different channel or code.

- D. Twenty (20) wireless headsets shall be provided.
- E. Headset base stations and headset shall have the following features:
 - 1. Rechargeable batteries with a run time of 12 hours (minimum)
 - 2. Multiple charging stations shall be provided; charging stations shall be rapid-charge models providing a 90% or greater charge in less than one hour;
 - 3. Each headset shall be equipped with a microphone mute (momentary and selectable on-off) and a momentary PTT switch.
 - 4. Each headset shall be equipped with a locking phone “on-hook” and “off-hook” switch.
 - 5. Headsets and base stations shall be capable of full-duplex operation, and shall provide the same features and functions of the current wired headsets.
 - 6. Voice and signaling transmissions shall be secure and not readily decoded by common equipment.
 - 7. Belt-mounted transceivers shall be equipped with a headset socket to allow removal of the headset. It is desirable that belt-mounted units be capable of using any manufacturers headset,
 - 8. Each base station shall be capable of supporting two simultaneous headsets (one for dispatcher and one for trainee). One headset shall act as master, and be able to override the other (supervisory override).
 - 9. Base stations and belt-mounted transceivers shall be extremely durable and designed for full-time (24/7/365) use.
 - 10. Base stations and belt-mounted transceivers shall be capable of operation on up to twelve different channels or codes, which are selectable through programming or switches.
 - 11. Base stations and rechargers shall be connected to backup power (provided by City).
 - 12. Up to twelve units must be simultaneously operational without causing mutual-interference.
 - 13. It is desired that units be radio-frequency based as opposed to optical to provide non-line-of-sight performance.

Paging/Signaling Encoder Functions

Workstations shall be equipped with internal paging/signaling encoders with the following features and functions:

- A. Encoder functions shall be accessible from the LCD display through dedicated single-button actuator graphics.
- B. Each radio control position shall have independent paging-tone synthesizers.

- C. The encoder equipment must be capable of a minimum of the following formats, but only programmed for those currently in use:
1. All common industry individual and group codes, and code plans, including 4-digit entry plans using A, B, C, and D keys (1+1)
 2. All industry standard individual and group.
 3. All industry standard 5/6 tone code plans including USA/EIA, CCIR, EEA, ZVEI and others.
 4. All 16 DTMF tone pairs, with up to 12-digit store and forward operation, with programmable tone duration and inter-tone gap length.
 5. 1500 Hz and 2805 Hz digital dial interrupter at 10 pps or 20 pps under program control, with up to 12-digit store and forward operation.
 6. Mnemonic paging shall permit the use of custom tone plans, tone timing and custom access codes for the existing PLECTRON tone plan, including warbles.
 7. Current paging formats in use are:
 - DTMF
 - Motorola Quick Call II
- D. Encoders shall permit at least four (4) individual calls to be chained together using one access code entry.
- E. Encoders shall permit at least four (4) individual calls to be entered as a stack for a single command transmission in the sequence in which they were entered.
- F. Encoder keys shall provide the following:
1. A SEND key that permits any number of paging keys to be stacked in a queue, then transmitted as a group
 2. A CLEAR key to empty the stack queue without sending the pages
 3. An ABORT key to instantly terminate transmission of the paging stack.
- G. Encoders shall permit either priority single-button pages to be instantly transmitted without disturbing the stack queue, or instant transmission of single-button pages without the use of a STACK or SEND function.
- H. Any page or individual pages, within a stack or chained sequence, shall be automatically directed to a predetermined transmission path under program control. This includes specific sites, frequencies, or CTCSS operation
- I. Workstations shall support up to 255 single button switch graphics. Each page graphic shall permit channeling of up to sixteen (16) dispatcher-programmable individual or group calls, or an unlimited number of preprogrammed calls.
- J. Encoders shall have a level of redundancy consistent with the number of console positions and radio paging channels in the system. Any CCE card having control of paging for more than one console position or radio channel shall include a "hot standby" capable of

automatically assuming all functions without operator intervention in the event of failure of the primary control card.

- K. Encoders shall be equipped with an RS232C I/O port for future interface to a Computer Aided Dispatch (CAD) system. The encoder shall be capable of accepting page initiation commands from the CAD system and sending page acknowledgment to the CAD system.
- L. Paging activity shall be logged and available as a text file through the dispatch center workstations. Files shall be automatically archived for a period of time, and eventually deleted by the workstation system.
- M. The CCE shall provide a field-programming tone generator and a Project 25 digital test sequence for special applications. Tone frequency (60 Hz to 4 kHz), delay and duration shall be programmable.

Maintenance Features

Dispatch workstations shall be equipped with the following maintenance features:

- A. An internal 1004 Hz test-tone generator and Project 25 test sequence for trouble-shooting and alignment
- B. Test points for each audio and data line from the central electronics to the specific radio control position
- C. Interrogation of system alarms or operations at one position shall not interrupt operations at any other position
- D. Automatic diagnostics function, with problem reporting in plain text to the designated supervisor's workstation.
- E. System shall provide in electronic file or a diagnostic output (for a terminal and/or printer) that reports all service interruptions and failures relevant to system/console/channel/talk group operation. All messages shall be in plain text for easy troubleshooting.
- F. Capability to automatically send an alphanumeric pager message to a service interruption to a technician.

Management Software for Radio Control Positions

Contractors shall propose costs for an advanced management tool that would provide:

- A. Airtime & call count statistics, by position and operator – maintain 18 months of archived records of airtime and call counts, by operator ID, summed in one-hour bins (for workload calculations)
- B. Per dispatcher log-on statistics – such as the time the dispatcher logged on and off the system
- C. Capability to archive, and generate reports against archived data
- D. Raw text airtime data output (capable of being imported into Microsoft Access and/or Excel) for special analysis purposes.

Radio Control Redundancy

- A. Radio control positions shall continue to provide basic transmit and receive functions during a server failure.
- B. Position PC shall boot and provide basic transmit and receive functions during a server failure.
- C. No single point of failure shall exist in the system.
- D. System shall be able to with stand multiple failures and continue to operate.

Future Interconnection to CAD and Workstation Systems

It is desired that the proposed workstations be capable of sending routine and emergency button IDs to an external CAD system for association and display of a user's ID. The controls should also accept the user's alias text from the department's CAD database. (The CAD database contains all current vehicle associations, and could contain portable radio information in the future; some City users are assigned personal portable radios, while others share radios).

The City is aware that an additional CAD software module may be required to support this feature in the future. Contractors shall disclose their ability to interface their workstations to an existing CAD system, and the necessary software or hardware. A software development kit shall be supplied for this.

Miscellaneous Features and Functions

- A. The time-of-day display on the radio control must be synchronized to other systems in the center. These were specified in Section 3, System Time Clock.
- B. Workstations shall indicate the voted site selection for PD GREEN and SLOFD channels.
- C. CCE equipment racks shall meet seismic requirements for Earthquake Zone 4.

Reliability & Diagnostics Features

Due to the critical nature of the communications services provided, a high degree of reliability from the radio workstation is required. The workstation, to the greatest extent possible, shall:

- A. Be self-healing such that critical components and devices are redundant and backed- up using modern methods.
- B. Provide continuous and automatic self-testing and diagnosis via event logger software and printouts.
- C. Provide an alert to all workstation operators in the event of component or sub-system failure.
- D. Allow continued operation in the event of failure of a workstation sub-system, through isolation of the defective sub-system.
- E. Provide a high degree of modularity to reduce the number of sub-systems affected by a single component failure.
- F. If continued workstation operation is possible after the failure of a defective sub-system, repair of the sub-systems shall be possible without totally disabling the workstation. Removal and/or replacement of the circuit cards of the common-workstation electronics equipment from their housing shall be possible while under power.

- G. Provide two Ethernet ports at the common-electronic equipment assembly, which can be interfaced with a local and/or remote personal computer for events such as reprogramming workstation parameters, system monitoring, identifying sub-system failures, capturing system use data and for making service related inquiries.
- H. Provide one Ethernet 100Base-T network port so that a password protected PC can be used to reprogram workstation parameters, monitor the workstation sub-system for errors or normal operation, for identifying sub-system failures, capturing system use-data and for making service related inquiries.

Management Features

- A. The workstation shall be equipped to produce usage activity information and data to be used to generate reports.
- B. Captured activity data shall be able to be queried or sorted by operator position, channel, time, type of event, etc.
- C. The information and data shall include, at a minimum, the following:
 - 1. Each event time and date stamped.
 - 2. Number of transmissions per position.
 - 3. Number of transmissions per channel or talkgroup, per hour.
 - 4. Total transmission time per position.
 - 5. Total transmission time per channel or talkgroup.
 - 6. Total receive time per position.
 - 7. Total receive time per channel or talkgroup, in one-hour increments.

Power

- A. The equipment shall operate primarily from an external City-provided Commercial power source with UPS and generator backup. This source is a nominal 120 VAC at 60 Hz, single phase.
- B. Power losses, restorations, surges, sags and/or brownouts shall not alter the system software and/or operating parameters. Other than total power loss or lethal surges, the workstation shall remain operational while experiencing any of these occurrences within the specifications of its design.
- C. The power sub-system of the common-workstation electronics equipment shall consist of hot-standby power supplies or hot-parallel power supplies.
- D. Transition from the primary to the standby power supply shall not cause the workstations to lose and/or reset any of its functional and/or operational capabilities.
- E. Failure of one of the power supplies shall not cause the workstations to lose and/or reset any of its functional and/or operational capabilities.

- F. All workstation operators shall be alerted of the transition to the standby power supply and shall be alerted of the failure of the hot standby power supply when the primary power supply is in use.

Instant Recall Recorder (IRR)

Contractor shall supply a GUI-based IRR to support all radio communications audio at each operator position. Both transmit and receive audio shall be recorded for instant recall. This may be integral to the dispatch workstation application software.

PTT ID/Emergency Display

- A. The workstation shall be equipped to display the PTT ID and emergency PTT ID of all properly equipped mobile and portable radio units.
- B. All operator positions shall be equipped to display the IDs on the display screen.
- C. The screen shall be equipped to display the ID with numeric, alphanumeric or a combination of numeric and alphanumeric characters.

Logging Recorder Interface

- A. The common-workstation electronics equipment shall provide multiple independent audio outputs suitable for connection to an existing logging recorder.
- B. The outputs shall supply audio from all conventional radio channels controlled by the workstation to the logging recorder. A common transmit and receive audio source shall be provided.
- C. The common-workstation electronics equipment audio outputs shall filter guard and function tones associated with tone remote controlled conventional base stations.
- D. The successful contractor shall furnish and install all audio couplers, impedance matching devices, signal level boosters, cabling and connectors as necessary for a complete and fully functional interface between the common-workstation electronics equipment and the logging recorder.

Section 4. INTERCONNECT SYSTEMS

This Section includes the requirements for furnishing multiplex or LAN equipment that utilizes existing City fiber infrastructure. While several leased T1 lines exist and are in use today, it is the City’s desire that the contractor utilize existing City-owned fiber.

Existing Systems

The following interconnect systems are currently in use.

Table 11. - City Leased Circuits

<i>From</i>	<i>To</i>	<i>Qty.</i>	<i>Service Type</i>
Police Department	955 Morro	1	Two-wire analog
	990 Palm	1	Two-wire analog
	25 Prado	1	Two-wire analog
	1260 Chorro	1	Two-wire analog

The City has completed installation of single-mode fiber to most all City-owned facilities. A routing diagram is not currently available. Fiber to be used as part of the current project is shown below.

Table 12. - South Hill<>Fire Station 2 Fiber

Distance:	25,370 feet
Fiber type:	Single-mode
Optical loss @ 1310 nm:	-3.5 dB (measured)
Fiber manufacturer and model:	Corning/Secor Dri-Flex #91545
Count and type:	Loose Tube Fiber; 168 count armor - Leaf Fiber
Termination type:	S.C. UPC
Splice Type:	Fusion

Table 13.- South Hill<>Fire Station 3 Fiber

Distance:	9,680 feet
Fiber type:	Single-mode
Optical loss @ 1310 nm:	-1.9 dB (measured)
Fiber manufacturer and model:	Corning/Secor Dri-Flex #91545
Count and type:	Loose Tube Fiber; 168 count armor - Leaf Fiber
Termination type:	S.C. UPC
Splice Type:	Fusion

Table 14.- South Hill<>Fire Station 1 Fiber

Distance:	8,032 feet
Fiber type:	Single-mode
Optical loss @ 1310 nm:	Unknown
Fiber manufacturer and model:	Corning/Secor Dri-Flex #91545
Count and type:	168 Count Underground; 24 fiber aerial to South Hill.
Termination type:	S.C. UPC
Splice Type:	Fusion

An additional 24-fiber run exists between South Hill and the Corporation Yard (25 Prado) and 919 Palm and Fire Station 1 that shall also be used if needed.

Interconnect Systems

The City desires that all conventional stations communicate via VoIP technology (TCP/IP or UDP-based packets) to the greatest extent possible. This will simplify alignment and troubleshooting and allow transmission over broadband connections if needed in the future. Other signaling should also be broadband-based to the extent possible.

However, contractors are permitted to use traditional multiplex methods to backhaul voice communications and signaling if necessary.

Radio Network Connectivity

The contractor shall utilize existing fiber for the following point-to-point connections for the conventional networks. It is envisioned that either Ethernet switches, or multiplexers will be used to terminate each line:

<i>Fiber Path No.</i>	<i>From</i>	<i>To</i>	<i>Use</i>
A	South Hill	Fire Station 1	Conventional repeaters Maintenance subnet
B	Fire Station 2	Fire Station 1	Conventional receivers Fire Station 2 Transmitter (TRANS2) Maintenance subnet
C	Fire Station 3	Fire Station 1	Conventional receivers Fire Station 3 Transmitter (TRANS3) Maintenance subnet
D	919 Palm	Fire Station 1	Maintenance subnet

Equipment

Broadband Switches and Routers

The City’s network currently runs on Extreme Networks equipment. The City would prefer solutions and/or options that utilize Extreme Networks equipment in order to reduce ongoing spare parts, maintenance, and training costs.

Broadband switches and routers shall be equipped with the following features and functions:

- A. SNMP (Simple Network Management Protocol) and SSH interfaces shall be provided for in-band management.
- B. Trivial File Transfer Protocol (TFTP) for administering software upgrades from a centralized location.
- C. Network Timing Protocol (NTP) to provide accurate and consistent time stamp for all events
- D. Each port shall be equipped with two LEDs for visual indication of the port link status.
- E. All 10BASE-T/100BASE-TX ports port shall be capable of rate auto-sensing and auto-negotiation that automatically selects half- or full-duplex transmission mode to optimize bandwidth on all ports.
- F. Automatic cable type determinations and switching to correct for cable type (straight through vs. crossover) between the attached Ethernet device and switch line pairs.
- G. Equipped for DC power at remote sites (AC power is permissible at the prime site). Redundant DC power supplies shall be provided if failure of this device could cause service interruptions.
- H. Equipment shall be rack-mounted with all critical cables secured and dressed.

Digital Channel Banks

The following shall apply to any multiplex equipment deployed in the network.

- A. PCM channel banks shall be provided at each site to meet the requirements of the channel plan. The use of intelligent channel banks is permitted to achieve the most flexible and cost-effective solution to the City's networking requirements.
- B. The digital channel bank shall operate at the standard DS-1 rate of 1.544 Mb/s with Superframe (SF) or extended Superframe (ESF) format and bipolar (AM1) or B8ZS line coding.
- C. Channel banks shall interface directly to City fiber. Contractor shall provide all cross connects between the City's fiber termination point and their equipment.
- D. Channel bank(s) at the prime site shall be capable of internally cross-connecting individual DS0 circuits across separate T1 lines, or cross-connecting entire T1 lines. Channel Banks shall be capable of grooming and consolidation of partially utilized T1's onto a single T1 for transmission over the ring system (typical multiple spur-to-loop connection).
- E. Termination Units. Proposed multiplex models shall be capable of providing the following interfaces:
 - 1. 10BaseT Ethernet (at reduced bit rate)
 - 2. BRI ISDN S/T or U Interface
 - 3. DS0-DP tandem (DS0 level cross-connect)
 - 4. 9.6 and 56 kb (DDS service)
 - 5. 64 kb, 128 kb, 256, 364 and 768 kb rates

6. Multiple sub-rate per DS0 (RS-422/423 interface @ 1.2, 2.4, 4.8, 9.6, 14.4, 19.2 kb)
 7. 4-wire voice, E&M signaling
 8. FXO (office) end
 9. FXS (subscriber) end
 10. 2- and 4-wire voice, E&M signaling
 11. Private line ringdown
- F. Carrier and Equipment Performance Monitoring - Error Detection and Reporting. The digital channel bank shall continuously monitor the status of all elements or components of the equipment, including loopback testing. The digital channel bank equipment shall generate an alarm in case of a malfunction, and respond to yellow, blue and out-of-frame alarms received on the DS1 span.
- The performance monitoring parameters and thresholds should be provisioned from a local interface or from a remote workstation.
- G. Test Access. Test Access, Loopback function (hard, soft, or both) shall be provided. Metallic test access shall be provided via faceplate mounted bantam jacks. A software configurable option shall be available with the Intelligent Access Multiplexer. The digital channel bank shall have the following maintenance features:
1. Front-panel mounted ACO cutoff switch, front-panel mounted bantam jacks for testing and alignment;
 2. Digital 1-kHz and quiet code sources for channel unit testing or alignment;
 3. Dry, Form-C, relay contracts (rated at 48V dc, 1 amp) for office alarm; local channel loopback;
 4. LED status indicators, such as ACO, power on, power failure, PCM fail, frame loss, and trunk processing. It also processes and displays local alarms and remote alarms.
- H. Loopback. The digital channel bank shall provide the following loopback capabilities:
1. Local Transmit Test Loopback
 2. Local Transmit AIS Loopback
 3. Network Loopback
 4. Channel Unit and CSU Loopbacks
- I. Local Alarm Notification. The digital channel bank shall provide a channel bank control, alarm, and monitor module that can display alarm status and provide the function of control for the equipment configuration. The feature should be built into the line interface unit (LIU). The LIU shall have front-panel LEDs that indicate local and remote alarms. It also shall have dry relay contacts for external audible and visual alarms. The digital channel bank equipment shall have the following trunk port (common equipment) visual indicators:
1. Line Interface Unit (LIU)

2. Frame failure (FRMF)
 3. PCM Failure (PDMF)
 4. Remote Alarm (REM)
 5. Trunk processing (TP)
 6. Alarm Cut Off (ACO)
- J. Internal Oscillator Accuracy. The digital channel bank system internal oscillator accuracy shall be equivalent to a stratum 4 clock.
- K. DC Power Input. The digital channel bank shall operate from DC at remote sites and AC at the Prime site.
- L. Frequency Response Range. Required frequency responses are listed below for 2-wire and 4-wire channel units:

<i>Frequency</i>		Level (dB)	
		<i>XMT</i>	<i>RCV</i>
2-Wire	60 Hz	-20.0 max	
	200 Hz	-3.0 to 0.0	-2.0 to 0.0
	300 to 3000 Hz	-0.5 to + 0.25	-0.5 to +0.25
	3200 Hz	-0.75 to +0.25	-0.75 to +0.25
	3400 Hz	-1.5 to +0.25	-1.5 to +0.25
4-Wire	60 Hz	-14.0 max	
	200 Hz	-2.0 to + .015	-1.0 to +0.15
	300 to 3000 Hz	± 0.15	± 0.15
	3200 Hz	-0.75 to + 0.15	-0.75 to +0.15
	3400 Hz	-1.5 to +0.15	-1.5 to +0.15
	4000Hz	-14 max	-14 max

- L. Idle Channel Noise. Idle channel noise: <20dBrc
- M. Impulse noise. The individual channel units must comply with the following impulse noise requirement:

<u>Threshold</u>	<u>Counts in 30 minutes</u>
41 dBrcO	10
51 dBrcO	1
58 dBrcO	0.1

- N. Signal to distortion. The individual channel units shall comply with the following signal to distortion requirement (C-message weighed):

<u>Input level</u>	<u>Minimum S/D</u>
--------------------	--------------------

0 to -30 dBmO	33 dB
-40 dBmO	27 dB
-45 dBmO	22 dB

- O. Crosstalk. The individual channel units shall comply with the crosstalk requirement of a minimum of 65 dB.
- P. Insertion Loss @ 1000 Hz. Insertion Loss 0 dB min. \pm 1.0 dB. Level deviation measured at 1004 Hz from input levels of -50dBmO to + 3 dBmO.
- Q. Transhybrid Loss. 2-wire Transhybrid Loss (@ 600/900 ohms impedance)

<u>Frequency</u>	<u>Loss (dB)</u>
ERL	\geq 34
SRL	\geq 20

- R. Return Loss. The return loss requirements for the individual channel units shall be in accordance with the following:

Four wire return loss.

4-Wire Return Loss (@ 600 ohms impedance):

<u>Frequency</u>	<u>Return Loss (dB)</u>
1000 Hz	28 min.
300 to 3000 Hz	23 min.

Two wire return loss.

2-wire Return Loss (@ 600/900 ohms impedance):

<u>Frequency</u>	<u>Return Loss (dB)</u>
ERL	28 min.
SRL	20 min.

Electromagnetic Interference

Equipment should be operationally compatible with the following types of equipment located in the same shelter or in a nearby shelter. The system should also be operationally compatible with these facilities located on the same tower.

- A. FDM-FM Microwave
- B. VHF and UHF Base Stations
- C. VHF/UHF/700 MHz/800 MHz Hand-held Radios (operated in shelter)
- D. High Power AM Broadcast Stations

Physical Conditions

- A. Environmental Conditions. Equipment will function properly under the following environmental conditions:

Temperature Range:	0°C to +50°C
Storage:	-40°C to +65°C
Humidity:	5% to 95% non-condensing

B. Equipment Mounting

All equipment shall be installed in 19" EA equipment racks. All racks, supporting hardware, and installation material must meet Zone 4 seismic requirements.

Section 5. MOBILE EQUIPMENT

Mobile radio equipment has been categorized into three type series.

- A. Police models are UHF and shall be capable of Project 25 conventional digital operation, capable (but not equipped with) digital encryption, and equipped with 64 channels. These shall be equipped with remote control heads, remote speakers and microphones. Transceivers shall mount in vehicles trunks or under seats to save space.
- B. Public Works/Utilities series are UHF, front-mount (non-remote) models, where controls and the transceiver are mounted in the front of the vehicle. This equipment is not capable of digital operation or encryption. They shall be equipped with 48 channels.
- C. Fire radios are similar to Police radios, except that they are VHF and analog-only models. They shall be equipped with 256 channels. Other more subtle differences exist and are described in this Specification.

In all cases, the City reserves the right to change equipment quantities, features and even types, if needed

Mobile Radio Equipment

Mobile Radio Technical Features (All Models)

- A. Transmitters and receivers shall be capable of operating on existing 25 kHz channels (20K0 emission designator) and 12.5 kHz channels (11K3 emission designator) through software or firmware changes. No hardware changes shall be required to change between bandwidths.
- B. The receiver selectivity and transmitter voice frequency response, deviation, and transmit power shall be automatically controlled by an internal microprocessor, based on the transmit and receive frequency selection. It shall not be necessary to program these parameters for each radio frequency.
- C. Audio levels of analog wideband and analog narrowband messages heard from radio speakers shall be identical and not vary by channel. No user adjustments shall be necessary when switching between wideband and narrowband channels.
- D. Radios shall employ receiver circuitry to detect dropout of the repeater transmitter, such as digital or continuous tone-coded squelch, with provision of a method ("squelch-tail eliminator") to eliminate the noise burst at the end of transmissions.
- E. Radios shall incorporate carrier squelch as well as EIA standard analog Continuous Tone Controlled Squelch System (CTCSS) and Digital Coded Squelch formats. All radios shall be equipped for "AND" squelch operation.
- F. Radios shall be available in either dash-mount or trunk-mount configurations. In trunk-mount configuration, the control head, speakers, and new microphone clip shall be mounted on the dash, or in a City-provided mobile console.
- G. The radio personality shall be capable of being reprogrammed in the field using a portable computer. The connection shall be accessible without requiring the removal of equipment from its mounting bracket.

- H. Radios shall be capable of conventional repeater operation or talk-around on any of the wideband or narrowband frequencies in the 150-174 MHz or 450-470 MHz land-mobile bands (as appropriate).
- I. Coded squelch encode and decode tones shall be channel-slaved, and the radio shall be capable of operating with encode selections that are different from the receiver decode selections, or having a mix-mode (analog and digital) on a per-channel basis. A monitor switch shall be provided to enable or disable the coded squelch function for maintenance.
- J. Radios shall be housed in rugged cases, with all points of access gasketed and sealed against dust and directed water. No internal ventilation shall be required. Cable connectors shall be securely attached to unit.
- K. Metering and alignment of all essential circuits shall be possible while the radio is installed and operating within the vehicle, and shall be accomplished through software control.
- L. Time-out Timer: A time-out timer shall turn off the transmitter after a time interval (adjustable up to three minutes) of continuous transmit, generate an alert tone on the radio speaker, and reset upon release of the PTT switch.
- M. Primary power to the radio shall use a dedicated cable direct to the battery. Fuses or circuit breakers shall be easy to reach; labeled "RADIO" with the proper replacement fuse amperage identified. Spare fuses for mobile installations shall be provided.
- N. Radios shall not receive, or transmit, ignition noise, alternator whine or other forms of interference. The Contractor shall be responsible to equip radios with noise reducing hardware, and/or redesign installation wiring to eliminate interference problems if they occur.
- O. As the City has exclusive use of its channels, the radio should operate in coded squelch at all times regardless of whether the microphone is off or on the hang-up switch.
- P. The contractor shall provide the City with a radio master list indicating radio model number, serial number, and programming template. This list shall be provided in paper, and in Microsoft Excel.
- Q. Radios and associated control heads shall meet all specifications when operating within 15% of 13.8 VDC, negative ground, and be protected against damage in the event of lead reversal.
- R. Radios and associated control heads shall be capable of "cloning" radio personality (without individual ID numbers) to minimize future reprogramming costs.
- S. PTT ID: Radios shall be capable of individual identification numbers that are transmitted with every PTT.
- T. Mobile radios, including the control heads, and motorcycle types (if any) shall meet Military Specification 810C, 810D, and 810E for high- and low-temperature, shock, vibration, and moisture resistance.
- U. Service and programming software shall operate on Windows XP Professional PC based laptops.
- V. All radio types shall be provided with an ignition sense lead that may be used in cases where high-current power cables need to run directly to vehicles batteries for performance reasons.

- W. Radios shall be equipped with a momentary auxiliary horn-honk relay output that can be individually activated by the dispatch center, field radios equipped with a built-in list or a direct-dial keypad. Radio display on the called radio shall indicate that a call has been received, and the identifier of the calling party shall be accessible.
- X. Radios shall be capable of a global minimum volume setting to reduce the chances of a missed message.

Mobile Radio Features (Fire)

Mobile radio equipment shall be equipped with the following features:

- A. Mobile radio transceiver shall be remote-mounted unless specified otherwise.
- B. The radio shall be equipped with a control head with a 14-character dot-matrix alphanumeric display to allow the user to assign a descriptive name to each operating condition. Control head displays shall be clearly labeled and visible in bright sunlight, with variable brightness. The display shall be either backlit or vacuum florescent for night visibility.
- C. Multi-Control Head: Vehicles equipped with more than one control head may utilize a single radio, which is interfaced to multiple control heads.
- D. Radios shall be capable of the following features (some features are described later in this section):
 - Priority Scan
 - Caller ID Display
 - Emergency Alarm
 - PTT-ID, 512 Channels, Multiple Groups, Tone Selectable
- E. Emergency Button: Radios shall be supplied with an emergency alert button that, when depressed, will transmit the individual identification number of the unit in distress. The button shall be protected from inadvertent activation.
- F. Priority Scan: Units will provide conventional priority scanning with the following operational requirements:
 1. Capable of priority scanning user-selected conventional channels. Radios shall be capable of prioritizing the selected channel, and of simultaneous scanning a mix of up to 256 other conventional channels.
 2. Capable of instantaneously (in under 300 ms) locking-out up 255 active channels from the scan list by pressing a single switch, without deleting it from the user-defined scan list. The channel shall be "undeleted" by cycling the power, or by selecting a different channel.
 3. In priority scan mode, the display shall continue to show the selected channel (the channel that will be transmitted upon) unless another active channel is being received.
- G. Conventional talkaround: A button on the control head assembly shall enable the talkaround function on any selected conventional repeater channel, using the receive CTCSS code as the transmit CTCSS code. Talkaround should operate when in scan mode.
- H. Home button: A home button shall force the mobile radio to a pre-designated channel.

- I. Channels: Radios and associated control heads shall be capable of any combination of 256 channels/talk groups (minimum, not including talkaround channels using a switch or button), up to 256 digital conventional systems, and sixteen digital systems (minimum).
- J. Channels: Radios and associated control heads shall be capable of any combination of 256 analog conventional or digital conventional channels (if applicable) not including talkaround channels using a switch or button.

Mobile Radio Features (Police)

Mobile radio equipment and motorcycle radios shall be equipped with the following features:

- A. Mobile radio transceiver shall be remote-mounted unless specified otherwise.
- B. The radio shall be equipped with a control head with a 14-character dot-matrix alphanumeric display to allow the user to assign a descriptive name to each operating condition. Control head displays shall be clearly labeled and visible in bright sunlight, with variable brightness. The display shall be either backlit or vacuum florescent for night visibility.
- C. Multi-Control Head: Vehicles equipped with more than one control head may utilize a single radio, which is interfaced to multiple control heads.
- D. Radios shall be capable of the following features (some features are described later in this section):
 - Priority Scan
 - Caller ID Display
 - Emergency Alarm
 - PTT-ID
- E. Emergency Button: Radios shall be supplied with an emergency alert button that, when depressed, will transmit the individual identification number of the unit in distress. The button shall be protected from inadvertent activation.
- F. Priority Scan: Units will provide conventional priority scanning with the following operational requirements:
 - 1. Capable of priority scanning user-selected conventional channels. Radios shall be capable of prioritizing the selected channel, and of simultaneous scanning a mix of up to 64 other conventional channels.
 - 2. Capable of instantaneously (in under 300 ms) locking-out up 64 active channels from the scan list by pressing a single switch, without deleting it from the user-defined scan list. The channel shall be "undeleted" by cycling the power, or by selecting a different channel.
 - 3. In priority scan mode, the display shall continue to show the selected channel (the channel that will be transmitted upon) unless another active channel is being received.
- G. Conventional talkaround: A button on the control head assembly shall enable the talkaround function on any selected conventional repeater channel, using the receive CTCSS code as the transmit CTCSS code. Talkaround should operate when in scan mode.

- H. Home button: A home button shall force the mobile radio to a pre-designated channel.
- I. Channels: Radios and associated control heads shall be capable of any combination of 64 channels/talk groups (minimum, not including talkaround channels using a switch or button), up to 64 digital conventional systems, and sixteen digital systems (minimum).
- J. Channels: Radios and associated control heads shall be capable of any combination of 64 analog conventional or digital conventional channels (if applicable) not including talkaround channels using a switch or button.
- K. Radios appropriate for use on a motorcycle shall be available.
- L. Radio shall be capable of Project 25 Phase I digital operation.
- M. Radio shall be capable of digital encryption as described elsewhere in this specification.

Mobile Radio Features (Public Works / Utilities)

Mobile radio equipment shall be equipped with the following features:

- A. Mobile radio shall be front mount unless specified otherwise.
- B. The radio shall be equipped with a control head with an eight-character alphanumeric display to allow the user to assign a descriptive name to each operating condition. Control head displays shall be clearly labeled and visible in bright sunlight, with variable brightness. The display shall be either backlit or vacuum florescent for night visibility.
- C. Radios shall be capable of the following features (some features are described later in this section):
 - Priority Scan
 - Caller ID Display
 - Emergency Alarm
 - PTT-ID
- D. Priority Scan: Units will provide conventional priority scanning with the following operational requirements:
 1. Capable of priority scanning user-selected conventional channels. Radios shall be capable of prioritizing the selected channel, and of simultaneous scanning a mix of up to 48 other conventional channels.
 2. Capable of instantaneously (in under 300 ms) locking-out up 47 active channels from the scan list by pressing a single switch, without deleting it from the user-defined scan list. The channel shall be "undeleted" by turning cycling the power, or by selecting a different channel.
 3. In priority scan mode, the display shall continue to show the selected channel (the channel that will be transmitted upon) unless another active channel is being received.
- E. Conventional talkaround: A button on the control head assembly shall enable the talkaround function on any selected conventional repeater channel, using the receive CTCSS code as the transmit CTCSS code. Talkaround should operate when in scan mode.
- F. Home button: A home button shall force the mobile radio to a pre-designated channel.

- G. 48 Channels: Radios and the associated control head shall be capable of a minimum 48-channel operation (this does not include the talkaround channels using a front panel switch).

UHF Mobile Radio Technical Specifications

Table 15A. – Mobile Radio Transmitter Technical Specification - Police

Frequency range	450 to 470 MHz
Frequency spread (min.), no degradation	20 MHz
Programmable channel steps	12.5 kHz
Power output, vehicular (EIA Intermittent)	40 W
Spurious and harmonic emissions	-70 dBc

Table 15B. – Mobile Radio Receiver Technical Specification - Police

Frequency range	450 to 470 MHz
Frequency spread (min.), no degradation	20 MHz
Channel steps	12.5 kHz
Analog Sensitivity, 12 dB SINAD	-116 dBm
Digital Sensitivity, 5% BER (DAQ 3.0)	-116 dBm
Selectivity, EIA, @ 25 kHz bandwidth (analog)	-80 dB
@ 12.5 kHz bandwidth (analog)	-70 dB
Intermodulation immunity	-80 dB
Spurious and image rejection	-80 dB
Speaker input power, (minimum)	8 W

Table 16A. – Mobile Radio Transmitter Technical Specification – Public Works/Utilities

Frequency range	450 to 470 MHz
Frequency spread (min.), no degradation	20 MHz
Programmable channel steps	12.5 kHz
Power output, vehicular (EIA Intermittent)	40 W
Spurious and harmonic emissions	-70 dBc

Table 16B. – Mobile Radio Receiver Technical Specification – Public Works/Utilities

Frequency range	450 to 470 MHz
Frequency spread (min.), no degradation	20 MHz
Channel steps	12.5 kHz
Analog Sensitivity, 12 dB SINAD	-116 dBm
Digital Sensitivity, 5% BER (DAQ 3.0)	-116 dBm
Selectivity, EIA, @ 25 kHz bandwidth (analog)	-75 dB
@ 12.5 kHz bandwidth (analog)	-65 dB
Intermodulation immunity	-75 dB
Spurious and image rejection	-70 dB
Speaker input power, (minimum)	4 W

VHF Mobile Radio Technical Specifications

Table 17A. – VHF Mobile Radio Transmitter Technical Specification - Fire

Frequency range	150 -174 MHz
Frequency spread (min.), no degradation	24 MHz
Programmable channel steps	2.5 and 7.5 kHz
Power output, vehicular (EIA Intermittent)	50 W
Spurious and harmonic emissions	-70 dBc

Table 17B. – VHF Mobile Radio Receiver Technical Specification - Fire

Frequency range	150-174 MHz
Frequency spread (min.), no degradation	24 MHz
Channel steps	2.5 and 7.5 kHz
Analog Sensitivity, 12 dB SINAD	-116 dBm
Digital Sensitivity, 5% BER (DAQ 3.0)	-116 dBm
Selectivity, EIA, @ 25 kHz bandwidth (analog)	-80 dB
@ 12.5 kHz bandwidth (analog)	-70 dB
Intermodulation immunity	-80 dB
Spurious and image rejection	-80 dB
Speaker input power, (minimum)	8 W

Equipment Housing and Physical Requirements

- A. The transceiver housing shall house all electronic circuits and/or circuit cards associated with the equipment.
- B. Microphones, external speaker housings and transceivers housings shall be constructed of high impact polycarbonate plastic or other suitable high impact material.
- C. 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.
- D. The physical operating requirements for mobile radios are:
 1. The radio and associated hardware shall meet specifications under ambient conditions of -30° to +60° C, and 5% to 90% relative humidity.
 2. The equipment shall meet or exceed all the requirements of MIL-STD 810C, D and E standards for shock, vibration, salt, fog, dust and rain.
 3. Cable connectors shall be securely attached to the mobile via hermetically sealed connectors.
 4. Fuses or circuit breakers installed in vehicles shall be easy to reach, labeled "RADIO", and have the proper replacement fuse amperage identified.
 5. One spare fuse for each mobile installation shall be provided.
 6. Details of mounting and installation will vary among vehicle types and shall be coordinated with the fire mechanic.

Vehicle Antennas

- A. All vehicular antenna cable kits shall be tested with an antenna, or a matched load. Cable kits exceeding a 1.5:1 VSWR shall be replaced with NMO-style mounts.
- B. All existing quarter-wave UHF vehicular antennas shall be replaced with new Antenna Specialists ASPR7495 wideband quarter-wave units. Motorola or Antenna Specialists UHF models with 5 dB gain shall be retained if in good condition. Assume 25% of vehicles have 5 dB gain antennas.
- C. All existing VHF fire antennas shall be replaced. Single band antennas shall be Antenna Specialists ASP7455 3 dB gain units. Proposers shall recommend a Dual-band (460/155 MHz) model.
- D. All antennas and cables shall be tested to confirm that the VSWR is less than 1.5:1.
- E. The roofs of some City vehicles are fiberglass, and antenna installation may require the addition of a ground plane, to be supplied and installed by the contractor. Contractors are to work with the City to determine which units require such ground planes.

Section 6. PORTABLE EQUIPMENT

Portable radio equipment has been categorized into three series.

- A. Police models are UHF and shall be capable of Project 25 conventional digital operation, capable (but not equipped with) digital encryption, and equipped with 64 channels.
- B. Public Works/Utilities series are UHF analog models (not capable of digital or encryption). They shall be equipped with 48 channels.
- C. Fire series are VHF analog models (not capable of digital or encryption), and equipped with 512 channels. Other more subtle differences may exist and are described in this Specification.

Other differences exist and are described in this Specification. In all cases, the City reserves the right to change equipment quantities, features and even types if needed.

Portable Radio Equipment

Portable Radio Technical Features (All Models)

- A. Transmitters and receivers shall be capable of operating on existing 25 kHz channels (20K0 emission designator) and 12.5 kHz channels (11K3 emission designator) through software or firmware changes. No hardware changes shall be required to change between bandwidths.
- B. The receiver selectivity and transmitter voice frequency response, deviation, and transmit power shall be automatically controlled by an internal microprocessor, based on the transmit and receive frequency selection. It shall not be necessary to program these parameters for each radio frequency.
- C. Audio levels of analog wideband and analog narrowband messages heard from radio speakers shall be identical and not vary by channel. No user adjustments shall be necessary when switching between wideband and narrowband channels.
- D. Radios shall employ receiver circuitry to detect dropout of the repeater transmitter, such as digital or continuous tone-coded squelch, with provision of a method ("squelch-tail eliminator") to eliminate the noise burst at the end of transmissions.
- E. Radios shall incorporate carrier squelch as well as EIA standard analog Continuous Tone Controlled Squelch System (CTCSS) and Digital Coded Squelch formats. All radios shall be equipped for "AND" squelch operation.
- F. The radio personality shall be capable of being reprogrammed in the field using a portable computer. Service and programming software shall operate on Windows XP Professional.
- G. Radios shall be capable of conventional repeater operation or talk-around on any of the wideband or narrowband frequencies in the 150-174 MHz and 450-470 MHz land-mobile bands.
- H. Coded squelch encode and decode tones shall be channel-slaved, and the radio shall be capable of operating with encode selections that are different from the receiver decode selections, or having a mix-mode (analog and digital) on a per-channel basis. A monitor switch shall be provided to enable or disable the coded squelch function for maintenance.

- I. Radios shall be housed in rugged cases, with all points of access gasketed and sealed against dust and directed water. No internal ventilation shall be required.
- J. Metering and alignment of all essential circuits shall be possible via service software. Radio shall not require disassembly.
- K. Time-out Timer: A time-out timer shall turn off the transmitter after a time interval (adjustable up to three minutes) of continuous transmit, generate an alert tone on the radio speaker, and reset upon release of the PTT switch.
- L. The contractor shall provide the City with a radio master list indicating radio model number, serial number, and programming template. This list shall be provided in paper, and in Microsoft Excel.
- M. Radios shall be capable of "cloning" radio personality (without individual ID numbers) to minimize future reprogramming costs.
- N. PTT ID: Radios shall be capable of individual identification numbers that are transmitted with every PTT.
- O. Portable radios, including the speaker-microphone units, shall meet Military Specification 810C, 810D, and 810E for high- and low-temperature, shock, vibration, and moisture resistance.
- P. Radios shall meet the electrical performance requirements of EIA RS 316-B except as detailed herein.
- Q. A ~3" (UHF) removable, flexible antenna shall be supplied. It shall be coated for insulation and protection against abrasion and damage. Antenna connectors shall be SMA-type.
- R. A ~5" (VHF) removable, flexible antenna shall be supplied. It shall be coated for insulation and protection against abrasion and damage. Antenna connectors shall be SMA-type.
- S. All portable radios shall provide for attachment of a separate speaker-microphone unit, and provide a standard, weather-sealed 1/8" earphone socket.
- T. Fire department portable radios and batteries shall be capable of being certified as intrinsically-safe.
- U. Radios shall be capable of a global minimum volume setting to reduce the chances of a missed message.
- V. Regardless of the input speaker power rating specified herein, adequate speaker sound pressure level and clarify if required to overcome ambient noise typical in fire and law enforcement operations.

Portable Radio Features (Fire)

Portable radio equipment shall be equipped with the following features:

- A. Alphanumeric display: Equipment shall be supplied with an eight-character (minimum) alphanumeric display with backlighting that is conveniently viewable when mounted on the belt.

- B. Conventional talkaround: A button on the radio shall enable the talkaround function on any selected conventional repeater channel, using the receive CTCSS code as the transmit CTCSS code. Talkaround should operate when in scan mode.
- C. Rotary Knob Controls: Both the volume and channel controls shall be rotary knobs, differentiated by texture and/or size, and be located on the top of the radio (zone or group switches may be on front of radio). Channel knobs shall have a detent on each position, and mechanical end stops. Ramp switches shall not be accepted (except for channel “group” selection). Volume knobs shall have adequate friction and protection to reduce inadvertent adjustment.
- D. Must be able to program a minimum volume setting.
- E. Battery: Radios shall be equipped with rechargeable Lithium-Ion or NiMH battery packs capable of operating the radio for 8 to 10 hours at a minimum of 80% of rated power, with a duty cycle of 5% transmit, 5% receive (full volume), and 90% standby. They shall be capable of a one-hour rapid charge. The battery pack shall be securely fastened to the radio, and replaceable without the use of tools.
- F. Channels: Radios shall be capable of any combination of 256 channels (minimum, not including talkaround channels using a switch or button), and 256 digital conventional systems. Radios shall be capable of the following features (some features are described later in this section):
 - Priority Scan
 - Caller ID Display
 - Emergency Alarm
 - PTT-ID, Tone Select, Channel Groups
- G. Emergency Button: Radios shall be supplied with an emergency alert button that, when depressed, will transmit the individual identification number of the unit in distress. The button shall be protected from inadvertent activation.
- H. Priority Scan: Units will provide conventional priority scanning with the following operational requirements:
 1. Capable of priority scanning user-selected conventional channels. Radios shall be capable of prioritizing the selected channel, and of simultaneous scanning a mix of up to 512 other conventional channels.
 2. Capable of instantaneously (in under 300 ms) locking-out up 512 active channels from the scan list by pressing a single switch, without deleting it from the user-defined scan list. The channel shall be "undeleted" by turning cycling the power, or by selecting a different channel.
 3. In priority scan mode, the display shall continue to show the selected channel (the channel that will be transmitted upon) unless another active channel is being received.
- I. Speaker Microphones: Radios shall allow connection of small speaker-microphone units. The City also desires units with a high/low volume switch and noise canceling ability.
- J. Home button: A home button shall force the portable radio to a pre-designated channel.

- K. Cases: D-clip type swivel mount cases and belt receptacles shall be provided. Belt receptacles shall fit users' work belts (3" width).

Portable Radio Features (Police)

Portable radio equipment shall be the same as Fire above, with the following exceptions:

- A. Channels: Radios shall be capable of any combination of 64 analog conventional or digital conventional channels (if applicable) not including talkaround channels using a switch or button.
- B. Cases: Metal or plastic loop-type radio holders shall be provided which fit users' work belts (3" width).
- C. Priority Scan: Units will provide conventional priority scanning with the following operational requirements:
 - 1. Capable of priority scanning user-selected conventional channels. Radios shall be capable of prioritizing the selected channel, and of simultaneous scanning a mix of up to 64 other conventional channels.
 - 2. Capable of instantaneously (in under 300 ms) locking-out up to 63 active channels from the scan list by pressing a single switch, without deleting it from the user-defined scan list. The channel shall be "undeleted" by turning cycling the power, or by selecting a different channel.
 - 3. In priority scan mode, the display shall continue to show the selected channel (the channel that will be transmitted upon) unless another active channel is being received.

Portable Radio Features (Public Works / Utilities)

Portable radio equipment shall be the same as Police above, with the following exceptions:

- A. Channels: Radios shall be capable of any combination of 48 analog conventional or digital conventional channels (if applicable) not including talkaround channels using a switch or button.
- B. Radios need not be equipped with the emergency alarm feature.
- C. Priority Scan: Units will provide conventional priority scanning with the following operational requirements:
 - 1. Capable of priority scanning user-selected conventional channels. Radios shall be capable of prioritizing the selected channel, and of simultaneous scanning a mix of up to 48 other conventional channels.
 - 2. Capable of instantaneously (in under 300ms) locking-out up to 47 active channels from the scan list by pressing a single switch without deleting it from the user-defined scan list. The channel shall be "undeleted" by turning cycling the power, or by selecting a different channel.
 - 3. In priority scan mode, the display shall continue to show the selected channel (the channel that will be transmitted upon) unless another active channel is being received.

UHF Portable Radio Technical Specifications

**Table 18A. – UHF Portable Radio Transmitter Technical Specification –
Police and Public Works / Utilities**

Frequency range	450 to 470 MHz
Frequency spread (min.), no degradation	20 MHz
Programmable channel steps	12.5 kHz
Power output, vehicular (EIA Intermittent)	4 W
Emission designators	20K0 and 11K3
Spurious and harmonic emissions	-70 dBc

**Table 18B. – UHF Portable Radio Receiver Technical Specification
Police and Public Works/ Utilities**

Frequency range	450 to 470 MHz
Frequency spread (min.), no degradation	20 MHz
Channel steps	12.5 kHz
Analog Sensitivity, 12 dB SINAD	-116 dBm
Digital Sensitivity, 5% BER (DAQ 3.0)	-116 dBm
Selectivity, EIA, @ 25 kHz bandwidth (analog)	-70 dB
@ 12.5 kHz bandwidth (analog)	-60 dB
Intermodulation immunity	-70 dB
Spurious and image rejection	-70 dB
Speaker input power, (minimum)	0.5 W

VHF Portable Radio Technical Specifications

Table 19A.– VHF Portable Radio Transmitter Technical Specification - Fire

Frequency range	150 -174 MHz
Frequency spread (min.), no degradation	24 MHz
Programmable channel steps	7.5 kHz
Power output, vehicular (EIA Intermittent)	5 W
Emission designators	20K0 and 11K3
Spurious and harmonic emissions	-70 dBc

Table 19B. – VHF Portable Radio Receiver Technical Specification - Fire

Frequency range	150-174 MHz
Frequency spread (min.), no degradation	24 MHz
Channel steps	7.5 kHz
Analog Sensitivity, 12 dB SINAD	-116 dBm
Digital Sensitivity, 5% BER (DAQ 3.0)	-116 dBm
Selectivity, EIA, @ 25 kHz bandwidth (analog)	- 75 dB
@ 12.5 kHz bandwidth (analog)	- 65 dB
Intermodulation immunity	-75 dB
Spurious and image rejection	-70 dBc
Speaker input power, (minimum)	8 W

Equipment Housing and Physical Requirements

The physical operating requirements for portable radios are:

- A. The radio and associated hardware shall meet specifications under ambient conditions of -30° to +60° C, and 5% to 90% relative humidity.
- B. The equipment shall meet or exceed all the requirements of MIL-STD 810C, D and E standards for shock, vibration, salt, fog, dust and rain.

Portable Radio Charging Equipment

All chargers shall provide the following:

- A. The charger shall be mechanically configured to provide electrical contact to the radio batteries upon insertion of the radios or individual batteries into the charger.
- B. The charger shall have a charging rate regulator that will select as appropriate a full charge or a reduced charge rate. The charge current shall be of such value as to cause no damage to the batteries being charged or the attached radio. The regulator shall automatically adjust the charge rate with respect to the condition of the batteries. Use of timers, alone which are reset by battery insertion or power interruption as the only means for determining battery recharge rate, is not acceptable.
- C. An indicator shall be provided to display the relative charge status of the battery. The indicator shall indicate a single point charge condition on the battery charging curve, i.e., a light that illuminates when the battery has reached a specified charge level, or when the charger is switched from a full charge rate to a reduced charge rate, or turns off.

Multi-Unit Desk Chargers

The chargers shall have the following operational specifications and features:

- A. Chargers shall provide proper charging of batteries whether attached to or removed from the portable radio.
- B. The charger shall operate from a 120 VAC, +/- 10%, 60 Hz single-phase power source.
- C. The charger shall be capable of simultaneously charging six (6) or more completely discharged battery packs to 90% of their maximum charge within four hours.

- D. It is desired that chargers have the same diagnostic capabilities as those described in the “Battery Analyzer/Exerciser/Discharger” Section below.

Single-Unit Desktop Chargers

Chargers shall have the same operation specification as the multi-unit chargers, including the following:

- A. Chargers shall provide proper charging of batteries whether attached to or removed from the portable radio.
- B. The charger shall operate from a 120 VAC, +/- 10%, 60 Hz single-phase power source.
- C. The battery charger shall be capable of recharging a completely discharged battery to 90% of its maximum charge within 1 hour. The charger shall have a charging rate regulator that will select as appropriate a full charge or a reduced charge rate. The charge current shall be of such value as to cause no damage to the battery being charged or the attached radio. The regulator shall automatically adjust the charge rate with respect to the condition of the battery. Use of timers alone which are reset upon battery insertion or power interruption, as the only means for determining battery recharge rate, is not acceptable.
- D. Charger shall allow radios to remain powered on while being charged without affecting the charge rate or radio operation. Charger shall be capable of powering the portable radio in transmit mode even with a fully-discharged battery (instantaneously charging and transmitting is not required).

Single-Unit Vehicular Rapid Chargers

Vehicular chargers shall have the same operation specification as the single-unit desktop chargers, including the following:

- A. The battery charger shall operate from 13.8 VDC source.
- B. Charger shall allow radios to remain powered on while being charged without affecting the charge rate or radio operation. Charger shall be capable of powering the portable radio in transmit mode even with a fully-discharged battery (instantaneously charging and transmitting is not required).
- C. Units shall be equipped with a locking mechanism.

Single-Unit Vehicular Cup Chargers

These are primarily used by Fire and are only used to charge batteries that are not attached to a radio. These units shall operate from 13.8 VDC source.

Desktop Battery Analyzer/ Exerciser/Discharger

The Contractor shall supply eight (8), six (6) position battery analyzer capable of determining the condition of portable radio batteries. The analyzer shall incorporate a discharge function, and identify the condition and capacity of each battery.

Section 7. CONTROL STATION EQUIPMENT

Three general control stations types are described herein.

- A. Type A control stations are only deployed in the Dispatch Center Equipment Room for specific channels. This type shall be rated for continuous-duty operation and be equipped with separate transmit and receive antenna ports.
- B. Type B control station specifications are similar to the mobile radio specified for the particular department. This type shall be supplied with either local control or remote control and are used at fire stations as well as City office complexes.
- C. Type C control stations are only deployed in the Dispatch Center Equipment Room for specific channels. Some may be digital (See Table 9, Dispatch Center Radio Equipment). They have higher-powered transmitters than Type B above are otherwise identical.

Features and Technical Specifications – Type A

The following specifications apply to both VHF and UHF Type A control stations.

- A. Control station transmitters and receivers shall comply with Part 90 of the FCC Rules and Regulations. Transmitters shall conform to EIA-152-C standards and specifications through 470 MHz. Receiver equipment shall conform to EIA-204-D to 470 MHz and meet Class A specifications
- B. Conventional control station receivers and transmitters shall be capable of operating on existing 25 kHz channels (20K0 emission designator) or 12.5 kHz channels (11K3 emission designator) through programmable software changes. No hardware or firmware changes shall be required to change between bandwidths.
- C. Audio levels of analog wideband and analog narrowband messages heard from radio speakers shall be identical and not vary by channel. No user adjustments shall be necessary when switching between wideband and narrowband channels.
- D. It is not necessary that these stations be capable of digital operation, as they will operate on conventional analog channels.
- E. Conventional control stations shall be programmable to encode and decode any combination of 37 EIA CTCSS and 83 standard DCS codes. Receivers shall be capable of operating on any of three different CTCSS and/or DCS codes simultaneously.
- F. Transmitters shall employ a means of encoding a coded squelch "phase-reversal," or a digital turn-off code to eliminate the noise burst at the end of transmissions that would otherwise be heard by mobiles. Control station receivers shall also be equipped with circuitry to detect a coded squelch "phase-reversal," or a digital turn-off code from a mobile.
- G. Each control station shall be equipped with a local speaker and volume control to monitor all on-channel signals.
- H. Transmitters and receivers shall be programmable in consecutive 2.5 (VHF) or 12.5 kHz (UHF) steps, to comply with current FCC refarming requirements.

- I. Equipment shall operate continuously within full specifications between 0 to +40 C and 5% to 90% RH EIA (50 C).
- J. Control stations shall be equipped for 120 VAC operations unless specified otherwise.

Table 20A.– Control Station UHF Transmitter Specifications

Control station transmit powers shall be selected to meet licensed ERPs, using the antenna and combiner types specified herein.

RF power output, watts (EIA Continuous)	25
Frequency range (MHz)	450-470
Frequency Spread (MHz)	20

Table 20B.– Control Station UHF Receiver Specifications

Frequency range (MHz)	450-470
Analog Sensitivity, 12 dB SINAD (dBm)	-116
Digital Sensitivity, 5% BER (DAQ 3.0) (dBm)	N/A
Selectivity, EIA, @ 25 kHz bandwidth (analog)	-80 dB
@ 12.5 kHz bandwidth (analog)	-75 dB
@ 12.5 kHz bandwidth (digital)	N/A
Intermodulation immunity, EIA SINAD, @ 12.5 kHz BW	-80 dB
Spurious and image rejection	-90 dB
Frequency Spread (MHz)	20

Table 21A.– Control Station VHF Transmitter Specifications

Control station transmitter set points shall be selected to meet the licensed ERPs shown in the Appendix, using the antenna and combiner types specified herein.

RF power output, watts (EIA Continuous)	25
Frequency range (MHz)	150-174
Frequency Spread (MHz)	20

Table 21B.– VHF Receiver Specifications

Frequency range (MHz)	150-174
Analog Sensitivity, 12 dB SINAD (dBm)	-116
Digital Sensitivity, 5% BER (DAQ 3.0) (dBm)	N/A
Selectivity, EIA, @ 25 kHz bandwidth (analog)	-80 dB
@ 12.5 kHz bandwidth (analog)	-75 dB
@ 12.5 kHz bandwidth (digital)	N/A
Intermodulation immunity, EIA SINAD, @ 12.5 kHz BW	-85 dB
Spurious and image rejection	-90 dB
Frequency Spread (MHz)	20

Features and Technical Specifications – Type B

Where radio access is needed at one location only, the control station shall be locally controlled. Where multiple remotes are required at the same location, on the same channel, desktop remote controls shall be connected to a common control station. The standard operational features of the

control station, and/or multi-channel remote controls shall be equivalent to features specified for Type B mobile radios.

The technical specifications and features shall be the same as those for Type B mobiles, except that control stations shall have a power output of 10 watts, and be rated for 10% transmit, 10% receive, and 80% standby.

All control stations and remotes shall meet the following requirements:

- A. Remotes shall be equipped with a handset with PTT switch, integral speaker, microphone, volume control, a minimum volume control setting, and provisions for adding a desktop microphone.
- B. Control stations associated with multiple desktop remotes shall operate on a single channel and will not require remote channel selection capability.
- C. Remotes shall be capable of using standard 26-gauge, twisted-pair telephone wire. A junction box shall be provided for locations requiring more than one remote per control station.
- D. It is desirable to have the remotes fully line-powered, to eliminate the use of wall adapters. (This will allow Participants to place a single emergency power supply at the control station, if required.) For extremely long cable lengths, a power supply or wall adapter shall be acceptable.
- E. Remotes connected to voice-encrypted or digital control stations by in-house wire-line shall not require encryption at the remote.
- F. All control stations shall operate from 120 VAC unless otherwise noted.
- G. Remotes, local remotes and control stations shall be operational and maintain all settings previously in effect following restoration of 120 VAC power.

Features and Technical Specifications – Type C

The technical specifications and features shall be the same as those for Type B mobiles, except that control stations shall have a power output of 30 watts, and be rated for 10% transmit, 10% receive, and 80% standby. Additionally, some control stations shall allow remote channel selection via pull-down menu on the dispatch workstations, and/or may be digital. See Table 9, Dispatch Center Radio Equipment.

Power Surge and Lightning Protection

- A. All equipment powered from commercial 120 VAC power shall be equipped with an external surge protector with ground conductor.
- B. All antenna feedlines shall be equipped with an external lightning arrestor with ground conductor.

Control Station Antennas

Fire Station 1

The following table lists the current models and use of stations at the existing dispatch center located

in the Police Department on 1042 Walnut, as well as their disposition as part of this project. In some cases, the existing radio equipment shall be relocated to the new Dispatch Center Equipment Room and reused. Other equipment will be discarded, or be replaced with new equipment. In all cases, all equipment shall be connected to the new antenna systems as listed below.

Antenna assignment and numbering is provided in the Exhibit 3, Site Data.

The contractor shall supply and install the combining and filter equipment, and connect this equipment to the stations and antenna transmission lines (at the lightning protection devices) in the Dispatch Center Equipment Room. Others will be responsible for supplying and installing the lightning protection devices, transmission lines and the antennas.

Table 22. – Dispatch Center Radio Antenna Assignments

Control Stn. Mode	Planned Use	TX Freq. (MHz)	RX Freq. (MHz)	Combiner	TX Ant. Port Treatment	RX Ant. Port Treatment	TX Antenna Model	RX Antenna Model			
UHF											
Type C	White monitor	465.0250(1)	460.0250	A	None	8-port muticoupler w/ Dual Bandpass Filters 460-464 MHz pass 453-454 MHz pass (4 ports used; 4 ports spare)	DB420D-B (#2T)	DB420-B (#1)			
Type C	S.O. Red	465.0500	460.0500								
Type C	S.O. Blue monitor	465.1500(1)	460.1500								
Type C	S.O. Yellow	465.4750	460.4750								
Type A	Orange net Link	458.5875	453.5875	B	None		DB420D-B (#2B)		DB420-B (#1)		
Type C	OES Law	458.6750	453.6750								
Type C	TA	458.7500	453.7500								
Type C	B/U C.S. 1	458/465	453/460	C	None		DB436C			DB420-B (#1)	
Type C	B/U C.S. 2	458/465	453/460								
Type C	B/U C.S. 3	458/465	453/460								
Type C	Medcom 2 monitor	468.TBD(1)	463.TBD	None	None	None	DB420-B (#1)				
VHF											
Type C	County Fire	159.3150	151.3250	D	None	Two Notch Filters (similar to DB4140-1A) Notch 1: 154.3 MHz Notch 2: 159 MHz		DB616AB (#3)			DB616AB (#1)
Type C	B/U C.S. 4	155.XXXX	159.XXX								
Type C	B/U C.S. 5	155.XXXX	159.XXX								
Type A	Tassajera Repeater (City Net)	N/A 154.2050	155.1450 N/A	E	Three Bandpass Filters (similar to DB4001-3) 154.205- 154.310 MHz	Passive Two-Port Splitter plus one Notch Filter (similar to DB4140-1A) Notch 1: 159 MHz		DB616AB (#4)	DB616AB (#2)		
Type A	Fire White 1	154.2800	154.2800								
Type A	Fire TAC Net Alt.	154.3100	154.3100								
Type B	CHP Mon (Low Band)	42.7200	42.5600	None	None	None		None	CO-35A		

(1) Transmitter not enabled. (#2T) - Refers to antenna number two, top element set (of a dual-feed antenna model) (#2B) - Refers to bottom element set.
C.S. - Control Station B/U - backup

Antenna placement and combiner, filter and multicoupler design is intended to minimize mutual-degradation of the various receivers. Contractor shall either verify that the proposed combiner and multicoupler design and configuration is practical, or propose a different alternative. Contractors will be responsible for proper operation of all supplied and installed equipment.

All Other Locations

Other control stations shall utilize DB436 and DB230 model antennas.

Cable losses shall not exceed 37% of transmitter power. In-line TVSS unit shall be provided.

Transmitter Combiners – Control Stations

UHF stations at Fire Station 1 shall utilize three, four-port dbSpectra DBS-HC114 control station combiner units. Receive ports on each combiner shall connect to a master 8-port UHF multicoupler equipped with parallel bandpass filters tuned for 453-454 and 460-463 MHz passbands. The multicoupler shall also directly connect to a 463 MHz MEDCOM receiver. The remaining four ports shall be spare. Transmit ports shall connect to separate antennas.

VHF stations shall either connect to a four-port dbSpectra DBS-HC115 control station combiner unit with receiver preamplifier, a hybrid combiner, a passive splitter, or a separate, dedicated antenna. There are various bandpass and notch filters that must be installed in some of the antenna lines. These are detailed in the previous table. Contractor shall verify the configuration and design of the combiners. Contractors are responsible for proper design and operation.

Control station combiner and filter placement is described in the previous table.

Active control stations combiners shall be connected to backup power.

Section 8. BACKUP POWER SYSTEMS

This section includes the requirements for backup power systems at remote sites. In general, all remote sites shall be equipped with DC battery float systems using modular rectifiers.

Related Work by Other Contractors

The City shall supply UPS and generator power to all equipment at Fire Station 1, including the Equipment Room and the dispatch workstations. The contractor shall provide load, power dissipation (BTUH) and outlet requirement information to the City as soon as possible.

The City shall also supply backup generator power to equipment at Fire Station 2, Fire Station 3, and South Hill.

Any additional electrical work required shall be performed by the City.

General

- A. All essential site equipment shall be powered by a DC battery power supply furnished by the Contractor. The system shall include batteries, battery racks, float-type battery rectifiers, DC load centers and rack distribution/fuse panels.
- B. 48 VDC systems are preferred unless a significant portion of equipment is not capable of this supply voltage. All power systems shall utilize the same voltage.
- C. The contractor shall be responsible for connecting the radio system equipment to the commercial, DC power plant and emergency generator at each site.

Run Times

Run times are specified in the Wireless Systems Section.

Batteries

- A. Modular stationary batteries shall be sealed maintenance-free type with sufficient ampere-hour capacity to provide for the minimum run times.
- B. Battery life expectancy shall be at least 10 years in normal float-type service. No venting facilities or special battery rooms shall be required for normal operating conditions.
- C. Battery racks shall be furnished with plastic rail covers to preclude corrosion of battery rack. The battery bank, and all motion stabilizing hardware required for seismic considerations shall be assembled using appropriate corrosion-resistant hardware (e.g. lead plated intercell connector straps, terminal lugs and bolts/nuts).

Battery Rectifiers

- A. Battery rectifiers shall provide sufficient current output to supply station load requirements (plus a 25 percent station load expansion) and simultaneous charging of a fully discharged battery bank to full capacity in 24 hours. Battery rectifiers shall employ a redundant, load-sharing design. The charger shall operate in ambient temperatures of 0°C to +50°C.
- B. The power plants shall be designed for mounting within a standard 19" or 23" wide relay rack. The contractor shall supply racks of sufficient vertical height and depth to safely accommodate the power plants and provide suitable ventilation for heat dissipation.

- C. Contractor shall supply suitable battery trays for each power plant to safely accommodate the battery backup system.
- D. Each power plant shall have a battery disconnect switch, and individual rectifier alarms with form-C contacts.
- E. The power plant shall have at least two rectifiers for load current redundancy. It shall be an N+1 design with “hot-swap” removable rectifier units.
- F. The battery rectifiers shall be rack mounted. They shall be configured for operation from 120, 208 or 240-volt single phase AC power as necessary for site compatibility.
- G. The battery rectifiers shall contain a two-pole AC circuit breaker, DC circuit breaker, minimum 2% accuracy DC voltmeter and DC ammeter, 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 rectifiers or provided in separate rack mount assemblies.
- H. The charger shall have the following minimum alarm points:
 - AC Power Failure
 - Low DC Voltage
 - High Voltage Shutdown
 - High DC Voltage
 - No Charge (Low Current)
 - Minor Rectifier Failure
 - Major Rectifier Failure
 - Distribution Fuse/Breaker Trip
- I. The charger shall maintain its DC output voltage to within 0.5% at any load from no load to full load with 10% variation in the AC input voltage.
- J. Ripple output of the charger shall be filtered to less than 30 millivolts RMS with electrical noise limited to less than 32 dBm with C message weighting when connected to a battery bank.
- K. Charger performance shall not be affected by local transmitter emissions, including those from portable two-way radio transmitters operated nearby.

DC Load Center and Rack Distribution

- A. A rack mounted DC Load Center with breakers shall be provided with the battery power system to provide a protected DC distribution to all DC powered telecommunications equipment.
- B. All equipment racks shall be equipped with DC and isolated ground distribution busses with replaceable fuses. 50% additional fuses shall be provided.
- C. Both positive and negative battery leads shall be run to and from all sources to minimize induced noise and interference.
- D. All AC and DC power connections on rectifier and battery racks shall be protected with clear plastic covers that shall be easily removable for service without breakage.
- E. Protection covers that are designated as by the City “nuisances” (those that are poorly designed with regard to construction, retention or can become easily damaged shall be redesigned and/or replaced with improved devices prior to acceptance of the product.

Electrical Requirements

- A. Nominal DC Output Voltage: -48 Volts

- B. Electrical Noise: Less than 100mV Peak to Peak from 0 to 20Mhz and less than 200 mV Peak to Peak from 0 to 100Mhz
- C. Harmonic Distortion: 7 % Total Harmonic Current Distortion at full load
- D. Audible/Acoustic Noise: Each rectifier has a maximum audible noise of less than 54dB when measured 3 feet from the equipment, while operating at no load, partial load, or full load
- E. Efficiency: >90% Efficiency at 100% load (-48 VDC)
- F. Power Factor: Active power factor correction circuitry achieves >.98 PF from 25% to full load.

Environmental Specifications

Operating Temperature range shall be -20°C to +50°C (Relative Humidity 0% to 95% non-condensing).

Section 9. INSTALLATION AND SERVICE REQUIREMENTS

This section covers services and installation of equipment.

The contractor shall perform installation and programming of all fixed site equipment, as well as vehicular equipment planned for all Fire vehicles, Police vehicles, Police motorcycles and City Services vehicles.

General

- A. The scope of work for the radio system contractor includes, but is not necessarily limited to, the following:
- B. The contractor shall design, furnish, and install all necessary system computers, controllers, base station repeaters, transmission lines, transmitting and receiving antennas, fiber-optic equipment, amplifiers, interconnecting RF cabling, software, and all other devices and equipment required to completely implement the City's radio system.
- C. Engineering, furnishing, installing, and testing all necessary fixed-site and mobile equipment, devices, interconnecting cabling, and software. This shall include electrical connection to commercial and emergency power supplies (where specified), physical installation, connection to new and existing termination blocks, connection to any new and existing logging recorders, and connection to telephone lines or other interconnecting systems necessary to provide complete functionality.
- D. Providing all labor, materials, appliances, tools, equipment, software, facilities, documentation, training, transportation, and services necessary for or incidental to performing all operations of the work of this Specification, completely, as specified herein. It is the intent of this Specification to provide for a complete, integrated, working system. Inadvertent omission of any necessary items of work, material, or equipment shall not negate the contractor's responsibility to provide those items.
- E. Providing post project award engineering data and services, as required by City, regarding the necessary site preparations, facilities, field installation, and solutions to technical problems related to the contract, throughout the design, implementation, installation, and testing phases through final acceptance.
- F. Conducting site visits and providing close coordination and technical support as necessary to ensure that the design and functions of the radio system meet the specified requirements.
- G. Coordinating installation details and schedules with City to ensure adherence to the implementation schedule.
- H. Guaranteeing that all equipment and material furnished meets or exceeds all the requirements of this Specification and of the manufacturer's specifications, unless City specifically waives compliance.
- I. Ensuring that the equipment, materials and installation comply with all applicable FCC rules and regulations, with the provisions of the NEC, OSHA, and all local electrical, fire, and building codes, and with local seismic requirements for the zone in which the equipment will be installed.

- J. Providing electrical connections to existing commercial and emergency power supplies and outlets. The contractor shall advise City of any electrical work that may be required to distribute backup power to the proposed equipment based upon results of the site inspections. This includes details such as the number of additional outlets and capacity (in amperes) and grounding requirements.
- K. Disconnection, removal and disposition of old equipment and hardware from fixed sites and vehicles. Contractors shall consult with City to determine if some vehicular wiring should remain.
- L. The contractor shall be responsible that all material and components are delivered to the proposed sites.
- M. Personnel designated by the City will 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.
- N. Notwithstanding the details presented in these specifications, it is the responsibility of the contractor to verify the correctness of the material lists and suitability of devices proposed to meet the requirements of the specifications.
- O. The contractor shall be responsible for providing or arranging for all parts necessary for the equipment and its installation up to and including final system acceptance.
- P. Any equipment or parts required to provide a complete and operational system, and not specifically mentioned herein, shall be provided by the contractor without any claim for additional payment. It shall be understood that the contract and agreement contemplates and requires the "turnkey" construction and installation of a completely operational communication system that meets the standards of the City.
- Q. All rubbish and debris associated with site preparation; unpacking of shipping materials, and/or installation of new equipment related to this project shall be removed from the premises by the contractor. At the end of each working day, the contractor shall swept and clean any debris and trash at the location where work is being performed.
- R. Removal of rubbish and debris shall be performed daily.
- S. For purposes of continuity and quality control, to the greatest extent, the contractor shall maintain the same installation crew(s) through completion of all installs. At a minimum, separate crews will be permitted for fixed-site installations and vehicle installations. The City requires consistent installation approaches.

Related Work by Other Contractors

Others will install the Dispatch Center radio tower and conduits.

Others will supply generator and UPS backup power in the Dispatch Center Equipment Room.

City Responsibility

The City will be responsible for the following:

- A. Completing specified facility and civil work, such as shelters, towers and environmental systems, prior to installation of the communications equipment.
- B. Specified electrical work, such as additional or relocated outlets and grounding points.

FCC Licensing

The contractor shall not be responsible for frequency coordination or FCC licensing. However, the Contractor shall be responsible for providing all information required to complete modifications or new applications for all frequencies within 45 days of the Final Design Review.

The contractor shall be responsible for all reasonable costs associated with license modification or relicensing as a result of errors, omissions or unplanned design changes following the Final Design Review. Such costs include coordination and FCC fees, as well as required efforts by the City or its agents.

Fixed Equipment Installation

The following standards shall apply to all fixed equipment:

- A. Installation shall fully comply with all UBC and State seismic requirements for the local Earthquake Zone, specifically including the provisions of the State of California Health and Safety Code pertaining to Essential Services Buildings, and associated regulations.
- B. All fixed equipment shall be securely attached to the floor and/or wall. If applicable, the first rack in each row shall be securely anchored to the wall, and additional racks shall be bolted to the adjacent rack at the top of the rack. Stand-alone racks, and every third rack, shall be securely cross-braced to the ceiling or employ loose-fitting steel cable supports to prevent tipping.
- C. Racks and cabinets shall be shimmed to plumb alignment.
- D. Equipment rack spacing shall allow not less than 3' clear working space when possible. All equipment shall have full access front and rear, except equipment mounted on swing-out type racks.
- E. All equipment and equipment racks shall be separately and securely grounded to a single point.
- F. Audio lines and control function lines shall be terminated on industry-standard "66-type" punch blocks, with pre-wired 25-pair telephone-type connectors. Color-coding shall follow telephone industry standards. Without exception, all sites shall be wired identically. The City must approve exceptions to this.
- G. Flexible conduit and hardwiring shall be used for 120V AC or greater power into equipment cabinets, if applicable.
- H. All cable wraps, ties, etc. shall not be left with sharp edges.

- I. Significant inter-cabling, whether RF, AC, AUDIO or CONTROL cables and/or wiring, shall be labeled with pre-printed adhesive wire markers. Markers shall be placed at each end, adjacent to the connector, plug or terminus. This data shall be recorded and match that in the installation documentation.
- J. All equipment cables or cable bundles, to the greatest extent feasible, will be neatly tied by means of plastic tie wraps and secured by clamps to flat surfaces.
- K. All cable/wiring bundles exiting the equipment must do so through the top of the cabinets. Rubber grommets or other suitable protection shall be used at cabinet knockouts to protect the cable/wiring. Splicing of AC, AUDIO or CONTROL cable/wiring will not be permitted.
- L. With the doors closed, all equipment cabinets shall present a sealed enclosure to minimize the entry of insects and to prevent entry of birds and rodents.
- M. All equipment operating from AC power, including radio controls, central electronics, repeaters, remote receivers, control stations, controllers, and computer terminals, shall be equipped with surge protection devices. All outlet strips and surge protection shall be rack mounted.
- N. Lightning suppression devices shall be provided for power input circuits, control circuits, telephone lines, antenna transmission cables, and all other circuits, equipment, and cabling that could be exposed to lightning-generated transients. Surge protection devices shall be rated for maximum surge suppression and noise suppression as appropriate to the protected device, and the Contractor's equipment and design.
- O. Lightning suppression devices shall be rated for maximum surge current, turn-on voltage, turn-on time, power capacity, and other characteristics as appropriate to the protected circuit, and the Contractor's equipment and design. Lightning suppression devices shall be connected to earth ground with insulated wire appropriate to the application. The following are general requirements:
 - P. Maximum surge current shall be 20,000 A, based on the IEEE 8-microsecond rise-time/20-microsecond decay-time waveform.
 - Q. The turn-on voltage shall be no less than 600 VDC.
 - R. The turn-on time shall be no more than seven nanoseconds after voltage attains the 600 VDC turn-on level.
 - S. The device shall be capable of passing up to 600 microJoules of energy.
 - T. High-current spike suppression shall be capable of 15,000 A, based on the IEEE 8-microsecond rise-time/ 20-microsecond decay-time waveform.
- U. High frequency noise suppression shall be:
 - 1. -Greater than 20 dB at 1 MHz
 - 2. -Greater than 35 dB at 10 MHz

Mobile Installations

- A. The Contractor shall coordinate with the City to establish a work area, other necessary facilities for mobile equipment installations, vehicle availability, and detailed schedule.

- B. The Contractor shall perform a sample installation of mobile equipment on one each of the various types of vehicles. The sample installations shall be modified as necessary and pre-approved by the City before additional mobile equipment is installed.
- C. Both positive and negative high-current power cables shall be run in parallel directly to the vehicle battery to ensure a noise-free installation. The contractor may take exception to a direct battery route only if it can be shown that alternator or ignition noise would not result in received or transmitted signals.
- D. Radio should power down when vehicle ignition is off, except for police vehicles. Thus, a separate ignition sense lead must be provided on the radio, or external connection must be equipped with power relays.
- E. Installation of mobile equipment shall minimize the exposure to and possibility of damage due to abuse, vandalism, and theft. Theft-resistant fasteners and mountings shall be used when necessary. Cables shall be run in hidden and protected spaces to the degree possible.
- F. New microphone holders in vehicles shall be located in a position convenient to the driver; exact locations shall be coordinated with the City for each type of vehicle.
- G. Mobile installations shall not interfere with the vehicle's air bag systems and appropriate solutions for installing equipment in very limited physical space shall be part of the installation. Installations shall not interfere with the vehicle's instruments or controls.
- H. When applicable, mobile installations shall require the complete removal of existing units.
- I. The contractor shall note that the mobile installations may also necessitate temporary removal or relocation of other existing vehicle radios and controls such as electronic sirens, etc.
- J. All cables associated with the installations shall be protected by rubber grommets when routed through vehicle chassis perforations.

Control Stations

- A. The contractor is fully responsible for installing the radio transceivers, including furnishing and installing cables linking the control stations with the remotes.
- B. The City shall approve unit placement, antenna mounting locations.
- C. The City shall approve all interior and exterior antenna feedline routes. All exterior antenna feedline connection points shall be sealed with weatherproofing compound.
- D. All exterior antenna feedline runs shall not be hung or supported by nylon or other plastic type cable ties unless UV rated.
- E. All exterior mounting hardware shall be stainless steel or galvanized.

Antennas and Transmission Lines

- A. Easiac cable cutting tool, Andrews Model 222951, shall be used to terminate all cables. For replacement blades, use Andrews Model 222954 blade kit (5 per kit).
- B. Antenna transmission lines shall be labeled with cable identification tags indoors at each connector. Labels shall denote the antenna model, frequency, height, azimuth and VSWR at installation. Labels shall be permanent and not hand written.
- C. The manufacturers' minimum bending radius shall not be exceeded during installation.

- D. Transmission lines shall be secured through standard cable hangers attached to channel supports or "Unistrut" as appropriate. All cables shall be dressed appropriately, and run parallel to each other.
- E. Wall feed-through boots shall be sized for the correct cable OD. Feed-through panels and boots shall be sealed to prevent moisture and dust intrusion.
- F. At sites with more than one antenna, antenna transmission lines shall be labeled with cable identification tags indoors at each connector. Labels shall denote the antenna model, center frequency, height, azimuth and VSWR at installation. Labels shall be permanent and not hand written.
- G. For each cable installation, the coaxial antenna transmission line shall be cut to length. The radio equipment end of this line shall terminate at a point where the lengths of jumper cables are kept as short as possible. This terminus shall be secured to a wall or ceiling surface.
- H. All coaxial antenna transmission line connectors shall be type 'N' or DIN. The ends of the transmission line shall not connect directly to the antenna, or to any RF equipment, interference protection, or multiplexing devices.
- I. The transmission line shall be fastened to the external antenna support structure in accordance to the manufacturers' specifications or every four (4) feet for vertical runs. Fasteners shall be of stainless steel; nylon cable ties are not acceptable.
- J. Transmission line runs inside equipment shelters or buildings shall be supported, every three (3) feet, with stainless steel cable hangers. Multiple cable runs shall not be bundled together but rather, shall be strung and supported adjacent to each other.
- K. All coaxial jumper cables for receivers shall be 1/2" diameter, such as Andrew Outdoor (where applicable) Superflex.
- L. The jumper cables shall be used to interconnect all interference protection or multiplexing devices with the coaxial antenna transmission line and radio frequency equipment.
- M. A jumper cable shall be used to interconnect the antenna(s) to the top end of the coaxial antenna transmission line. Jumper cables used to reach a side arm mounted antenna shall be shaped to form a drip loop.
- N. All jumper cables shall be cut to length and shall use type 'N male' or 7/16" DIN connectors except as dictated by the connector supplied with the antenna.
- O. To meet cable bend-radius specifications, receiver equipment cabinet intra-cabling will be permitted by the use of 1/4" diameter, such as Andrew Superflex, or RG-142 double shielded coaxial cable. These cables shall be limited to 6 feet in length.
- P. All coaxial cables exiting the equipment cabinets shall do so through cabinet feed-throughs.
- Q. Transmit antennas, combiners, connectors, and surge suppressors shall be selected to prevent radio signal degradation caused by Passive Inter-Modulation (PIM) interference. In some cases, 7/16 DIN connectors, and/or silver-plated connectors with gold center pins shall be required to meet the PIM specification. No additional components shall be used after the combiner except the RF surge protector, RF power sensors, coaxial cable, connectors, grounding kits, and antenna unless specifically required herein.

Grounding and Lightning Protection

- A. The City shall provide site ground busses. However, the contractor shall be responsible for providing all antenna grounding devices at the cable entry point, and for connection to the building ground system.
- B. Repeater site antenna protection. Contractors shall use a Polyphaser ISUT50HN lightning protection device (or equivalent) installed indoors in combined transmitter antenna lines. A Polyphaser ISGF50LN (or equivalent) shall be installed in the multicoupled receiver line.
- C. Receiver site antenna protection. Contractors shall use a Polyphaser ISGF50LN for the multi-coupled receiver line only. Includes all mounting hardware and cables to connect to existing site ground buss bars.
- D. Other sites antenna protection. An IS50NX-C2 shall be supplied and installed on the transmission line of non-multicoupled receivers or control stations. Includes all mounting hardware and cables to connect to existing site ground buss bars.
- E. The external commercial power feed to all new fixed equipment power supplies provided under this contract shall be protected by a device with silicon avalanche diode type primary, with MOV backup (Northern Technology Model TCS250BL or equivalent).
- F. All external radio control circuits, such as telephone lines, to the new fixed equipment provided under this contract shall be protected by a punch-down bridge clip suppressor, Northern Technologies Model TLP-M66 or equivalent.
- G. All impulse suppressors shall be placed at the point where the coaxial antenna transmission line connects to the jumper cable from the radio frequency equipment, and shall be grounded at this point.
- H. All radio frequency and ancillary equipment supplied by the contractor under this contract shall be grounded to a central ground bus. All grounding interconnections shall be made by using #2 AWG solid copper wire or flat copper strapping having a width of not less than 2 inches and comply with NEC Code 70 where applicable.
- I. All coaxial antenna transmission line outer conductors shall be grounded to the tower. These grounding points shall be:
 - 1. Below the top connector of the line
 - 2. Above the point at which bends are made to exit the tower or antenna support structure.
 - 3. At the cable entry port (outdoors)
- J. The ground points shall be made by using copper ground straps from the same manufacturer as that supplying the coaxial antenna transmission line and in accordance with the manufacturer's installation practices. No grounding to tower cross braces is allowed, only direct conductor to ground. Braided ground straps are not acceptable.
- K. Cuts made in the outer jacket of the transmission line to install the ground straps shall be thoroughly sealed with a water resistant tape or compound as required by the manufacturer. Ground connections to galvanized tower legs shall be made with transition clamps thereby reducing the oxidation effect of dissimilar metals.

Terminating Cross Connect

- A. To conserve space in the wall mounted cross connect backboard small "110" or 3 M "BICS" type blocks should be utilized.
- B. The preferred terminating/cross connect type equipment is the KRONE, INC. LSA-PLUS series of blocks.
- C. All terminations must be clearly marked and labeled to allow rapid identification of every circuit and its termination point to facilitate repair or relocation of equipment.
- D. To the greatest extent possible, all equipment intercabling and/or cable/wiring bundles shall be neatly secured by means of plastic tie wraps, secured by surface mounted clamps and hidden from view.

References

Without limiting the generality of other requirements of this Specification, all work specified herein shall conform to or exceed the applicable requirements of the referenced Standards; provided that wherever the provisions of listed publications are in conflict with the requirements specified herein, the more stringent requirements shall apply unless in conflict with the equipment manufacturer's written recommendations:

- Title 24 of the California Code of Regulations (CCR; Effective November 1, 2002), which includes:
 - Part 1 - California Building Standards Administrative Code
 - Part 2 - California Building Code (Volumes 1, 2 and 3)
 - Part 3 - California Electrical Code (effective August 1, 2005)
 - Part 6 - California Energy Code (effective October 1, 2005).
 - Part 9 - California Fire Code
 - Part 12 - California Reference Standards Code
- California Essential Services Building Act, Health and Safety Code Chapter 2, Section 16000 (includes, but is not limited to nonstructural components such as communications systems, power switching equipment, and emergency backup systems)
- NEC 70 (National Electrical Code) Sections 100-300 and Section 800
- All pertinent FCC rules and regulations, specifically including 47 CFR Part 90: Private Land Mobile Radio; Part 15, Subpart J: Computing Devices; and Part 2, Subpart J, FCC Equipment Authorization Procedures.
- 47 CFR 1.1310 – Radio Frequency Radiation Exposure Limits
- Project 25 System & Standard Definitions (TSB102A), and all referenced design documents (TSB [Telecommunications Systems Bulletin], IS- [Interim Standard] or TIA [Telecommunication Industry Association Standard]).
- Uniform Building Code, including the seismic requirements of Section 2312, for Earthquake Zone 4
- ANSI/TIA/EIA Standards RS 232-C, RS 485, Category 5/5e/6 ANSI/TIA/EIA-568-A/B

- TIA/EIA 603-1 – Land mobile FM or PM communications equipment measurement and performance
- TIA/TSB-88B - Wireless Communications Systems – Performance In Noise- And Interference-Limited Situations – Recommended Methods For Technology-Independent Modeling, Simulation, And Verification
- NENA 04-502, E9-1-1 PSAP CPE Site Characteristics, Technical Information Document, Issue 1, March 31, 2004
- R56 Standards and Guidelines for Communications Sites (Motorola)
- Codes and Standards of good practice issued by the following organizations:
 - National Electric Manufacturers Association (NEMA)
 - Underwriters Laboratories (UL)
 - National Fire Protection Association (NFPA)
 - Publication No. 70, National Electrical Code.
 - Occupational Safety Health Administration (OSHA) Standard
 - OSHA Standards, 29 CFR, Part 1910

Section 10. MANAGEMENT AND TRAINING

City Project Manager

The City has designated the Information Technology Manager as its project manager for this project. After award, this individual will be the focal point of the contact for all matters between the City and the contractor. Department representatives will attend meetings pertaining to radio functionality, integration with business operations, and user training.

Contractor's Project Manager and Project Team

- A. The contractor shall identify the individual who will serve as the contractor's project manager ("PM"). This individual shall serve as the single point of contact between the contractor and the City.
- B. The identified contractor's PM shall be an employee of the contractor at the time of the response submission. The PM shall have a proven record of experience in projects of similar scope.
- C. The contractor shall identify other key members of the Project Team. Project Team members shall be employees or current sub-contractors of the contractor at the time of the response submission. Project Team members shall have a proven record of experience in projects of similar scope.
- D. The City reserves the right to accept or reject the identified contractor's PM. If, during the term of the contract, it is necessary to replace the PM, the City reserves the right to accept or reject the newly identified PM.

Section 11. PROJECT SCHEDULE

The contractor's proposal shall include a Gantt chart showing the activities and durations required to implement the system. This project schedule shall include, at a minimum, the following activities. The contractor may include "expanded" activities based upon experience or project related requirements.

Table 23. – Minimum Schedule Components

1. Execute Contract
2. Kick-off meeting with selected contractor
3. Finalize and order user equipment
4. Contractor Submits Prelim. Design – Infrastructure
5. City Performs Prelim. Design Review – Infrastructure (PDR)
6. Contractor Submits Final Design – Infrastructure
7. City Performs Final Design Review – Infrastructure (FDR)
8. Site preparations (City)
9. Oversee System Acceptance Factory Testing
10. Technician and Administrative training
11. Infrastructure / user / workstation equipment arrival in SLO
12. Remote site infrastructure installation/optimization
13. FS#1 Infrastructure backroom install./optimize
14. FS#1 dispatch workstation backroom install./config.
15. FS#1 dispatch workstation install./config.
16. FS#1 dispatch workstation acceptance testing
17. FS#1 dispatcher workstation training
18. Dispatch Cutover to new Workstations
19. Contractor submits system documentation
20. Contractor Radio Coverage Testing
21. System Acceptance Field Testing (initial)
22. Contractor resolves performance & installation issues (fixed infrastructure)
23. System Acceptance Field Testing ("retest")
24. 5-day City functional/ reliability testing
25. Contractor completes final punchlist items (cleanup)
26. Infrastructure Acceptance
27. 30-day system burn-in period (contractual)
28. Non-Public Safety user equipment training
29. Non-Public Safety Vehicle installations (City/Contractor)
30. Non-Public Safety user cutover complete
31. Public Safety user equipment training
32. Public Safety Vehicle installations (City/Contractor)
33. Public Safety user cutover complete
34. Contractor resolves performance & installation issues (subscribers)
35. Subscriber Acceptance Field Testing
36. Project completion

It is understood that this project schedule shall not be construed to be complete or final. During the period of contract negotiations, City will allow the contractor to submit a detailed schedule for inclusion to the contract.

During the implementation phase of this project, the contractor shall be required to submit updated monthly project schedules based upon the final accepted project schedule.

Section 12. DELIVERY AND STORAGE OF MATERIALS

The City shall provide the storage facility for equipment. The contractor shall indicate if any improvements are necessary.

- A. The contractor shall be responsible for security at the storage facility, coordinating, unloading, inspecting, accepting and storing all material deliveries. City personnel shall be excluded from performing any of these activities.
- B. All claims necessary because of damage or loss during shipment shall be the responsibility of the contractor.
- C. All stored materials shall remain the responsibility of the contractor until accepted by the City.
- D. The contractors' PM or contractors' designate shall be the only individuals authorized to accept materials delivered to the contractor. The contractor shall present to the City a notification of items being delivered. The City's shall receive monthly inventory status of all delivered equipment.
- E. Contractors shall list in their response the facilities where they plan to deliver and store the major system items prior to installation.
- F. The storage facility shall be for the City's project only.

Section 13. ACCEPTANCE TESTS

General

- A. The contractor shall develop the test plans and conduct the tests defined in this section. Except as specifically stated in this section, the contractor shall provide all items, instrumentation, materials, equipment and personnel to conduct the tests. Contractors are to provide detailed preliminary test plans for City's approval within 120 calendar days of receiving a notice to proceed from City.
- B. For each one of the tests and inspections identified in this section, the contractor's response shall identify the anticipated responsibilities of City during such activities.
- C. Contractor costs associated with the tests and inspections defined in this Section shall be clearly and individually identified in the pricing section of the response.

Initial System Test and Staging

- A. Prior to the installation of the fixed infrastructure, the contractor shall stage and test, to the greatest extent, all the equipment and software to be supplied under this contract. At a minimum, this is to include the radio infrastructure and associated sub-systems to show operational functionality.
- B. The location of the staging area will be selected by the contractor and approved by City. All costs related to staging and testing will be borne by the contractor except City travel and subsistence.
- C. Thirty (30) calendar days prior to the commencement of this activity, the contractor shall deliver a final test plan to the City for review; modification, if necessary; and approval.
- D. At the conclusion of this activity, the contractor shall present to the City written certification that the tests performed were in accordance with the approved test plan that the results of the test were successful and the actual results of the test as recorded.
- E. City shall attend this test. Travel costs for City or designated personnel attending the test shall be the responsibility of City.

Field Acceptance Testing

- A. After field installation of the fixed infrastructure, the contractor shall perform those checks and tests that were not performed during the initial testing. During this activity, City also expects that certain critical system parameters and functions, tested during the initial test, will be verified.
- B. Thirty (30) calendar days prior to the commencement of this activity, the contractor shall deliver a final field test plan to the City for review; modification, if necessary; and approval.
- C. At the conclusion of this activity, the contractor shall present to the City written certification that the tests performed were in accordance with the approved test plan that the results of the test were successful and the actual results of the test as recorded.
- D. City shall attend this test. Travel costs for City or designated personnel attending the test shall be the responsibility of City

Field Inspections

- A. After installation of the fixed infrastructure, the contractor shall perform field inspections to verify that equipment installations have been completed in accordance with City's

specifications, the contractor's installation practices and standards, and City's expectations that the workmanship will be neat and professional.

- B. Thirty (30) calendar days prior to the commencement of this activity, the contractor shall deliver a final field inspection plan to the City for review; modification, if necessary; and approval.
- C. At the conclusion of this activity, the contractor shall present to City written certification that the field inspections performed were in accordance with the approved plan, and that the results of the inspections were satisfactory.
- D. City shall attend these inspections.

Radio Coverage Verification Tests

- A. The coverage verification tests are to be performed under full foliage conditions preferable in the month of July.
- B. Test routes or grid to be traversed in conducting the radio system coverage tests will be submitted by the contractor within thirty (30) calendar days after the notice to proceed is supplied by City. City must be included in the process of selecting routes and associated test grids prior to mutually agreeing to the test routes.
- C. Routes shall be described and shown on an appropriate map, suitable for use during the test. Test routes and the test evaluation shall emphasize roadways utilized by City.
- D. If the system is completed so that coverage testing would take place without full foliage conditions, the contractor shall propose either to:
 - 1. Postpone full system acceptance until testing can be done under full foliage conditions, or,
 - 2. Test without full foliage, but factoring in agreed-on attenuation factors as degradation of the test results to account for foliage.
 - 3. If #2 is proposed, the contractor shall spell out in detail how the obligations fulfill all specification requirements, including coverage reliability, will be met after testing has taken place.
- E. The final coverage test plan is subject to approval of City. Any testing conducted prior to final approval will not be considered valid.
- F. These test plans shall cover the City's service area (including Cal Poly campus).
- G. Locations serviced by TRANS2 and TRANS3 requirements, BER or subjective DAQ tests shall be performed to ensure signal quality.

Voice System Coverage Test Failure

A mobile or portable coverage test shall be considered to have failed if score does not meet at least a DAQ 3.4 in 95% or more of the grids tested

- A. If the system fails the coverage test, then the contractor shall take corrective action. This action shall be at no cost to City, either for the corrections or for re-tests to verify adequacy of the corrections.
- B. For the purposes of this test, contractors shall have the responsibility to provide the test vehicles and drivers.

- C. At the conclusion of this activity, the contractor shall present to the City written certification that the tests performed were in accordance with the approved plan, and that the results in reference to corrective action, have resulted in the passing of the prior failed test locations.
- D. City shall participate in these tests.

Operational System Test

- A. This test shall be performed to demonstrate that the radio system and related sub-systems have been properly configured and optimized; and that they will operate fully and properly without a major system failure.
- B. This test shall be performed after all the tests and inspections defined earlier in this section have been accepted, and before system cutover.
- C. During the test, all system features and functions shall be fully operational and accessible to the test users. City shall approve the selection of test users.
- D. The duration of this test shall not be for less than a continuous thirty (30) calendar day period.
- E. City requires the following, not to exceed, response and repair times during this period:
 - 1. For all fixed infrastructure equipment
 - a. 24-hour x 7-day coverage
 - b. 2-hour on-site response (OSR)
 - c. 4-hour repair from time of OSR
 - 2. For all mobile equipment
 - a. 24-hour x 7-day coverage
 - b. 2-hour OSR
 - c. 4-hour repair or exchange from time of OSR
 - d. 3 business days to complete repairs from time of OSR
 - 3. For all portable equipment, less accessories
 - a. 8-hour x 5-day coverage
 - b. 8-hour OSR
 - c. 3 business days to complete repairs from time of OSR
- F. If a major failure occurs within the thirty (30) calendar day period, the continuation or re-start of the test will be at the discretion of the City. City defines major failure as follows:

“Any failure that causes full featured or full function operation to be lost on any one radio channel or at any one fixed equipment site”.
- G. The Operational System Test shall consider at a minimum, system reliability functional performance as specified herein.

- H. The Operational System Test shall include complete tests of fire station alerting capability.

Final System Acceptance

The following items shall be the criteria for providing final system acceptance:

- A. Successful completion (passing) of all testing defined in the Acceptance Test Plan
- B. Passing a 30-calendar day reliability test period
- C. Completed delivery, installation and programming of all fixed, mobile, portable, interfaces and control station equipment
- D. Completed delivery of all manuals, as-build documentation, maintenance documentation and other documentation; completion of all “punch list” items; and completion of required training.

Training

- A. The contractor shall provide training for radio maintenance, system administrators, dispatchers and field users based on a train-the-trainer approach. The contractor shall assume that all [trainer] training will be conducted in facilities owned or operated by City.
- B. The contractor shall develop a training plan, which shall be subject to City’s approval. It is expected that this plan will include, as necessary, session syllabus, classroom materials, audiovisual aids, hands-on fixtures, session schedules, number of sessions, etc. The contractor shall provide a detailed training syllabus for all training courses being provided as part of this response within 120 days of receiving the notice to proceed from City.
- C. All training materials produced by the contractor shall become the property of City.
- D. City envisions that, at a minimum, training will encompass the following categories. Contractors are asked to offer additional categories than those identified herein if deemed suitable for the systems they are offering.
 - 1. System Administrator “User” training – system management, alarms, diagnostics & reports (3 people estimated)
 - 2. Dispatcher “User” training (Train the Trainer) – on radio workstations and some field equipment (4 people estimated)
 - 3. Field Users (Train the Trainer) – mobiles and portables (10 trainers; 3-4 per training session; 1 session 8AM-12PM; 1 session 1PM-5PM; 1 session 6PM-10PM).
 - 4. Radio Maintenance Staff - Technical Training on system-wide components including but not limited to repeaters, mobiles, portables, consoles, control equipment, alarms, diagnostics and report generation (1 session with 2 technicians).
- E. For the purposes of providing hands-on training and to the greatest practical extent, all sessions shall use equipment that is fully system operational.
- F. Costs associated with training shall be clearly and individually identified in the pricing section of the response.

Section 14. WARRANTY

- A. The contractor shall provide ten (10) years of warranty from the date of final system acceptance or as noted on other sections of the specification. This warranty shall include all radio coverage, parts, labor and travel related to all the equipment and software supplied under this contract.

- B. The contractor shall detail conditions and response times for infrastructure, mobile, portable and workstations:
 - 1. Coverage (24-hour x 7-day, etc.)
 - 2. On-site response time (OSR)
 - 3. Repair from time of OSR
 - 4. Equipment turn-around time from OSR

- C. The contractor shall identify in the response the local organization or organizations, which will be responsible for, warranty during the first year. If more than one (1) organization is offered, a breakout shall be provided which identifies the items for which each organization will be responsible.

Section 15. PREVENTIVE MAINTENANCE

- A. Preventive maintenance of the system and its components shall be performed during the warranty period. This maintenance shall be limited to the equipment and software supplied under this contract.
- B. City assumes that this maintenance will be performed at regularly scheduled intervals in accordance with the recommendations of the manufacturer.

Section 16. SYSTEM DOCUMENTATION

General

- A. Thirty (30) days prior to final system acceptance, the contractor shall deliver three (3) copies of the following to the City; equipment & system manuals, engineering drawings, as-built documentation as well as system documentation of final field conditions.
- B. The City shall approve the contents and organization of all field documentation to be submitted by the contractor.
- C. Costs associated with the documentation required shall be clearly and individually identified in the pricing section of the response.

Documentation Media

- A. Equipment & system manuals supplied by manufacturers will be accepted in their standard form. In addition to documentation in printed form, the contractor will also submit a complete set of documentation including systems diagrams, maintenance manuals, and equipment manuals in electronic form such as PDF files, Microsoft Word, and AutoCAD.
- B. To the greatest extent, all field documentation shall be prepared in a format suitable for loose-leaf storage in 3-ring binders. In addition, this information shall be provided in an electronic format. The contractor shall supply the binders as necessary.
- C. Software and associated documentation shall be supplied to City on mutually agreed media.

Installation Documentation

- A. At a minimum, the following documentation shall be provided:
 - 1. Simple single line "as-built" system block diagrams for fixed end equipment installations. Blocks illustrated on these diagrams shall be labeled in such a way as to easily identify the type of equipment represented.
 - 2. Simple single line "as-built" diagrams for the antenna systems at each main radio site. Diagrams shall be labeled in such a way as to easily identify the type of item represented including its make and model number. City envisions that, at a minimum, the following items will be illustrated:
 - a) Antennas and associated mounts
 - b) Main transmission line, coaxial jumper cables, and their approximate lengths
 - c) Cable entrance ports, lightning arrestors and ground straps
 - d) Filters, combiners, multicouplers, pre-amps, cross-band couplers, etc.
- B. For each repeater site, "as-built" antenna location plans illustrating the location, azimuth and height above ground level of the mobile system antennas.
- C. For each radio site, simple "as-built" floor plans illustrating the location of equipment and/or equipment racks supplied under this contract in relation with other existing site equipment. For ease of reference, rack mounted equipment shall be shown as a frontal elevation view. All plans shall be scaled. As-built documentation shall also include operational test results for baseline documentation.

- D. A detailed inventory of fixed equipment installed shall be supplied to the City. The inventory shall be prepared in a Microsoft Excel spreadsheet format and shall include, at a minimum, make, model, serial number and location. The inventory shall be submitted in both printed and soft form.
- E. A detailed inventory of each mobile and portable equipment shall be supplied to the City. The inventory shall be prepared in a Microsoft Excel spreadsheet format and shall include, at a minimum, make, model, serial number and vehicle number. The inventory shall be submitted in both printed and soft form.

Operator Manuals or User Guides

- A. An operator manual and/or user guide shall be supplied with each mobile and portable delivered.
- B. A radio workstations operator manual and/or user guide shall be supplied for each dispatch position.
- C. A base radio and associated desktop remote operator manual and/or user guide shall be supplied for each facility that they are installed in.

Maintenance Manuals

Three (3) complete printed and (2) CD sets of all necessary installation and service manuals for each type of equipment supplied, regardless of whether it is manufactured by the Contractor or another supplier. Manuals shall be professionally bound. They shall be provided prior to final acceptance of the system.