

CITY OF HOUSTON

FINANCE & ADMINISTRATION DEPARTMENT
STRATEGIC PURCHASING DIVISION

REQUEST FOR PROPOSALS FOR A CITYWIDE
700 / 800 MHz TRUNKED RADIO SYSTEM

RFP NO. S29-T22459
VOLUME 2



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Section

1

Current Radio Communications Environment

1.1 Houston Airport System

1.1A The Houston Airport System has three facilities; George Bush Intercontinental Airport, William P. Hobby Airport, and Ellington Field. The 3-airport system served over 51 million passengers in 2006, including over 7 million international travelers.

1.1.1 Current Operations

1.1.1A The Houston Airport System has gone through a radio system transition over the last several years. The single-site 800 MHz EDACS (Enhanced Digital Access System) radio system that was purchased by the City of Houston for the Airport System in 1999 has been decommissioned. Radio coverage problems at the George Bush Intercontinental Airport, Hobby Airport and Ellington Field and other factors prompted HAS to join the Regional Radio System operated by the Harris County IT Department. HAS will utilize its 800 MHz radio channels to support the addition of new ASTRO 25 v7.1 trunked repeater sites at the George Bush and Hobby airport facilities.

1.1.1B Today Harris County actually has two separate voice radio trunked system platforms, an older SmartZone v4.1 system and a newer ASTRO 25 v7.1 system. The ASTRO 25 v7.1 system is currently much smaller than the SmartZone 4.1 system, but it is the platform that Harris County will be developing from this point forward.

1.1.1C The Houston Airport System is now in the process of developing 2 new Motorola Astro 25 800 MHz radio repeater sites to support airport radio communications needs. The two new sites will be networked into the Harris County Astro 25 System when completed and become part of the Regional Radio System. The new 5-channel Astro 25 (V7.X) repeater site for Intercontinental Airport will be located on airport property at the FIS building, parking garage, level 8, in the southeast corner of the building.

1.1.1D The new 5-channel repeater site for Hobby Airport will be installed at 8700 Paul B. Koonce Street in the old FAA building next to the fire station on the south side of Hobby Airport. A third site is also planned in order to provide wide-area mobile coverage between all three Houston airports. This site will be installed on the Allied Tower Building in downtown Houston, which was the first repeater site on the older Smartzone 4.1 system.

1.1.2 Radio System Coverage

1.1.2A As previously mentioned, the Regional Radio System has an older SmartZone 4.1 platform. This system will be used by the Houston Airport System until the new Astro 25 repeater sites are completed. The SmartZone 4.1 coverage is provided by several sites at each of the airports and it is also supplemented at Intercontinental Airport by a DAS (Distributed Antennas System). HAS recently finished implementing a new DAS that extends radio coverage to the underground tunnel system and all airport terminals except Terminal E. The DAS is a channelized, optically distributed antenna system that allows for multi-band

radio frequency operation. This system was installed by the Sprint consortium, a group made up several of the commercial cellular providers.

- 1.1.2B Once the new IAH Astro 25 repeater site is completed and on the air, the DAS system will be configured to tap directly into the repeater site via an optical or coaxial connection, thus eliminating the over-the-air link which is currently used to provide the source signal to the DAS.
- 1.1.2C With the DAS now in operation, the Regional Radio System coverage within the terminals at IAH is reportedly between 90-95%. This coverage is provided by multiple sites, some of which are a significant distance from the airport. The repeater sites used at Intercontinental Airport are as follows:
- ◆ Tomball repeater site provides coverage to the Northwest corner of IAH
 - ◆ Tamina Road repeater site provides coverage to the North side of IAH
 - ◆ Humble repeater site provides coverage to the Northeast corner of IAH
 - ◆ Houston repeater site (Allied Bank) provides coverage to the Southside of IAH
- 1.1.2D Radio coverage in the Hobby Airport terminal is reported as being excellent without the use of any bi-directional amplifiers. The Houston repeater site (Allied Bank) provides coverage to the north side of Hobby Airport, while the Pearland repeater site provides coverage to the south side.
- 1.1.3 Dispatch Operations
- 1.1.3A The Houston Airport System is divided into three separate geographic zones of operation:
- ◆ Zone (A) - Houston Intercontinental Airport (IAH)
 - ◆ Zone (B) - Hobby Airport
 - ◆ Zone (C) - Ellington Field
- 1.1.3B Airport communications operations are handled by two groups: C3 and RACOM. C3 (Communications Command Control) provides all dispatching services for airport security. It is part of the airport Public Safety Group, which handles security Issues, inspects the airport for safety, and initiates the appropriate action.
- 1.1.3C The RACOM Communications Center operates FIDS the Flight Information Display System (FIDS), the main switchboard, and provides radio dispatch services for all other airport operations other than security. This includes Airfield & Grounds, PPM, Operations. RACOM initiates alerts to operations personnel, provides dispatch services for maintenance and provides backup for airport paging operations.
- 1.1.3D The Houston Airport System has a Motorola Gold Elite console system with a CEB (Central Electronic Bank) at both Intercontinental Airport and at Hobby Airport. The 21-dispatch console position system was installed by the Harris County IT Department.
- 1.1.3E **IAH Airport** has a total of fifteen (15) Gold Elite console positions. There are 10 consoles in the RACOM area, one of which is designated as a supervisory position. There are also 5 consoles located in C3, including the designated supervisory position.

1.1.3F A general console layout for the RACOM and C3 dispatch positions is provided in Figure 1.1.3A & Figure 1.1.3B.

Figure 1.1.3A

RACOM

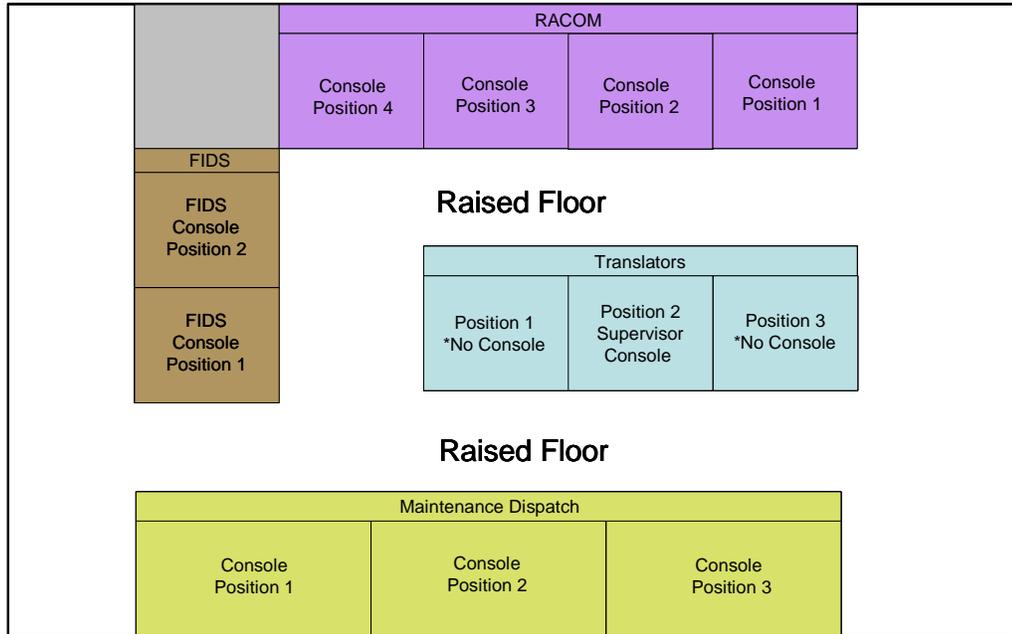
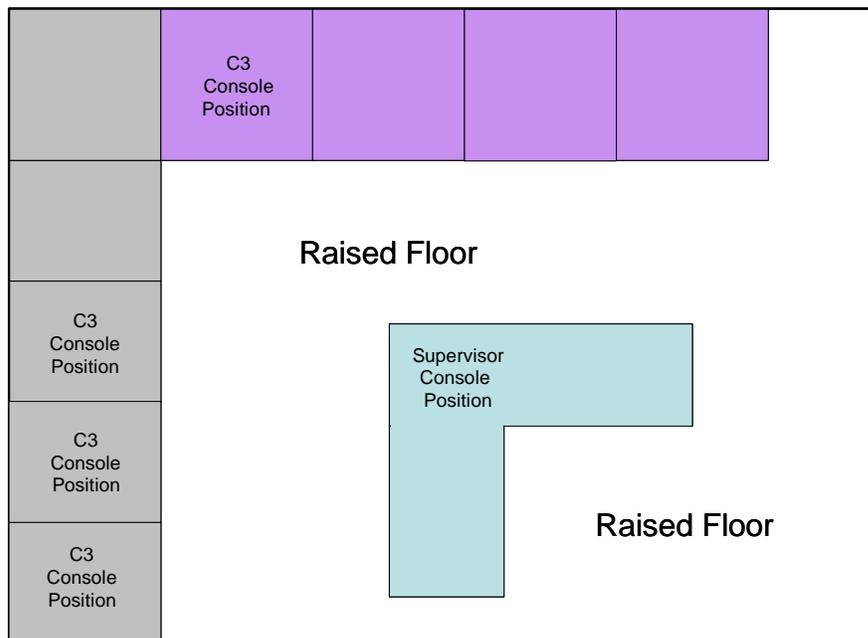


Figure 1.1.3B

C3



1.1.3G The dispatch positions within RACOM are designated as follows:

- ◆ Maintenance Dispatch has three console positions. There are usually two dispatchers on duty at any given time. The dispatchers are not dedicated to a specific function. They share the workload and handle calls for service. Maintenance dispatch uses the following seven talkgroups:
 - Airfields and Grounds
 - Tech Systems
 - Tech Services
 - PPM (Physical Plant Maintenance)
 - Building Services
 - Electrical
 - Systems
 - FIDS (Flight Information Display System) has two (2) console positions and operates on a single talkgroup known as FIS (Federal Inspection Service). Airport staff working in Terminal D (international), Terminal E and FIS all use this talkgroup to communicate information pertaining to arriving international flights.
 - RACOM has four (4) dispatch console positions and one (1) supervisor position with override capability. Each console is configured with the following 12 talkgroups:
 - Airfields and Grounds
 - Tech Systems
 - Tech Services
 - PPM (Physical Plant Maintenance)
 - Building Services
 - Electrical
 - Systems
 - FIS
 - Management
 - Ops Private
 - IT
 - Survey

1.1.3H **Hobby Airport** has a total of six (6) Gold Elite console positions. Hobby operates with the similar setup as IAH, with one less console in C3. There are two consoles in RACOM, one of which is designated as a supervisory position and four consoles located in C3, with a single position designated as the supervisory position. There are plans to add a third console to RACOM in the fourth quarter of 2007.

1.1.3I **Ellington Field** does not currently have any dispatch console equipment.

Backup Equipment

- 1.1.3J IAH has portable radios for backup radio dispatch operations.
- 1.1.3K Hobby has desktop control stations with individual UPS for backup radio dispatch operations.

Air Traffic Control Tower

- 1.1.3L HAS Air Traffic Control Tower has an 800 MHz trunked radio on the Harris County radio system and also a dedicated talkgroup (Ops Private). The 800 MHz trunked radio is only used as a backup in case the phone and the primary radio fails.
- 1.1.3M ARF (Aircraft Rescue and Fire) apparatus which are operated by the Houston Fire Department, each have a HFD UHF radios, 800 MHz trunked radios, airband VHF AM radios, and MDTs. The tower primarily uses an airband VHF AM radio operating on the ground control frequency (121.9 MHz) for all ground coordination.

Logging Recorder

- 1.1.3N HAS is in the process of purchasing a NICELOG recording system for each airport to record all their talkgroups. They already have a console based instant recall recorder at each console position.

1.1.4 Needs & Requirements

Future Needs:

- 1.1.4A Additional future radio dispatch equipment requirements expressed by the HAS are as follows:
- ◆ Ability to use the existing console furniture for any future radio system dispatch console equipment.
 - ◆ **Multiple types of alert tones:** The only alert tone they currently use is the warble tone.
 - ◆ The Call Alert feature would be useful in the future.
 - ◆ **Patching:** The capability of patching multiple talkgroups from the dispatch console is required.
 - ◆ PTT (Push to Talk) Unit ID that displays the radio identification number of the radio that is transmitting.
 - ◆ Radio Alias database will be required. Individual names will be used on some radios, while others will have an operational position or functional description instead of a name.
 - ◆ Emergency Alerting is required for all HAS portable and mobile radios.
 - ◆ Headsets that are set up to allow dispatchers to operate on either the radio dispatch console or the telephone system with a single headset and the ability to select the desired outbound audio source by using a multi-pedal foot switch.

- 1.2.1C The Department's simulcast system was originally installed in 1990, and was cutover and became operational in 1991. The system is based on Motorola's 225-watt MSF-5000 repeaters and analog simulcast technology. Most of the simulcast equipment is no longer manufactured and is facing declining support, the MSF 5000 has not been supported since 2000..
- 1.2.1D The simulcast system incorporates four transmitter sites, three of which are City-owned tower sites:
- ◆ Lake Houston
 - ◆ Teague Road
 - ◆ Reed Road
- 1.2.1E The fourth site is located at One Shell Plaza.
- 1.2.1F The prime simulcast control point is located near the roof of One Shell Plaza. The City currently leases a number of suites at that facility, which support Police and Fire radio equipment, the City's optical fiber terminal, and two offices for Police and Fire Radio Maintenance personnel.
- 1.2.1G Four primary repeater channels have also been installed at the City's Coletto tower site, which incorporates an equipment shelter, 300' self-supporting tower, and auxiliary power generator at one of the City's Public Works facilities. The Coletto site is shared with the Police Department.
- 1.2.1H One Shell Plaza also serves as the focal point for the dispatch console system. Therefore, dispatcher consoles would also be disabled, requiring dispatch personnel to utilize handheld radios to communicate with field personnel.
- 1.2.1I The City's radio equipment is located in a secured environment, and is also supported by a City-owned auxiliary power generator within the building. The prime simulcast control point is linked to the various transmitter sites via the City's optical fiber network. In addition, the Fire Department also leases T-1 service from Southwestern Bell to serve as backup links to the transmitter sites in the event that a portion of the fiber optic network fails.
- 1.2.1J To help provide reliable inbound radio communications from field personnel to the dispatch center, the radio system incorporates 24 receiver sites locations, including the 4 transmitter sites. Of the 24 receiver sites in operation, 20 are considered satellite receive locations, strategically located throughout the City at various fire stations. Most of the receiver sites utilize leased telco circuits for connectivity between the receiver location and the voting comparator at One Shell Plaza. Telephone circuits that are used to provide connectivity between remote receivers and radio system have been diversified. This method of connectivity allows a reliable connection during major catastrophes such as hurricanes. Connectivity is accomplished by several methods including PLPA, FDPA and Fiber T-
- 1.2.2 User Equipment
- 1.2.2A The Department's mobile and portable radios are manufactured by Motorola and are from a variety of Motorola product lines, depending upon the particular application and age of the equipment. Currently, the Department operates approximately 954 mobile radios and approximately 1,776 portable radios, supporting both Fire and EMS divisions. As the City of

Houston population continues to expand, additional homes and businesses are added, and the Fire Department's demand for service increases, the radio user population will grow as well.

1.2.2B The Department's radio inventory currently breaks down as follows.

Fire Subscriber Radio Equipment

<u>Type</u>	<u>Quantity</u>	<u>Band</u>	<u>Model</u>
Portable	1,045	UHF	Motorola XTS5000R
Portable	373	UHF	Motorola XTS3500R
Portable	5	VHF	Motorola XTS5000R (Used for I.C.R.I.)
Portable	140	800 MHz	Motorola XTS5000R
Mobile	158	UHF	Motorola XTL5000
Mobile	169	UHF	Motorola Astro Spectra
Mobile	412	UHF	Motorola Spectra
Mobile	109	VHF	Motorola Spectra (Back Up Station Alerting)

1.2.3 Dispatch Operations

1.2.3A On September 23, 2003, the Police and Fire Departments both relocated their dispatching operations from their old dispatch facilities to the new Houston Emergency Communications Center (HEC) located at 5320 North Shepherd Drive, just north of downtown. Prior to moving to the new facility, the Fire Department Office of Emergency Communications (OEC) center was located at 333 Preston Avenue, and supported radio operator consoles based on Motorola's Centracom II technology. The City's fiber system provided connectivity between the Preston facility and One Shell Plaza. The Fire Department had also installed a 23 GHz microwave link between the two facilities to help maintain the OEC operation in the event that the fiber link failed. A third layer of connectivity was also provided via a leased Southwestern Bell T-1 service. The HFD OEC has been relocated to the HEC Center; the Preston facility has been dismantled and is no longer operational.

1.2.3B The new Fire/EMS radio officer consoles located at the HEC Center were manufactured by Orbacom, and are based on their T-5 system technology.

1.2.3C Houston Fire Department also maintains an 8 channel remote dispatch center located at Ben Taub. Emergency Medical units report back to a primary EMS channel "MED 1" and then are directed by the dispatcher to 1 of 7 other medical frequencies. These channels will not allow responding units to simulcast thus keeping patient confidential information from being monitored. Only the dispatch center at Ben Taub is simulcasted.

1.2.3D The HEC Center call-take and dispatch center is located on the 2nd floor and is divided into three operational areas. The HFD Fire/EMS radio officers and call-takers are located on the left-hand side of the room, City of Houston call-takers and Police call-takers are located

in the center area of the room, and Police dispatch personnel are located on the right-hand side of the room.

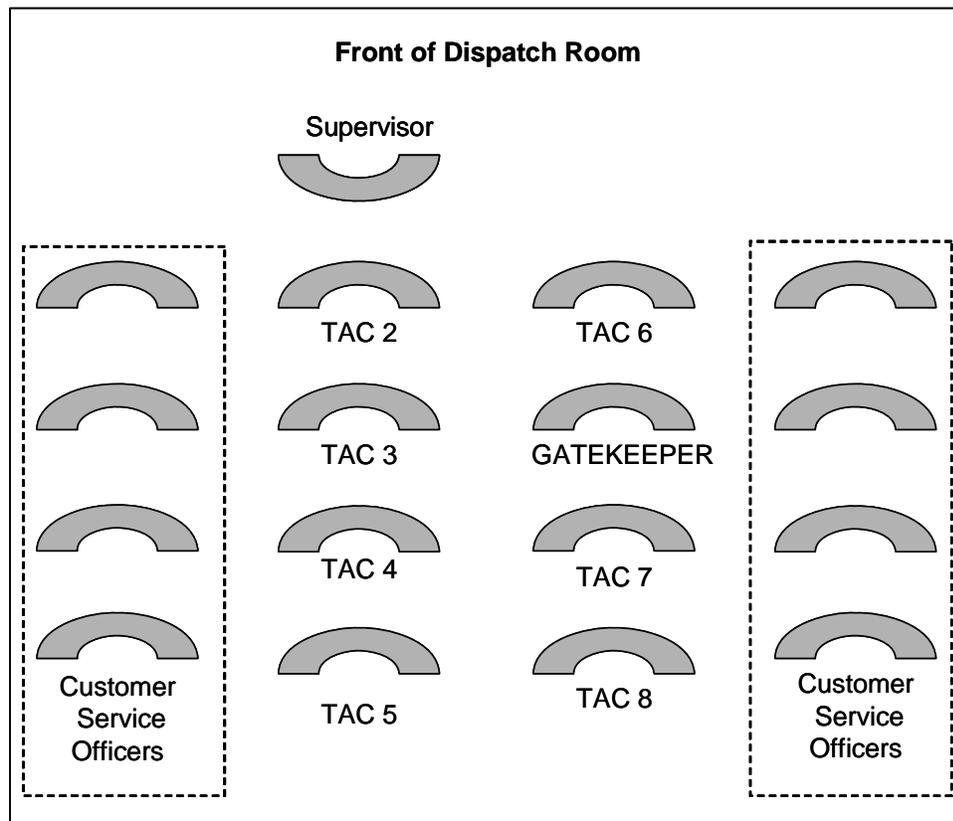
- 1.2.3E Communications links between One Shell Plaza and the HEC Center are provided by Southwestern Bell and are part of the company's Megalink III service offering. According to City staff, Southwestern Bell provides redundant fiber service to the facility; however, it is unknown whether the redundant service utilizes entirely different routes between the two facilities.
- 1.2.3F The Houston Metropolitan Statistical Area (MSA) was recently selected to receive approximately \$6 million in Federal matching grant funds from the Community Oriented Policing (COPS) grant fund. The purpose of the Federal assistance is to improve radio communications interoperability within the Houston MSA. Approximately \$2.5 million of the funding will be utilized to construct a new radio communications tower at the HEC Center and to provide licensed microwave connectivity between the HEC Center, One Shell Plaza, and 61 Riesner (HPD). This microwave capability will help support connectivity between the HEC Center and the HPD and HFD radio control points.
- 1.2.3G The old OEC facility has been dismantled, but the Fire Department still has an essential need for a viable backup dispatch facility. Tentative plans involve the development of backup Fire dispatch capability within the old Police dispatch center at 61 Riesner Street. The City is planning to reconfigure the old HPD dispatch center to support both Police and Fire dispatch operations in the event that dispatching from the HEC Center is disrupted. (This project has not been instituted.) The exact schedule and timeframe for completion of the backup dispatch facility at Reisner has not been finalized. During this interim period, if the HEC Center becomes disabled, HFD OEC (Office of Emergency Communications) could relocate to 602 Sawyer Avenue (City Neutral 9-1-1 PSAP), to receive and dispatch calls for Fire/EMS services. OEC personnel would utilize handheld radios to communicate with personnel in the field.
- 1.2.3H As of today, the property at 333 Preston could be restructured to provide a backup facility for emergency dispatch and communications in the event that the HEC Center became disabled. However, the Preston property is in high demand and it is unknown if the City of Houston is still seeking to sell the property.
- 1.2.3I Fire and EMS radio equipment are programmed to operate in four different categories of radio channels, as follows:
- ◆ **A Channels**—Supported by the simulcast system in a repeated mode
 - ◆ **B Channels**—Nationwide medical channels
 - ◆ **C Channels**—Configured as a scan group for Channels 1-8
 - ◆ **D Channels**—Talk around frequencies based on the A channels, not recorded at OEC, and can occasionally interfere with the associated A channels if operated in close proximity
- 1.2.3J The A Channels are currently configured as follows:
- ◆ **A1**—Citywide operation, EAS Voice Alerting, and UHF MDC data to Fire station radios

- ◆ **A2**—Citywide Primary Tactical channel
 - ◆ **A3**—Citywide Primary Tactical channel
 - ◆ **A4**—Citywide Primary Tactical channel
 - ◆ **A5**—Citywide Secondary Tactical channel used during major Fire and EMS emergencies
 - ◆ **A6**—Citywide Administrative channel, used for information updating, formerly EMS Dispatch. Also utilized as an interoperability channel with HPD and other agencies.
 - ◆ **A7**—Citywide Secondary Tactical channel used during major Fire and EMS emergencies and serves as a direct communication link with Life Flight helicopter (a national Emergency Medical channel)
 - ◆ **A8** - Citywide Secondary Tactical channel used during major Fire and EMS emergencies
- 1.2.3K The Fire Department also operates a new Emergency Alerting System (EAS), which provides automated fire station alerting for Fire and EMS calls for service. The EAS system transfers dispatch information from the new Computer Aided Dispatch system, located at the Houston Emergency Communications Center, to the various fire stations and responding Fire and EMS units throughout the City. The EAS system utilizes the Police Department's Motorola 800 MHz Mobile Data Computer system infrastructure for the transmission of call data.
- 1.2.3L Once the call data has been transmitted and received by the targeted fire stations, a personal computer utilizing software developed by Custom Logic Design displays the dispatch information on the computer's display, prints the information, and converts the text information to speech, which is routed to the Public Address speakers in the station and to in-service mobile apparatus.
- 1.2.3M The Department also operates a secondary alerting system through the UHF simulcast system over Channel A1. The system alerts each fire station via a unique data code. Each station is equipped with an independent Motorola Spectra radio configured to respond to its unique address sent from the OEC. Upon receipt of a station alert message, the radio activates station lights and the Public Address system within the station. Once alerted, the Fire/EMS radio officer provides incident information by voice over the simulcast Channel A1. The system is automated by the CAD system and offers a suggested response to the radio officer. Upon review and approval of the suggested response, the radio officer can normally utilize a single button or command in order to alert all companies associated with the event. The alert includes both the primary and necessary backup stations.
- 1.2.3N VHF station alerting equipment is also maintained as a third level of alerting capability and provides a functionality similar to the UHF alerting system.
- 1.2.3O Within the OEC, when a call is first received, it is routed to the HFD Fire/EMS radio officer position that serves as a gatekeeper to evaluate the call type and route it to the appropriate Fire/EMS radio officer position. Fire calls are dispatched originally over Channel A1, the citywide channel that supports Voice Alerting to the Fire stations. Channel A1 serves as

the "home channel". Department personnel also monitor this channel when they are not actively involved in a call for service. Once a station has been alerted to respond to an event, the Computer Aided Dispatch (CAD) system at the HEC Center tells the responding personnel which tactical channel they have been assigned to for the call via the Mobile Data Computer (MDC) in the apparatus. All "front line" apparatus are equipped with a Motorola MW-520 or MW-800 mobile data computer. As the responding units receive their assignment and begin proceeding to the given location, the personnel in the vehicle update their status condition to show that they are en route by pressing the appropriate status button on the Mobile Data Computer.

- 1.2.3P The responding crews do not normally use the voice radio except in unusual circumstances. This helps minimize voice traffic on the radio system, and helps eliminate mispronunciation of street names and numbers. The voice radios are generally used to get clarify information that was sent over the data system or that appears be in error. When the units arrive at the scene, they update their status condition again by depressing the "Arrived at Scene" button on the Mobile Data Computer. The status change is reflected at the Fire/EMS radio officer positions on their CAD system status monitor.
- 1.2.3Q If the responding units arrive and discover that the fire is small and can be handled with the water supply in the tanker, and supply lines do not need to be run to a nearby water source, responding units will likely remain on the original TAC channel that was assigned at the beginning of the call.
- 1.2.3R If the fire is sizeable, and the crew lays water lines to a nearby water source, the emergency crews will most likely request to be moved to another tactical channel for the duration of the event. The tactical channels used for fire ground communications include Channels A7, A8, and A5. These tactical channels are assigned by OEC in that order, with Channel A7 being the first choice, and Channel A5 being the last choice. Channel A5 is the last channel to be selected because, on occasion, there is internal system intermodulation interference resulting from a mix of other HFD system frequencies. HFD typically uses A5 for EMS, especially for large EMS events. If there is a large Fire event it is not uncommon for EMS units to be switched to A5 to keep traffic low on the Fire Ops channel (A7 or A8).
- 1.2.3S The C channels allow supervisory personnel and other Fire Department staff to monitor activity on the Fire radio system. Even with the new radio system, the Department's radios will still need to have scan capability. It is preferred that the radio equipment in a new system be equipped to provide user definable scan lists so that the personnel using the equipment can select only the particular channels that they wish to monitor while using the scan feature.

Figure 1.2.3 Fire Dispatch Positions



1.2.3T The Fire Department OEC currently operates 9 radio officer positions at the Houston Emergency Center (HEC), and a single console position in the Fire Radio Maintenance Facility at One Shell Plaza. There are nine (9) Fire dispatch positions as depicted in Figure 1.1.8, configured as follows:

- ◆ **Position 1** - Citywide Fire Dispatch channel
- ◆ **Position 2** - Citywide Primary Tactical channel
- ◆ **Position 3** - Citywide Primary Tactical channel
- ◆ **Position 4** - Citywide Primary Tactical channel
- ◆ **Position 5** - Citywide Secondary Tactical channel
- ◆ **Position 6** - Citywide Administrative/Tactical channel
- ◆ **Position 7** - Citywide Secondary Tactical channel
- ◆ **Position 8** - City Secondary Tactical channel
- ◆ **Position 9** - Supervisor

1.2.3U There is one additional Orbacom T-5 console training position configured for Fire. With the exception of the supervisor's console, all radio officer console positions are equipped alike, so that any position can be used to support any Fire/EMS dispatching need. Each OEC position is also equipped with a handheld radio to allow the radio officer to reach field personnel in the event that that OEC console position or the entire console system were to fail.

- 1.2.3V Fire/EMS radio officers rely heavily on the Computer Aided Dispatching system to help track the current unit status of all of the departmental resources and to help recommend the best suggested equipment response to any given incident. If the CAD system becomes unavailable, Fire/EMS radio officers can dispatch by voice radio, but it is more difficult to know who is available and to identify the best suggested response without the aid of the CAD system.
- 1.2.3W The Fire Department currently operates 22 districts, each of which supports approximately 3-5 stations. At the present time, one of the primary problems they experience is an inadequate number of tactical channels for use throughout the City's service area. Most EMS emergencies are handled on the original tactical channel that was assigned. While working Fire emergencies utilize one or more tactical channels. The optimum number of tactical channels needed for any multiple alarm fire or major incident would consist of three to five (3-5) channels to properly operate utilizing the National Incident Management System (NIMS). On a busy day or night, the tactical channels can be overwhelmed with traffic because they may be supporting multiple ongoing events at one time. Multiple alarm fires may involve 30-40 companies, with over 100 personnel located at the scene. On extended events, the Fire Department can bring in its Incident Command vehicle to help support the logistics of the situation. Communication traffic levels are high in these types of events, due to the need for supporting multiple divisions and sectors necessary during emergency events (i.e., EMS, Rehab, Staging, HazMat, etc.).
- 1.2.3X The Houston Fire Department is also responsible for providing Emergency Medical Service response throughout the City's service area. EMS is a division of the Houston Fire Department. All EMS personnel are also certified firefighters, and are required to respond to Fire and EMS emergencies. Today, EMS operates 99 units and 9 Supervisors that are all strategically stationed throughout the City's service area. Currently, 51 of the EMS units are considered Advanced Life Support (ALS) Medical Response units.
- 1.2.3Y The Fire Department currently operates 87 fire stations, some of which support both Fire and EMS units. Some fire stations are equipped with multiple EMS response units. EMS operates three basic types of units, including:
- ◆ **Squads**—Non-transport units providing support personnel
 - ◆ **Basic Units**—Staffed by Emergency Medical Technicians (EMT's)
 - ◆ **Advanced Life Support (ALS) Units**—Staffed with paramedic level personnel
- 1.2.3Z One of HFD's goals is to equip all of the City's fire stations with at least one EMS unit, and some with two units, within the next five years. At the present time, the EMS Division handles approximately 80% of the call volume handled by the Department. The remaining 20% of calls are fire responses.
- 1.2.3AA EMS personnel report that radio coverage is generally good, however, coverage in high-rise and other hardened or reinforced buildings and far outlying areas have always been a problem.
- 1.2.3BB All of the EMS units are equipped with two mobile radios, one in the front cab of the vehicle, and the other in the rear medic compartment. The mobile radios are Motorola wide-band analog Spectra mobiles that range in age from 13 years old to recently purchased units.

- 1.2.3CC The Fire Department is currently working to implement Automatic Vehicle Response (AVR) technology in all of its units. The Fire Department's AVL system currently supports mapping capability at the HEC Center, but does not support Automatic Vehicle Response (AVR) with the CAD system. The Department utilizes an ACS Records Management System.
- 1.2.3DD EMS utilizes 12-lead telemetry equipment to transmit EKG information to local area hospitals. Cellular telephones in the ambulances or a telephone line at the patient's home are used to transfer EKG information. Although the Department still operates radio equipment on the Med channels for verbal communications to and from telemetry, the Med channels are no longer used for the purpose of submitting EKG information.
- 1.2.3EE In addition to their mobile radios, each EMS unit is equipped with a two portable radios, and a vehicular charger within each unit keeps it charged. EMS is being required to change from the vehicular chargers because Motorola no longer makes them for the Saber portable radios. EMS is in the process of installing portable radio chargers in the stations. In the new radio system, EMS needs 2 portable radios per unit, and the estimated radio count provided by the Department's Radio Communications Management personnel includes 2 portables per unit for planning purposes. Some EMS units have a cellular telephone that supports both telephone calling and the transmission of telemetry data.
- 1.2.3FF Now that EMS units are no longer going to be equipped with vehicular chargers, each EMS unit will be equipped with a spare battery for each associated portable radio. The Fire Department currently has approximately 756 Fire and EMS personnel on duty per shift, plus an additional 100 administrative personnel. While vehicle chargers if available would provide convenience to the emergency responders, bank chargers will be required at all Fire stations and other facilities where HFD employees equipped with portable radios are assigned (i.e. OEC, Logistics, Arson, Fire Prevention, etc.).
- 1.2.3GG Mobile and portable radios for EMS are programmed just like their Fire counterparts. Primary operations take place on the 8 repeated channels that include the following:
- ◆ **A1**—Citywide Fire and EMS dispatch via the EAS system, and MDC data to fire stations
 - ◆ **A2**—Citywide Primary Tactical Channel
 - ◆ **A3**—Citywide Primary Tactical Channel
 - ◆ **A4**—Citywide Primary Tactical Channel
 - ◆ **A5**—Citywide Secondary Tactical Channel
 - ◆ **A6**—Citywide Administrative channel, used for information updating, formerly EMS Dispatch. Also utilized as an interoperability channel with HPD and other agencies.
 - ◆ **A7**—Citywide Secondary Tactical channel used during major Fire and EMS emergencies and serves as a direct communication link with Life Flight helicopter (a national Emergency Medical channel)
 - ◆ **A8**—Citywide Secondary Tactical Channel used during major Fire and EMS emergencies.

1.2.3HH The EMS Division is dispatched by the HFD Fire/EMS radio officers located in the OEC at the HEC Center. The new CAD system operates differently than the previous system, which has required the Fire Department to modify its operational procedures somewhat.

1.2.3II The process for the dispatching of an EMS call is as follows:

- ◆ Call for service is received by the HFD Fire/EMS gatekeeper, who evaluates the type of call and loads it into the CAD system for routing to the appropriate tactical radio operator.
- ◆ The CAD system routes call information to the Mobile Data Computer in the assigned units and to the EAS computers at fire stations. The EAS terminal at the stations “reads” the dispatch message over the station PA system. Dispatch information includes the assigned tactical radio channel for use.
- ◆ The EMS incident information is then transmitted to the responding crews and their associated stations, utilizing the same method as dispatching Fire Emergencies.
- ◆ Call information is sent to alphanumeric pagers of responding units via the Arch Wireless Network. Information sent to the pagers is essentially the same information sent to the Mobile Data Computer.
- ◆ Crews have 2 minutes to get “en route” from the time the call is originally dispatched.
- ◆ Once the crew is “en route” they depress the “en route” status key on the Mobile Data Computer, which tells the CAD system the unit is currently responding to their given assignment.
- ◆ Crew arrives at the scene, and depresses the “arrived at scene” button on the Mobile Data Computer to notify their assigned tactical Fire/EMS radio officer and the CAD system that they have arrived.
- ◆ Crew handles the situation as necessary.
- ◆ Crew departs the scene, in route to a medical facility, updating their status via the Mobile Data Computer or they go back in-service.
- ◆ Crew arrives at the medical facility, once again updating their status via the MDC.
- ◆ Crew notifies their assigned tactical Fire/EMS radio officer that they are complete with the call, and once again available for service, via the MDC status change.

- 1.2.3JJ The Department's portable radios are used in a variety of configurations, depending upon the particular application. A few of the Fire Chiefs use portable radios equipped with speaker microphones but most of the radios worn on the belt are not equipped with the speaker mics. When the radios are used with the bunker gear they are placed inside a special pocket and they use special headsets which are designed to fit under the airmasks.
- 1.2.3KK All portable radios and their associated batteries carry an intrinsically safe rating, and the "ruggedized" option with fluorescent yellow color. Portable radio batteries are replaced on an annual basis or when they exhibit less than 80% of their original rated capacity. The battery technology currently in use is NiCad. The Department does utilize battery analyzers/ conditioners to help maintain peak operating battery efficiency. A variety of both individual and bank chargers are used as required. Currently the Fire Department uses Motorola Impress NiMH (Nickel Metal Hydride). Batteries.
- 1.2.3LL As part of its replacement program, the Fire Department has been purchasing narrowband capable portable radios. The new Motorola XTS-5000 series of portable radios are capable of both analog and digital narrowband operation. Once deployed, the majority of the HFD portable radios will be capable of narrowband digital operation, although the current HFD radio infrastructure will not support narrowband operation. At the present time, virtually none of the HFD mobile radios can support narrowband digital operation. All new mobile radios purchased will be capable of narrowband digital operation.
- 1.2.3MM The Department also utilizes approximately 1,200 Cingular cellular telephones which are distributed to Fire personnel on an "as needed" basis. The use of cellular phones is strictly limited to Fire Department business.

1.2.4 Radio System Problems

Coverage Problems

- 1.2.4A Today, the Fire Department is experiencing radio coverage problems within high-rise buildings, tunnel systems, parking garages at various facilities, within hospitals, shopping malls, and within the annexed City of Kingwood. Portable radio coverage is also problematic along the Houston Ship Channel.

Channel Congestion

- 1.2.4B Due to the growth and the demand for Fire and EMS service responses over the past 12 years, radio system activity has reached a level that can no longer be accommodated by the number of radio channels supported by the system. Today, there are seven tactical radio channels utilized to support Fire and EMS activities throughout the City. Under the current channel configuration, personnel responding to events in various parts of the City must share the use of tactical radio channels because there are simply not enough channels to go around.

Channel Interference

- 1.2.4C The Department does experience radio interference on Channel A5, which results from an intermodulation mix of three of the Department's transmit frequencies that can, on occasion, interfere directly with Channel A5. For this reason, A5 is the last tactical channel to be assigned to support field operations. Channel A5 is frequently used for EMS operations on large events and for communication between EMS units and Supervisors.

Outdated Equipment

- 1.2.4D As the Fire Department radio system enters its 17th year of operation, the majority of the radio infrastructure equipment is no longer either manufactured or supported by the manufacturer. The mobile and portable radio equipment is maintained in house by the Fire Department's Radio Communications Shop.

System Redundancy

- 1.2.4E Each repeater site incorporates multiple repeaters, and is supported by both the City's optical fiber network and leased T-1 service from Southwestern Bell. A redundant simulcast control point was not incorporated into the system, due to the high cost involved at the time the system was developed.
- 1.2.4F With relocation of Fire Dispatch to the HEC Center, new redundant optical fiber service has been provided by Southwestern Bell. True route diversity on the Southwestern Bell fiber has not been confirmed by the City. To help ensure redundant connectivity, the City is planning to construct a new self-supporting radio tower at the HEC Center and implement digital microwave links between the dispatch center, 61 Riesner (HPD), and One Shell Plaza. The microwave connectivity should be in place by mid 2008.

- 1.2.5 Needs & Requirements

Increased Channel Capacity

- 1.2.5A Under the current system configuration, Fire and EMS share 8 repeated radio channels (A1-A8), and find that there are simply not enough tactical channels in the current system to support both Fire and EMS operations adequately. Fire and EMS share tactical channels 2, 3, and 4. Ch 2 is North and Northeast, 3 is West and Northwest, and 4 is South and Southeast. Additional tactical channels are needed in the new radio system.

Fire and EMS need 40 independent tactical talkgroups to meet their needs. The exact make-up of the 40 talkgroups will be determined at a later date but the initial talkgroup plan is detailed in Figure 1.2.5A below:

Figure 1.2.5A Houston Fire Department Preliminary Talkgroup Plan

Houston Fire Department Talkgroup Operational Needs			
No.	Identified Use	Coverage	Agency/Monitor Status
1	(Gatekeeper)	Citywide Dispatch	HFD/Continual
2	Administrative Radio Operator	Citywide Dispatch	HFD/Continual
3	Event Radio Operator	Citywide Tactical	HFD/Continual
4	Event Radio Operator	Citywide Tactical	HFD/Continual
5	Event Radio Operator	Citywide Tactical	HFD/Continual
6	Fireground Operations - Major Event (1)	Citywide Tactical	HFD/Occasional
7	Fireground Operations - Major Event (1)	Citywide Tactical	HFD/Occasional
8	Fireground Operations - Major Event (1)	Citywide Tactical	HFD/Occasional
9	Fireground Operations - Major Event (1)	Citywide Tactical	HFD/Occasional

10	Fireground Operations - Major Event (1)	Citywide Tactical	HFD/Occasional
11	Fireground Operations - Major Event (2)	Citywide Tactical	HFD/Occasional
12	Fireground Operations - Major Event (2)	Citywide Tactical	HFD/Occasional
13	Fireground Operations - Major Event (2)	Citywide Tactical	HFD/Occasional
14	Fireground Operations - Major Event (2)	Citywide Tactical	HFD/Occasional
15	Fireground Operations - Major Event (2)	Citywide Tactical	HFD/Occasional
16	EMS Operations (1)	Citywide Tactical	HFD/Occasional
17	EMS Operations (2)	Citywide Tactical	HFD/Occasional
18	EMS Operations (3)	Citywide Tactical	HFD/Occasional
19	EMS Operations (4)	Citywide Tactical	HFD/Occasional
20	EMS Operations (5)	Citywide Tactical	HFD/Occasional
21	EMS Operations (6)	Citywide Tactical	HFD/Occasional
22	EMS Operations (7)	Citywide Tactical	HFD/Occasional
23	EMS Operations (8)	Citywide Tactical	HFD/Occasional
24	Telemetry Support (1)	Citywide Tactical	HCHD/Continual
25	Telemetry Support (2)	Citywide Tactical	HCHD/Continual
26	Telemetry Support (3)	Citywide Tactical	HCHD/Continual
27	Telemetry Support (4)	Citywide Tactical	HCHD/Continual
28	Telemetry Support (5)	Citywide Tactical	HCHD/Continual
29	Telemetry Support (6)	Citywide Tactical	HCHD/Continual
30	Telemetry Support (7)	Citywide Tactical	HCHD/Continual
31	Telemetry Support (8)	Citywide Tactical	HCHD/Continual
32	Training (1)	Citywide non-tactical	HFD/Occasional
33	Training (2)	Citywide non-tactical	HFD/Occasional
34	Training (3)	Citywide non-tactical	HFD/Occasional
35	Arson	Citywide non-tactical	HFD/Occasional
36	Inspection	Citywide non-tactical	HFD/Occasional
37	Administrative (1)	Citywide non-tactical	HFD/Occasional
38	Administrative (2)	Citywide non-tactical	HFD/Occasional
39	Mutual Aide (1)	Citywide Tactical	HFD/Occasional
40	Mutual Aide (2)	Citywide Tactical	HFD/Occasional

- 1.2.5B Fire and EMS personnel indicated that because they never know where fires or EMS events will occur, they need the 40 tactical channels throughout the entire City service area.

Improved Portable Radio Coverage

- 1.2.5C The Fire Department needs greatly improved portable radio coverage throughout its service area.

Use of the Radio

- 1.2.5D In firefighting activities, portable radios are often worn in a bunker pocket at chest level to help protect it from heat and water. Within the EMS Division, portable radios are typically

worn on the belt, both with and without speaker microphones. For planning purposes, the “worst case” situation should be used, which involves placement of the radio at belt level with a belt clip, not a swivel case.

Required Coverage

- 1.2.5E RCC met with Fire Department officials to discuss the need for reliable portable radio coverage on-street, within residential structures, within heavier buildings, within specific buildings and underground facilities. As a result of those discussions, the Fire Department identified their radio coverage requirements as shown in Section 3 of this document.

1.2.6 Functional Requirements

Emergency Alert Capability

- 1.2.6B The Fire Department does not currently use an Emergency Alert capability on its mobile and portable radios. This capability is provided by the GRACE Industries, Inc. PASS (Personnel Accountability Safety System). This system utilizes individual monitors equipped with accelerometer type motion sensors. Each monitor is capable of transmitting an alert signal to an on-scene central monitoring location, typically the incident command post. This system relies on unlicensed spread spectrum radio equipment that operates in the 902-928 MHz band. The Emergency Alert capability shall be provided on all new Fire Department mobile and portable radios.

GPS Location of Personnel

- 1.2.6C Fire Management personnel are interested in the possibility of having Global Positioning System (GPS) location capability in the new handheld radios that would be supported by a new radio infrastructure. This capability would be used to help better manage the deployment of resources, even though it would likely not operate within a building where the radio could not “see” the GPS satellites.

Unit Identification

- 1.2.6D The Department currently utilizes automatic radio user identification on all of its radios. Upon push-to-talk, each radio transmits its user ID to the dispatcher. This capability shall be provided in the new radio system.

Intrinsically Safe Portable Radios

- 1.2.6E All HFD portable radios and batteries carry the Factory Mutual Intrinsically Safe rating to prevent accidental ignition in explosive or flammable environments. This capability shall be provided in the new system.

Ruggedized Portable Radios

- 1.2.6F All portable radios purchased as part of the new system must involve the ruggedized option to help improve reliability and longevity. Fluorescent yellow cases are required for easy identification.

Batteries & Chargers

- 1.2.6G HFD requires that a vehicular charger designed for Public Safety use be available for all portable radio models used by the Department. For maintenance purposes, it is preferred that a single charger design support all models of portable radios supplied with the system.
- 1.2.6H Portable radio batteries should provide the capacity to complete a full 12-hour shift based upon a 10-10-80% TIA-603 duty cycle.
- 1.2.6I Charging devices for the portable radios must include individual desk chargers, bank chargers supporting a minimum of six (6) charger slots and battery analyzers/conditioners.

Carrying Devices

- 1.2.6J All portable radio devices must be available with leather carrying cases, and belt-clip carrying devices.

Speakers/Microphones

- 1.2.6K All portable radios must be equipped with an external connector port to support vehicular chargers, external Public Safety grade speaker/ microphones, and special aftermarket SCBA "headset" type devices.

Fire Station Alerting

- 1.2.6L The specific requirements for Fire Station Alerting are provided in detail in Section of 6 of this RFP.

Hospital Emergency Rooms

- 1.2.6M The Department will need a desktop control station radios installed at local emergency rooms to facilitate radio communications between Fire/EMS personnel and the medical facilities. Selective call capability is needed to allow EMS units to selectively communicate with the different facilities. In the new trunked system environment, each hospital will require a dedicated talkgroup. Group call capability for all hospital talkgroups is also required. Hospital Emergency Rooms that require desktop control stations are as follows.

Ben Taub General Hospital
1504 Taub Loop
Houston, Texas

Hermann Hospital
6411 Fannin
Houston, Texas 77030

West Houston Medical Ctr.
12141 Richmond
Houston, Texas 77082

Columbia Bellaire Hosp.
5314 Dashwood
Houston, Texas 77081

Pasadena Bayshore Hosp.
4000 Spencer Highway
Pasadena, Texas 77504

St. Johns (OCL) Hospital
18300 St. John Drive
Nasa Bay, Texas 77058

St. Joseph (ED) Hospital
1401 St. Joseph Parkway
Houston, Texas 77002

St. Luke's Hospital
6720 Bernter
Houston, Texas 77030

**Clear Lake (OCL) Hosp.
500 Medical Ctr. Blvd.
Webster, Texas 77598**

**Houston NW Medical Ctr.
710 FM 1960 West
Houston, Texas 77090**

**Memorial City Hosp.
921 Gessner
Houston, Texas 77024**

**Memorial Hermann N.W.
1635 north Loop West
Houston, Texas 77008**

**Memorial Hermann S.E.
11800 Astoria Blvd
Houston, Texas 77089**

**Memorial Hermann S.W.
7600 Beechnut
Houston, Texas 77074**

**Methodist Hospital
6565 Fannin
Houston, Texas 77030**

**NE Medical Center (OCL)
18951 Memorial North Blvd.
Humble, Texas 77338**

**East Houston Regional Med. Ctr.
13111 East Freeway
Houston, Texas 77015**

**Doctors Hospital (Parkway)
233 West Parker Rd.
Houston, Texas 77076**

**M.D. Anderson Hospital
1515 Holcombe
Houston, Texas 77030**

**Doctors Hospital (Tidwell)
510 West Tidwell
Houston, Texas 77091**

**Columbia Spring Branch
8850 Longpoint
Houston, Texas 77055**

**Twelve Oaks Hospital
Bayou City Med Ctr
4200 Twelve Oaks Drive
Houston, Texas 77027**

**Michael E. DeBakey
Veterans Affairs Med. Ctr.
2002 Holcombe Blvd.
Houston, Texas 77030**

**Cornerstone Hospital of Houston
5556 Gasmer
Houston, Texas 77035**

**Cypress Fairbanks M/C (OCL)
10655 Steepletop
Houston, Texas 77065**

**Lyndon B. Johnson Hospital
5656 Kelly
Houston, Texas 77030**

**Mem. Hermann Fort Bend
3803 FM 1092 @ Hwy 6
Missouri City, Texas 77459**

**Park Plaza Hospital
1313 Hermann Dr.
Houston, Texas 77004**

**Houston Community Hospital
(formerly Northside General)
2807 Little York Rd.
Houston, Texas 77093**

**Pasadena Bayshore Hosp. 4000
Spencer Highway
Pasadena, Texas 77504**

**Kingwood Hospital
22999 US highway 59
Kingwood, Texas 77339**

**Willowbrook Methodist
18220 Tomball Parkway
Houston, Texas 77070**

Radio Access at Pumper Control Panels

- 1.2.6N The Fire Department does not currently use rear radio control heads at the pump control panels. Instead, they use portable radios for more flexibility. Special high-volume speakers have been installed on the pump panels so that personnel working in that area can monitor radio communications in high noise environments. These speakers are capable of producing a Sound Pressure Level (SPL) of 110 dB. This capability is required in the new radio system.

Fully Compliant Partially Compliant Non-Compliant

1.3 Houston Police Department

1.3A The Department currently operates approximately 2,900 vehicles, most of which are equipped with a 460 MHz UHF mobile radio. In addition, the Department currently operates approximately 3,700 handheld radios, which are distributed to HPD personnel who operate throughout the City's service area.

1.3B The department's current two-way radio system was installed in 1991 and utilizes an analog UHF conventional radio technology. The system was originally developed on a "district basis". The Police Department currently operates 23 Master Police Districts supported by 12 primary radio channels, in addition to six channels supporting citywide operations.

- | | |
|--|--|
| ➤ NSDISP - Channel A1
North Division – Districts 3 & 6 | ➤ DEDISP – Channel A10
No Stations Associated, Citywide |
| ➤ NEDISP - Channel A2
Northeast – Districts 7, 8, 9 & 24 | ➤ NWDISP – Channel A11
Northwest – Districts 4 & 5 |
| ➤ SEDISP-Channel A3
Southeast – Districts 12,13 & 14 | ➤ WSDISP – Channel A12
Westside – Districts 18, 19, & 20 |
| ➤ SWDISP – Channel A4
Southwest – Districts 15 & 16
Fondren – District 17 | ➤ IADISP – Channel B10
Bush Intercontinental Airport – District 21
Hobby Airport – District 23
Ellington Field |
| ➤ CWDISP – Channel A5
No Station Associated , Citywide | ➤ Channel B3 .525 /TAC
Citywide |
| ➤ CNDISP – Channel A6
Central Division – Districts 1 & 2 | ➤ Channel B9
VICE/NARC/CID
Citywide |
| ➤ SODISP – Channel A7
Citywide, Special Operations, Downtown,
Truck Enforcement, Motorcycles Accident
Investigators, Traffic Enforcement | ➤ Channel B12
Hobby Airport – District 23
Ellington Field |
| ➤ SCDISP - Channel A9
South Central – District 10
Eastside – District 11 | |

1.3C The focal point for the radio system is located at Police Headquarters, 61 Riesner Street, in downtown Houston. The City's Central Radio Shop and the Police Communications Center is located in this facility, along with a 450' self-supporting backup communications tower, a Motorola satellite receiver voting/transmitter system, and a Supervisory Control & Data Acquisition system (SCADA) system, utilized for site alarm and data gathering purposes. The various HPD transceiver and receiver sites are linked to 61 Riesner Street via a combination of City owned and leased AT&T optical fiber cable along with standard telephone lease lines.

1.3D The Department currently operates approximately 3,400 Motorola Spectra mobile radios and approximately 3,700 Motorola Saber portable radios on its 460 MHz system. HPD personnel estimate the radio user population to grow to approximately 10,000 radios within the next 10 years. Within the equipment in use today, approximately 80% of the portable radios are over 8 years old, and 60% of the mobile radios are over 8 years old.

1.3E The Department's radio inventory currently breaks down as follows.

<u>Type</u>	<u>Quantity</u>	<u>Band</u>	<u>Model</u>
Portable	32	UHF	Motorola HT1000
Portable	331	UHF	Motorola MTS2000
Portable	83	UHF	Motorola MX300
Portable	100	UHF	Relm RPU3600A
Portable	2,406	UHF	Motorola Saber
Portable	849	UHF	Motorola Saber-AST
Portable	701	UHF	Motorola Saber-S
Portable	57	UHF	Motorola Visar
Portable	200	800 MHz	Motorola XTS5000
Portable	13	UHF	Motorola XTS5000
Mobile	68	UHF	Motorola MCX1000
Mobile	12	UHF	Motorola Radius
Mobile	57	UHF	GE Rangr
Mobile	3,161	UHF	Motorola Spectra
Mobile	252	UHF	Motorola Spectra-AST
Mobile	1,341	UHF	Motorola Spectra-S
Mobile	1	UHF	Relm TM800
Mobile	3	800 MHz	Motorola XTL5000
Mobile	8	UHF	Motorola XTL5000

1.3F The present radio system is a UHF conventional analog radio system that was installed in 1991. It was originally configured to meet the needs of the Department at the time. The system incorporates substantial redundancy to help maintain system operation, even during times of trouble.

1.3G To help improve system reliability, all of the HPD radio channels are provisioned with both primary and backup transmitters. In most cases, the primary and backup equipment are at different locations to minimize the loss of a complete radio channel.

1.3H The HPD radio system incorporates an extensive network of remote voting receivers located in each of the Patrol districts. All District radio channels have remote receivers, as well as the

citywide channels transmitted from the downtown area. There are 16 remote receiver sites per citywide channel.

- 1.3I The transmitter sites in the system are linked to HPD Headquarters at 61 Riesner Street via the City's RTS optical fiber system. Redundant Southwestern Bell T-1 circuits link the 61 Riesner facilities to the new HEC Center. As with the Fire Department, HPD has some concern that the redundant AT&T T-1 service may not actually provide completely diverse routing between the facilities. Once the new radio communications tower is constructed at the HEC Center, a dedicated digital microwave link will be established to support redundant connectivity between 61 Riesner and HEC.
- 1.3J The Houston Police Department, the Houston Fire Department, and the Harris County sheriff's Office maintain the various City of Houston radio tower sites through a cooperative effort. General site maintenance typically includes maintaining the locks on the gates at the sites, and mowing of the site grounds on an "as needed" basis. Responsibility for maintenance is assigned users and to City of Houston Building Services as follows:
- ◆ Huffman site – Harris County
 - ◆ Lake Houston site – Houston Fire Department and Building Services
 - ◆ Tomball site – Harris County (grounds keeping and strobe lighting)
 - ◆ Police Academy site – Houston Police Department and Building Services
 - ◆ Teague Road site – Houston Police Department and Building Services
 - ◆ Reed Road site – Houston Fire Department and Building Services
 - ◆ Clodine site – Houston Police Department and Building Services
 - ◆ Coletto site – Houston Fire Department and Building Services
 - ◆ Beechnut site – Houston Police Department and Building Services
 - ◆ Old DPS site – Houston Police Department and Building Services
- 1.3K HPD has fiber optic service to all of its active transmit sites, with the exception of Clodine, which utilizes Southwestern Bell leased T-1 service and the repeater located in Terminal D at IAH airport. There is currently no City-owned fiber to the Tomball or Huffman sites, which are not currently used by the City. Harris County utilizes these sites, and may lease T-1 service from Southwestern Bell for their use.

1.3.1 Dispatch Operations

- 1.3.1A As of August 23, 2003, HPD transferred its call-taking and dispatch operations to the new Houston Emergency Center (HEC). The HEC currently supports four operational groups including Houston Police, Houston Fire/ EMS, Office of Emergency Management, and the City's 9-1-1 calling system.
- 1.3.1B The HEC Operations Center is organized into three distinct areas, with the left-hand side supporting Fire call-takers (Figure 1.2.1A) and Fire dispatchers, the center of the room supporting the HEC call-takers,(Figure 1.2.1B) and the right-hand side of the room supporting Police dispatchers (Figure 1.2.1C). The dispatch area is located on the 2nd floor of the facility, above the redundant equipment rooms that support CAD, 9-1-1, and radio dispatch console equipment.

Figure 1.3.1A



Figure 1.3.1B

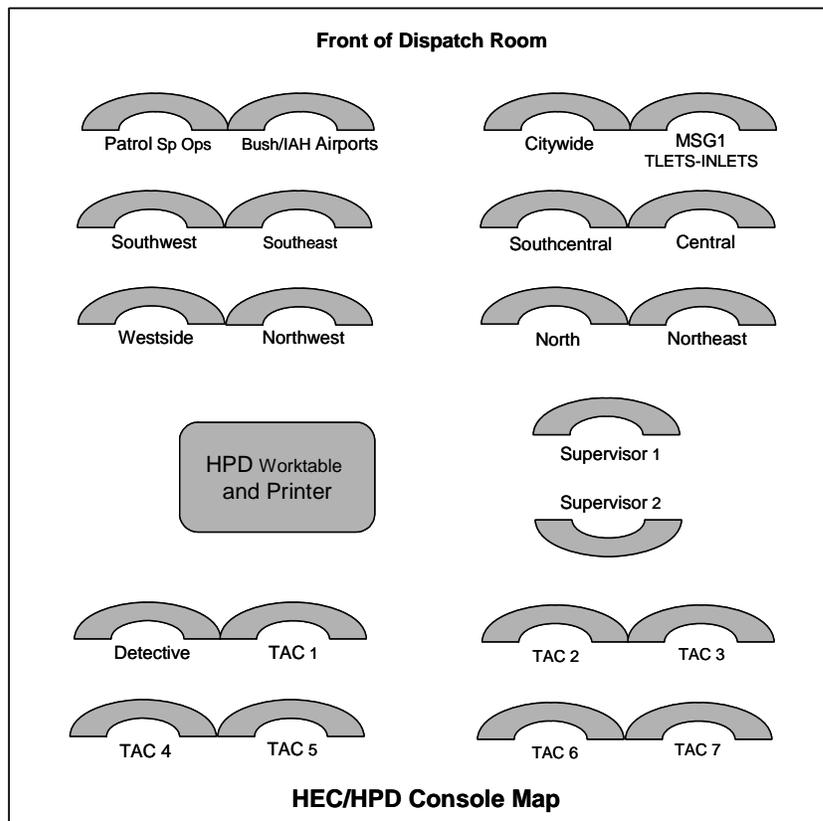


Figure 1.3.1C



- 1.3.1C Dispatch personnel that work in the HEC Center have been transferred from the Police and Fire Departments former facilities. The fire and police departments employ their respective dispatchers. The HEC department employs all call-takers.
- 1.3.1D The HPD area within the dispatch center is equipped with 20 dispatch workstations equipped with Orbacom T-5 radio consoles. The remaining positions support overload work situations, as well as provide redundant operator positions in the event that one or more of the operator positions suffer a non-radio equipment problem.
- 1.3.1E The HPD dispatch positions include the following:
- | | |
|--------------------------------|--------------------------------|
| ◆ Northeast | ◆ Detective |
| ◆ North Shepherd/North Command | ◆ Bush and Hobby and Ellington |
| ◆ Northwest | ◆ Special Operations |
| ◆ Westside | ◆ Police Supervisor 1 |
| ◆ Central | ◆ Police Supervisor 2 |
| ◆ South Central | ◆ Citywide |
| ◆ Southeast | ◆ MSG1 (TLETS and NLETS) |
| ◆ Southwest | |
- 1.3.1F Figure 1.2.1D provides a general console layout for the PD dispatch positions.

Figure 1.3.1D



- 1.3.1G Each dispatch position is equipped with 2 keyboards, one for CAD operation, and the other for the radio console operation. Each position is also equipped with a handheld radio to allow the dispatcher to communicate with personnel in the field in the event that a dispatch position becomes disabled.
- 1.3.1H Each dispatch operating position is equipped with four-color monitor screens as follows:
- ◆ Left Monitor—Orbacom radio console screen
 - ◆ Second Monitor—CAD
 - ◆ Third Monitor—CAD
 - ◆ Fourth Monitor—Map, CAD, or AVL
- 1.3.1I The HEC dispatchers also communicate to the police units in the field over the Mobile Data Computer System referred to as the MDT or MDC. The MDC system consists of multiple data radio channels in the 800 MHz frequency band installed at radio site similar to the radio voice channels. This provides a second means of secure communications between the officer in the field and the dispatcher at the HEC. The MDT's are not connected to the HPD main computers in the stations, so HPD officers are not able to read reports, charges, etc from the cars,
- 1.3.1J Police and Fire dispatch operators at HEC are supported by a new Northrop Grumman Computer Aided Dispatch (CAD) system, which supports digital dispatching via the HPD Mobile Data Computer (MDC) system. Patrol units are equipped with Motorola Mobile Data Terminals or mobile computers that display dispatch information and provide unit

status buttons to update the unit's status "arrived at scene", etc., as the call progresses. The Mobile Data system supports unit-to-unit messaging, database inquiries, and is interfaced with the Harris County Mobile Data system, which utilizes similar Motorola technology.

- 1.3.1K The HEC Center incorporates redundant equipment rooms to help support continuous, nonstop operation. The facility is supported by three 1.7 Megawatt diesel generators.

Radio Channel Capacity

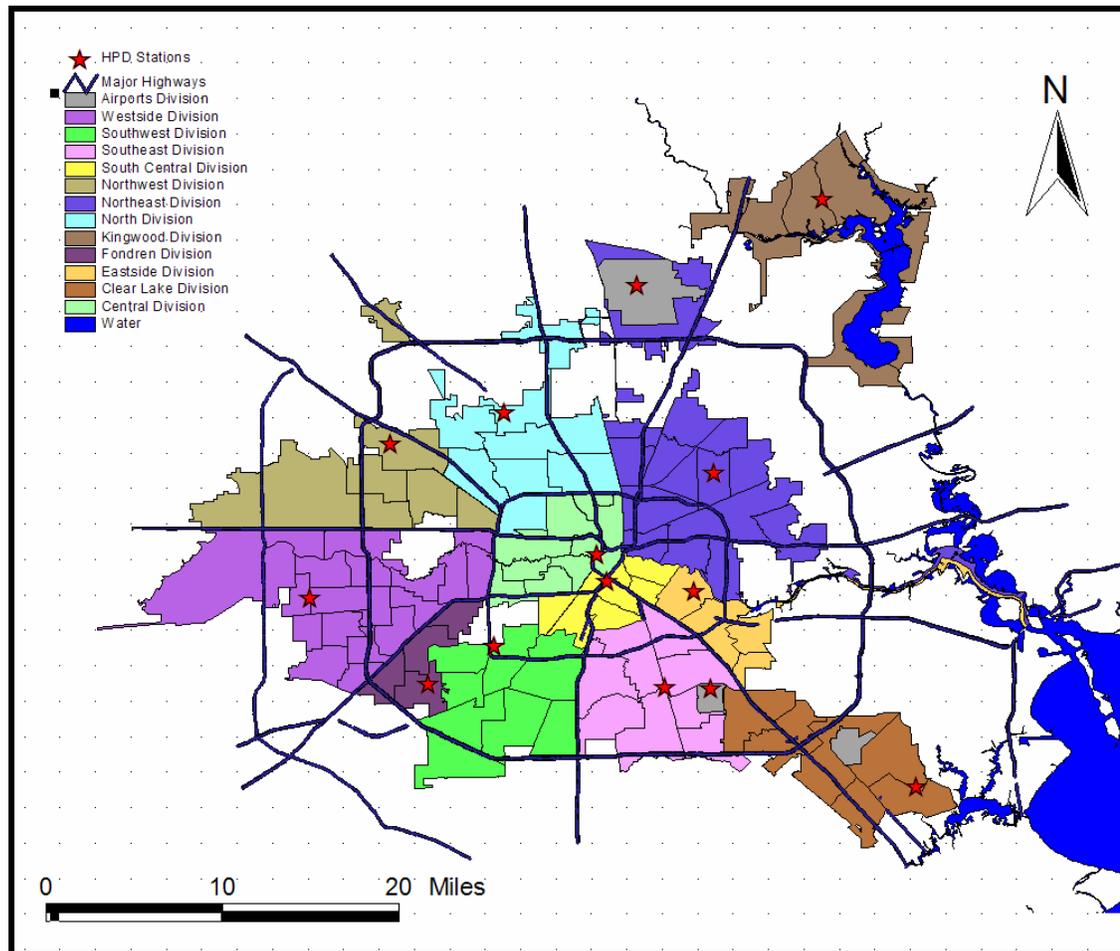
- 1.3.1L Most of the Divisions within the Houston Police Department indicated that they currently suffer from a shortage of available radio channels to help conduct their day-to-day and emergency operations. This negatively impacts departmental response times and officer safety.

Radio Coverage

- 1.3.1M The radio coverage performance provided by the HPD radio system varies somewhat throughout the City's service area. This occurs because the system has been deployed on a District basis, which means that certain repeater sites are targeted to provide coverage in specific areas of the City in accordance with the Department's District orientation.

- 1.3.1N The following beat map shows the geographic areas of responsibility for the different divisions within the Houston Police Department.

Figure 1.3.1E



- 1.3.1O The Northeast Division personnel and its associated dispatcher cover approximately 132 square miles of “noncontiguous” service area. There are large areas of incorporated/undeveloped land that divides the northeast service area, which often requires officers to travel through those areas to respond to calls for service. Due to these heavily wooded areas, radio communications can be a problem.
- 1.3.1P HPD has virtually no radio coverage throughout most of the downtown tunnel system. This has been an ongoing problem for many years, and is virtually the same for both the Police and Fire Departments. Although HPD does not routinely patrol the tunnel system, it does support calls for service within the system, just like it would within a high-rise building located within the City’s service area. Improvements are needed to help provide radio communications support within the tunnel system.
- 1.3.1Q There are also portable radio coverage problems in malls, hospitals and other large structures throughout the City. Coverage in the parking garages at the Galleria Mall is spotty, usable in some areas and unusable in others. Improved radio coverage is needed in those areas.
- 1.3.1R Officers working at or near Hobby Airport reported portable coverage problems in the airport terminal facilities, particularly in the lower levels.

Equipment Age

- 1.3.1S Nearly all of the Department's mobile and portable radios are 8 years old or older.
- 1.3.1T In terms of the radio system infrastructure, HPD faces similar problems as those experienced by the Fire Department. Repeater radio equipment located at the various tower sites is based upon Motorola's MSF5000 product line, which is no longer manufacturer supported. The Motorola DigiTAC receiver voting equipment currently in use at 61 Riesner is still supported by Motorola. The receiver voting equipment is utilized to help improve talkback radio coverage from low-powered portable radios out in the field.
- 1.3.1U The Valmet Supervisory Control & Data Acquisition (SCADA) system utilized to monitor equipment, intrusion, and smoke alarms at the various transmitter sites is also aging, and will need to be replaced along with the rest of the radio system infrastructure.

Encryption Capability

- 1.3.1V Some of the divisions within HPD need encryption capability to support the transmission of sensitive information for tactical and other purposes.

1.3.2 Needs & Requirements

Increased Channel Capacity

- 1.3.2A Under the current system configuration, there are not enough radio channels available in the system to meet the Department's requirements. Each of the District channels are busy, and personnel have indicated that an additional tactical channel for each District is needed to help support day-to-day and emergency activities.
- 1.3.2B Field personnel reported channel congestion problems with the following channels:
- Intercontinental Airport & Hobby Airport
 - Detective
 - Citywide Channel
 - Westside
 - Southwest
 - Fondren
 - Northeast Patrol
 - North Patrol
 - Southeast Patrol
 - Special Operations (SO)
 - Southwest Patrol
 - Northeast
- 1.3.2C In summary, the Police Department needs a minimum of 30-40 individual radio talkgroups (channels) to meet its current operational requirements and the ability to expand the number of talkgroups in the future as required to meet the Department's growing needs.

Improved Portable Radio Coverage

- 1.3.2D HPD needs improved portable radio coverage throughout its service area and beyond. Details on coverage requirements are provided in section 3 of this document.

Use of the Radio

- 1.3.2E Within HPD, portable radios are typically worn on the belt, both with and without speaker microphones. For planning purposes, the “worst case” situation should be used, which involves placement of the radio at belt level with clip not a swivel case.

Encrypted Communications

- 1.3.2F Several groups within the Houston Police Department need encryption capability in their radios to allow for communication of tactical or “sensitive” information on an “as needed” basis. Digital voice encryption required for the new radio system must provide a radio coverage range in the encrypted mode that is equivalent to the performance in the non-encrypted mode. In addition, audio quality in the encrypted mode must be equal to audio quality in the clear mode. This will allow HPD personnel to utilize encryption capability in an effective manner as needed. HPD will require the latest available encryption technology for the land-mobile radio industry, known as the Advanced Encryption Standard (AES),

Functional Requirements

- **Emergency Alert Capability**

The Police Department needs Emergency Alert capability on its mobile and portable radios.

- **GPS Location of Personnel**

HPD Management personnel are interested in the possibility of having Global Positioning System (GPS) location capability in the new handheld radios that will be supported by a new radio infrastructure. This capability would be used to help provide an additional “margin of safety” for officers and to better manage the deployment of resources, even though it would likely not operate within a building where the radio could not “see” the GPS satellites.

- **Unit Identification**

The Department currently utilizes automatic radio user identification on all of its radios. Upon push-to-talk, each radio transmits its user ID to the dispatcher. This capability is required in the new radio system.

- **Intrinsically Safe Portable Radios**

HPD would like to have the option of purchasing intrinsically safe equipment, if needed, for special applications.

- **Ruggedized Portable Radios**

HPD would like to have the option of purchasing all ruggedized portable radios.

Batteries & Chargers

- 1.3.2G HPD requires that a vehicular charger designed for Public Safety use be available for all portable radio models used by the Department. Vehicular chargers have proven to be problematic in the past, and will not be used in Patrol units, but may find use in other HPD

vehicles. For maintenance purposes, it is preferred that a single charger design support all models of portable radios supplied with the system.

- 1.3.2H Portable radio batteries should provide the capacity to complete a full 12-14 hour shift based upon a 10-10-80% EIA duty cycle. Charging devices for the portable radios must include individual desk chargers, bank chargers supporting a minimum of six (6) charger slots and battery analyzers/ conditioners.

Carrying Devices

- 1.3.2I All portable radio devices must be available with leather or vinyl carrying cases, and belt-clip carrying devices.

Speakers/Microphones

- 1.3.2J All portable radios must be equipped with an external connector port to support vehicular chargers, external Public Safety grade speaker/microphones, and special aftermarket "headset" type devices.

Radio Communications Interoperability

- 1.3.2K During the needs analysis process, HPD personnel indicated that they need radio communications interoperability with the following entities:

- ◆ Houston Fire Department
- ◆ Houston Airport System Security
- ◆ Houston Public Works Department
- ◆ Harris County Sheriff's Office
- ◆ Harris County Constables
- ◆ Texas Department of Public Safety
- ◆ Houston Metropolitan Transit Police Department
- ◆ Port of Houston Police Department
- ◆ Fort Bend County Sheriff's Office
- ◆ West University Police Department
- ◆ Bellaire Police Department
- ◆ City of South Houston Police Department
- ◆ City of Pasadena Police Department (includes Deer Park P.D.)
- ◆ City of Webster Police Department
- ◆ City of Friendswood Police Department
- ◆ City of La Porte Police Department
- ◆ City of Pearland Police Department
- ◆ City of League City Police Department
- ◆ City of Kemah Police Department
- ◆ Various School District Police Departments

Fully Compliant Partially Compliant Non-Compliant

1.4 Public Works and Engineering Department

1.4A The City of Houston Public Works and Engineering (PW&E) Department is an organization within the City government structure, much like the City's Police and Fire Departments. The Department has responsibility for all Public Works issues occurring within City Limits. PW&E is currently organized in divisions and branches and sections as follows:

- Engineering, Construction Division, including the following Branches:
 - ◆ Administrative Services
 - ◆ Construction
 - ◆ Engineering
 - ◆ Geo-Environmental Services
- Public Utilities Division, with the following Branches:
 - ◆ Operations Support
 - Graphics and Engineering Management Systems Section
 - Human Resources Section
 - Financial Management Section
 - ◆ Utility Maintenance
 - System Maintenance Section
 - Technical Services, Water Section, Water Planning & Analysis Section
 - **Technical Services Wastewater Section, Management & Support Section**
- Resource Management Division, having the following Branches:
 - ◆ Financial Management
 - ◆ Human Resources
 - ◆ Information Technology Team
 - ◆ Materials Management
 - ◆ Utility Customer Service
- Right-of-Way and Fleet Maintenance Division, including the following Branches:
 - ◆ Administrative
 - ◆ Storm Water Maintenance
 - ◆ Street and Bridge Maintenance
 - ◆ Fleet Maintenance
- Traffic and Transportation Division, including the following Branches:
 - ◆ Traffic Engineering and Operations
 - ◆ Signal Maintenance and Signs & Markings
 - ◆ Signal Engineering and Operations Branch
- Planning and Development Services , including the following Branches:
- Office of the City Engineer
 - ◆ Code Enforcement
 - ◆ Utility Planning & Analysis
 - ◆ Planning Branch

◆ Real Estate

1.4B The working groups using the PW&E radio system include the following I:

- Traffic Signals/Signs/Markings/Freeway Lighting
- Fleet Maintenance
- Building Services
- Street and Bridge Maintenance
- Waste Water
- Water Production
- Planning and Operations Support
- Utility Maintenance
- Utility Customer Service
- Neighborhood Protection
- Health
- Office of Emergency Management
- Parking/Municipal Court Security
- Solid Waste

1.4C Collectively, PW&E employs just over 5,000 personnel.

1.4.1 Radio System/Talk Group Structure

1.4.1A The PW&E radio system consists of a single site, 800 MHz, 23 channel, analog trunked Motorola type II system. The repeaters are located at the tallest building in Houston, the 75-story Chase Tower in downtown Houston. The antennas are located on top of the building at 311 meters, or 1020 feet above ground level. A 23 channel backup system has been assembled and is undergoing final construction at the Public Works Radio Communication office at 5711 Neches Street, almost 4 miles north and a little east of the downtown Houston site. The backup site antennas are mounted at a height of 96.9 meters, or 318 feet, which means that the backup system does not cover as much area as the primary site at Chase Tower. There are approximately 2,850 portable (handheld) radios and approximately 3,400 mobile radios currently being used on the system, for a total of approximately 6,250 radios. The following table provides a breakdown of user equipment.

Type	Quantity	Band	Model
Mobile	21		Motorola Astro Spectra
Mobile	30		Motorola GTX
Mobile	468		Motorola LCS2000
Mobile	98		Motorola Spectra
Mobile	2743		Motorola Maxtrac
Mobile	38		Motorola MCS2000
Mobile	21		Motorola XTL2500
Mobile	8		Motorola XTL5000
Console	18		Motorola XTL5000
Portable	598		Motorola MTS2000
Portable	159		Motorola MTX
Portable	621		Motorola LTS2000
Portable	427		Motorola STX
Portable	67		Motorola Visar
Portable	70		Motorola XTS
Portable	132		Motorola XTS
Portable	365		Motorola XTS

1.4.2 Dispatch Operations

1.4.2A In July 2006 the Utilities Maintenance Branch of the Public Utilities Division completely renovated their dispatch center at the Renwick Drive facility. The dispatch center is now equipped with 12 Motorola Centracom Gold dispatch consoles and a new logging recorder. This is the primary dispatch location for all of the Utilities Maintenance sections which includes the following sections:

- ◆ Repair
- ◆ Landscaping
- ◆ Concrete
- ◆ Heavy Construction
- ◆ Valves
- ◆ Stoppage.

1.4.2B The dispatch center operates 24/7 with a staff of 12 people during the day and a 2 people at night. The radio dispatch positions are all identically configured with the same channel control windows so that any position can be used by any dispatcher when necessary. The dispatch consoles are each configured with the following talkgroups:

- ◆ HPW Northwest
- ◆ HPW Northeast
- ◆ HPW Northeast -1

- ◆ HPW Southwest
 - ◆ HPW Southeast
 - ◆ Water Customer Service
 - ◆ Stoppage
 - ◆ Landscape
 - ◆ Water Quality
- 1.4.2C In addition to the aforementioned talkgroups on the Houston Public Works trunked radio system there are two channel control windows on each console labeled as Harris County and Homeland Security.
- 1.4.2D Harris County has provided a single talkgroup for the City of Houston Public Works on their older Smartzone 4.1 radio system. This talkgroup serves as a backup in case the Public Works radio system suffers a catastrophic system failure. This backup talkgroup is configured for single site operation off of the Allied Bank Building repeater site but is not currently functional.
- 1.4.2E Each of the 12 dispatch positions is configured with a dual foot pedal switch, a Powerware 9125 UPS a gooseneck microphone and a Plantronics wireless headset which allows the dispatcher to freely move approximately 20 feet from the console position and maintain communications. The consoles use RF links to communicate over the trunked radio system. Each of the talkgroups listed above has a dedicated control station rack mounted in an equipment room located on the second floor of the facility. The electronic equipment room located on the second floor has a dedicated Powerware model 9125 UPS (Uninterruptible Power System) to insure the consolettes, the CEB and the other support equipment remains operational in the event of a power outage. There is an older model Stewart and Stevenson diesel generator located in the front of the building that provides backup power to this facility. The City is also in the process of adding a second generator to accommodate increased demand for emergency backup power at this location.
- 1.4.2F Dispatchers are currently not able to generate a "Alert Call" to the field units unless the leave their console position, walk to another room and use 1 of 3 available consolettes to initiate the Alert Call. This problem is due to the fact that the consoles use an over the air RF interface rather than a direct wireline interface to connect to the radio system.
- 1.4.2G Other Public Works Branch's and Divisions dispatch their personnel from control stations (desktop radios) located throughout the Houston city limits. The radio equipment list includes 69 control stations used for dispatch. The Public Works divisions that utilize control stations include the following:
- ◆ Water Production/Water Quality – 21
 - ◆ Solid Waste – 10
 - ◆ Waste Water – 6
 - ◆ Street Maintenance/Fleet – 12
 - ◆ Health – 7
 - ◆ Miscellaneous - 13
- 1.4.2H The radio system's talkgroup mapping (channel configuration) installed in radios is being redone so that all radios have the same talkgroup template. This will help insure that all

Public Works radio users have the ability to communicate on other talk groups as well as their own departmental groups. The PW&E talkgroup structure is provided below:

- ◆ Public Works-2
 - Radio Shop
 - Comm. Maintenance
 - Comm. Business
 - IT Dept.
 - Test
 - Senior Staff
 - Pilot

- ◆ Emergency Management
 - E.O.C.
 - E.O.C. Maint.
 - E.M.O.
 - Mgt. Supt.
 - Mayor Staff
 - Hmst-1
 - Hmst-2
 - Hmst-3
 - Hmst-4

- ◆ Solid Waste
 - Admin. Maintenance
 - Heavy Trash-N
 - Heavy Trash-S
 - Collect. -SE
 - Collect. -NE
 - Collect. -NW
 - Collect. -SW
 - Recycling
 - Recycling-2

- ◆ Water-1
 - Process Operations
 - P.W. Equip. Maint.
 - Wasteload Control
 - WW-Treatment

- ◆ Water-2
 - Water Production
 - Water Cust. Service
 - Water Prod. (SWPP)

- Water Quality
- Water Conserv. Branch

- ◆ Public Works
 - T & T Signals
 - T & T Signs
 - Street Maint.
 - Bridge
 - ROW/TAC
 - City Hall Security
 - Grand Prix

- ◆ Public Works-3
 - Pub. Works-NW
 - Pub. Works-NE
 - Pub. Works-NE-1
 - Pub Works Security
 - Pub. Works Stoppage

- ◆ Public Works-4
 - Pub. Works-SW
 - Pub. Works-SE
 - Pub. Landscaping
 - Pub. Works-SE-Mgr.

- ◆ Parks & Recreation
 - Parks All Units
 - Parks Resource
 - Parks Permit
 - Parks Field
 - Parks Security
 - Parks Golf
 - Parks Miller Theatre
 - Parks Field2

- ◆ Public Works-1
 - Electrical
 - Fleet Management
 - Materials Management
 - Contract Procurement
 - Building Service

- ◆ Miscellaneous
 - Capital Project
 - Taxi (Enforcement)
 - Pub. Library/Real Estate
 - Building Inspections
 - Electrical Inspections
 - Mechanical Inspections
 - Occupancy Inspections
 - Structural Inspections
 - Plumbing Inspections
 - Sign Admin Inspections
 - Neighborhood Protection
 - Neighborhood Admin.
 - Communication Network

- ◆ Health
 - Air Qlty (Pollution)
 - Pub. Health Engineering
 - Animal Control
 - Animal Control Admin
 - Facility Maint.
 - Facility Maint-2

- ◆ Municipal Court
 - Court-1
 - Court-2

- ◆ HPD
 - HPD-A
 - HPD-B
 - HPD-C
 - HPD-D
 - HPD-E
 - HPD-F
 - HPD-G
 - Missing

- ◆ HPDT
 - HPDT-1
 - HPDT-2

- ◆ Aviation
 - Admin-Hobby

- Admin-IAH
- Field-Hobby
- Field IAH
- Maint-Hobby
- Maint- IAH
- Mgt.IAH

◆ Health and Human Service

- All Epi's & Supervisor
- Level-1 Ad's & Director
- Technology Tech Sup.
- Level-2 Managers/Chiefs
- BT F. Response Team, SNS
- Level-1 Administration
- Environmental Biowatch

◆ Home Land Security

- Cmd-01
- Cmd-02
- HPD-1
- HPD-2
- HFD-1
- HFD-2

◆ Harris County-PW. Radio Sys

- 1.4.2I Over the next 10 years, it is projected that both mobile and portable radio use will grow about 10-15%. Of course, the actual growth will depend on many factors, mainly economic conditions and the growth of the City of Houston boundaries.
- 1.4.2J Most portable/handheld radios (about 85-90%) are assigned to individuals, and the remainder (10-15%) are passed around, or shared among users, normally on different shifts. Most of the radios are taken home after duty hours. An exception to this rule is the Building Services Department, where pagers and mobile phones are used instead. Also, some of the Parking/Municipal Courts radios are not taken home. The Office of Emergency Management (OEM) has approximately 297 portable radios to pass out to key personnel in the event of an emergency.
- 1.4.2K Most departments have Ni-Cad radio batteries ranging from 1-5 years old, and most also have a spare battery for their radios. Each department purchases batteries directly from the radio vendor and they stock their own spares. OEM maintains a larger number of spares, and only OEM and Streets have their own battery conditioner/analyzers. New portable radios are purchased with Motorola Impress smart chargers.
- 1.4.2L Many divisions also use City of Houston provided, ATT cellular telephones and Blackberries, for a variety of reasons. These include backup communications, personnel without radios and certain personnel with the need to communicate with the general public.

The PW&E trunked system can support, but is not currently using, private call features. The system is also capable of being modified to support telephone interconnect.

- 1.4.2M Public Works and Engineering also has a VHF paging system with approximately 2000 pagers, a UHF mobile data system and a Teletrak system for vehicular tracking.

1.4.3 Current System Problems

- 1.4.3A **Inadequate Radio Coverage** – PW&E radio users indicated that their single largest communications problem is a lack of adequate radio coverage with mobile and portable radios in the Kingwood, Lake Houston and extreme southeast areas.

- 1.4.3B It should be noted City Hall has passive antennas in the basement, and several downtown buildings have leaky coax throughout the buildings to help improve radio coverage in the building. It was also noted that many employees live in the area to the north of the City of Houston, such as “The Woodlands”, and they often do not have adequate portable radio coverage when off duty.

- 1.4.3C Reliable in-building communication with handheld radios is needed by Building Services in buildings throughout the city limits, particularly inside the Beltway 8 area.

- 1.4.3D **Inadequate Inter-agency Radio Communications** – Many divisions have an interest in having improved radio interoperability with other agencies. Many of these external departments are not using 800 MHz Motorola analog trunked technology, so interoperability would be possible only with interoperability hardware added to integrate the systems together. The Public Works divisions will be installing a fixed rack mounted version of an ICRI (Incident Commanders' Radio Interface) at 5711 Neches facility. The ICRI will be used to help facilitate radio interoperability with disparate radio systems in the area including the 2 Harris County 800 MHz Regional Radio Systems, the Houston Police Department, Houston Fire Department. Additionally there will be a telephone line connected the ICRI to permit phone patches to be established.

- 1.4.3E **Dispatch Console System Interface** - Dispatchers are currently not able to generate a “Alert Call” to the field units unless they leave their console position, walk to another room and use 1 of 3 available consolettes to initiate the Alert Call. This problem is due to the fact that the consoles use an over the air RF interface rather than a direct wireline interface to connect to the radio system.

1.4.4 Needs & Requirements

Improved Radio Coverage

- 1.4.4A The Public Works Department needs improved mobile and portable radio coverage in the northeastern area of the City's service area, including the heavily wooded and newly annexed Kingwood area, particularly the Northpark and Lake Houston Parkway areas. Improvement is also needed in the southeastern areas of the city limits. In addition, radio coverage is needed in the downtown tunnel system and along electrical power grids located along Beltway 8 between Interstate 45 and U.S. Highway 59. It would also be beneficial to have improved radio coverage north of the City in The Woodlands area where many of the City's employees reside.

Improved Radio System Reliability

- 1.4.4B Auxiliary power for the all repeater sites is needed to help ensure continued operation during commercial power outages. The Public Works backup repeater site will not provide citywide radio coverage due to the limited antenna height at the current location. The new radio system should incorporate multiple levels of redundancy on critical components and also provide comparable coverage while operating in a backup mode.

Updated Equipment

- 1.4.4C The Motorola SmartNet analog trunked radio system utilized by the Public Works Department is approaching the end of its useful life. The repeaters and the trunking controller have both been replaced recently, in order to extend the trunked radio system's service life. Many of the of the mobile and portable radios have been replaced over the last few years in an effort to standardize equipment and reduce the number of different models supported by the radio shop. All the older non-rebandable subscriber units will be replaced with current models from Motorola's 2500 or 5000 series during of the rebanding process which is presently underway.
- 1.4.4D Advanced radio features such as Emergency Alert with ID Display, Individual Call, Telephone Interconnect and Voice Encryption are generally not needed by most Public Works divisions. Exceptions to this general rule were generally desires, not requirements, and they include:

Division	Advanced Feature Desired
Water Production and Waste Water	Emergency Alert with ID Display
Office of Emergency Management	Individual Call (executives only), Telephone Interconnect (very limited), Voice Encryption (also very limited)
Health	Emergency Alert with ID Display, Individual Call, Voice Encryption (most of these needs were related to Homeland Security and/or transmitting personal medical information)
Utility Maintenance	Individual Call

Improved Interagency Communications

- 1.4.4E The various divisions utilizing the Public Works trunked radio system need radio communications interoperability with the following agencies:
- Texas Department of Transportation
 - Texas Department of Public Safety
 - Environmental Protection Agency
 - Texas Department of Environmental Quality
 - Harris County Health Department and other surrounding County Health Departments

- 1.4.4F **Dispatch Console System Interface** - The Utilities Maintenance Division dispatch center needs a reliable direct connection from the Renwick Drive facility to the trunked radio system control point to insure the full suite of console features is supported on the system. This could be accomplished via a leased T1 circuit or a single City owned microwave hop or as part of a digital microwave ring.

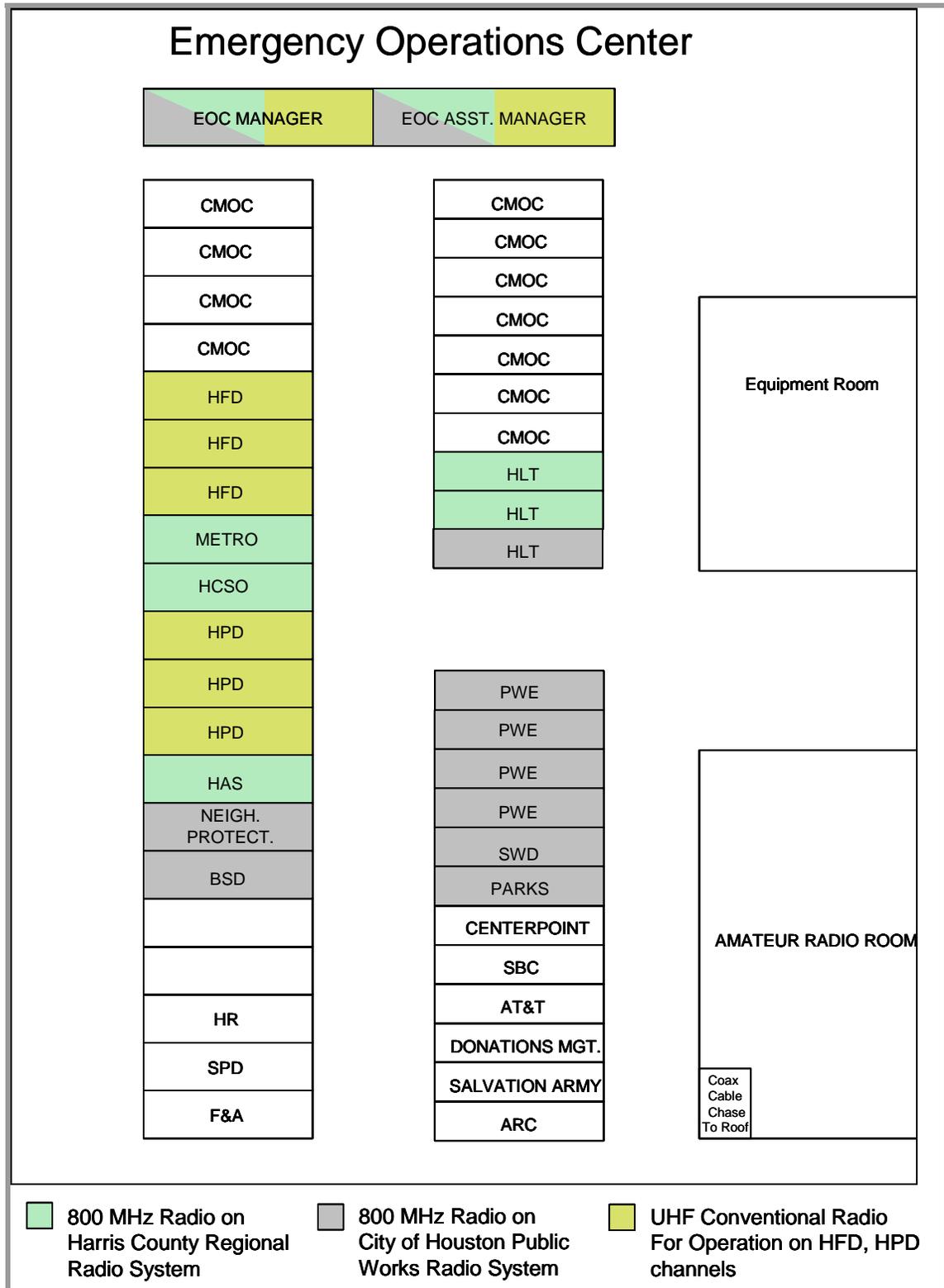
Fully Compliant Partially Compliant Non-Compliant

1.5 Office of Emergency Management

- 1.5A The Houston Office of Emergency Management operates the Emergency Operations Center within the Houston Emergency Center. EOC staff work with other City departments as well as federal, state, and county agencies to respond and effectively provide continuity of services to the public during an emergency. The operations center is located in room 2094 on the 3rd floor of the building. The EOC is equipped with 44 operating positions and 540 square feet of projected wall to display critical information. During an activation the operating positions are staffed by personal from City departments, Harris County, local utility providers and various other agencies. A basic EOC room layout drawing is provided in Figure 1.4A The number of positions and full department or agency names are as follows:

- (2) Houston Emergency Management
- (11) CMOC (Catastrophic Medical Operations Center)
- (3) HFD (Houston Fire Department)
- (1) METRO Police Department
- (1) HCSO (Harris County Sheriff's Office)
- (3) HPD (Houston Police Department)
- (1) HAS (Houston Airport System)
- (1) Neighborhood Protection
- (1) BSD (Building Services Department)
- (1) HR (Human Resources)
- (1) SPD (Strategic Purchasing Department)
- (1) F&A (Finance and Administration)
- (3) HLT (Health Department)
- (4) PWE (Public Works & Engineering)
- (1) SWD (Solid Waste Department)
- (1) Parks
- (1) CenterPoint Energy
- (1) Southwestern Bell
- (1) AT&T/Cingular
- (1) Donations Management
- (1) Salvation Army
- (1) ARC (American Red Cross)
- (2) **Not dedicated positions

Figure 1.5A Basic EOC Room Layout



- 1.5B Each operator position is equipped with a 20 position Telex RTS KP-832-20 key panel (See Figure 1.4B) which is part of the Telex Digital Matrix Intercom system. The EOC Manager and EOC Assistant Manager positions are equipped with the KP-832-20 and an additional 20 channel expansion panel. The main Digital Matrix Intercom audio switch and control unit is located in the equipment room adjacent to the Emergency Operations Center. For additional information on this equipment see the manufactures web site (click www.rtsintercoms.com).

Figure 1.4B Telex RTS KP-832-20 Intercom Control Unit



- 1.5C The EOC Manager and Assistant Manager operator positions each have a single Motorola 800 MHz control station programmed for operation on both the Harris County radio system and the City of Houston Public Work trunked radio system. These two positions also have UHF radios for operation on either the Houston Police Department or the Houston Fire Department conventional UHF radio systems.
- 1.5D CMOC (Catastrophic Medical Operations Center) which is run by the Hospital Preparedness Council has 11 positions in the EOC. Emergency Management is currently in the process of installing a new 800 MHz trunked radio for each of the 11 CMOC positions. The radios will be used to operate on the Harris County 800 MHz trunked radio system. The CMOC radios will be installed in an equipment rack which will be located in the amateur radio room directly adjacent to the EOC. The transmit and receive audio for these control stations will be routed through the Telex RTS unit located in the equipment room. All future radios shall be installed with the radio transceiver rack mounted in the amateur radio equipment room and the associated the control head remotely mounted at the designated operator position within the EOC.
- 1.5E There are 3 Houston Fire Department positions which are UHF today. Each operator can transmit and monitor 1 channel at a time and they can select a different channel via the radio control head which is mounted at the operator position on the underside of the top shelf
- 1.5F The 3 HPD positions are configured the same as the HFD positions with the radio control heads mounted at the operator position on the underside of the shelf and the transceiver unit mounted separately in the console furniture cabinet.
- 1.5G All other radio equipped operator positions have 800 MHz trunked radios on either the City of Houston Public Works Radio System or the Harris County radio system. These radios are installed the same way as the HPD and HFD radios.
- 1.5H The following photographs, Figures 1.4C and 1.4D of the EOC were taken from the east end of the EOC near Assistant Manager's console position. The equipment room is directly to the left of this view and the entrance to amateur radio room is at the far end room on the left side.

Figure 1.5C EOC Looking West



Figure 1.5D EOC Looking West



- 1.5I The Amateur Radio Operations Room has several operator positions and is equipped with HF, 2 meter and 70 cm amateur radio equipment. The coaxial cables from the control stations are routed under the floor of the EOC and over to a cable chase located in the northwest corner of this room. Here the coaxial cables are connected to a copper ground bus bar equipped with individual surge protectors for each transmission line.(See Figure 1.4E) The cables are then routed up the cable chase to the rooftop penetration depicted in Figure 1.4F. All the control station antennas and the amateur radio antennas are mounted on a purpose built steel frame located on the northeast corner of the HEC roof. (See Figure 1.4G)

Figure 1.5E Ground Buss Bar/Cable Chase

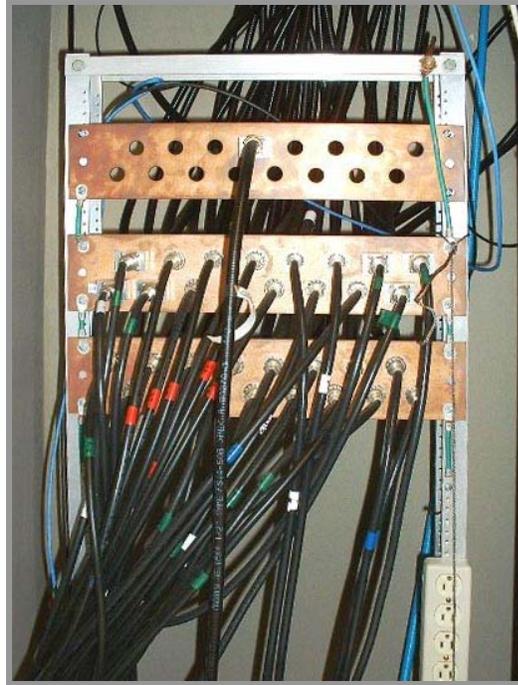


Figure 1.5F Coaxial Rooftop Penetration



Figure 1.5G Rooftop Antenna Frame



- 1.5J In addition to radio equipment at the HEC Center, the OEM operates a Mobile Command Center known as the FEOC (Field Emergency Operations Center). (Figure 1.4H below) The vehicle was constructed by Farber Specialty Vehicles in Columbus, OH.

Figure 1.5H FEOC



- 1.5K The Fire Department provides mechanical vehicle maintenance and the OEM performs all radio maintenance. The FEOC is a 34' long vehicle, 12' high counting the roof mounted antennas. It is equipped with dual air conditioners. The vehicle has its own generator and is also equipped with an external power connector. The FEOC is subdivided into three sections, plus a Drivers Compartment. The three sections are generally; (1) Radio Operations Room, (2) Equipment Area and Kitchenette, and (3) Control/Conference Room.
- 1.5L The Drivers Compartment area is equipped with the following:
- 3 ea. ICOM AM Airband Transceiver portables housed in a 6-port battery charger with three spare batteries and the portables kept "hot" at all times.
 - 3 ea. Motorola JT-1000 VHF Portables and 3 ea. Motorola JT-1000 UHF portables housed in a 12-port battery charger with the portables and batteries kept "hot" at all times.
 - 1 – HF Amateur Band radio
 - 1 – Midland 79-290 mobile radio operating on the Citizens Band (C.B.) channels
 - 1 – ICOM IC-A200 mobile Aircraft Radio
 - 1 – Motorola MCS-2000 VHF mobile radio, used to communicate with "Other Agencies".
 - 1 – Motorola MCS-2000 UHF mobile radio programmed with Police & Fire channels.
 - 1 – Motorola MCS-2000 800 MHz mobile radio programmed with Public Works channels
- 1.5M The "Radio Operations" section of the FEOC is subdivided into 5 operator positions and is equipped with the following:

- 5 – Motorola MCS-2000 UHF mobile radios programmed with Police & Fire channels.
- 5 – Motorola MCS-2000 800 MHz mobile radios programmed with Public Works channels
- 1 – Motorola MaxTrax UHF mobile radio
- 1 – Motorola VRM-650 data radio on the Police Mobile Data channel. There is no MDT in the vehicle. The Police Department delivers an MDT to the vehicle if one is required at an incident.
- 1 – ICOM Amateur Band dual-band VHF/UHF radio

1.5.1 Future Needs

1.5.1A Additional future radio requirements expressed by the OEM are as follows:

- ◆ The OEM needs portable in-building radio communications "anywhere within the city limits of Houston".
- ◆ Control stations at the EOC to replace the Police and Fire UHF radios and the Public Works 800 MHz radios.
- ◆ An option for small dispatch consoles to be installed at the EOC Manager and Assistant Manager operating positions at the EOC.
- ◆ New high tier portable radios
- ◆ Bank chargers for the new portable radios.
- ◆ New control stations in the FEOC to replace the HPD and HFD UHF radios and the Public Works 800 MHz radios.
- ◆ A mobile radio for each of the other 3 Emergency Management vehicles

Fully Compliant Partially Compliant Non-Compliant

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Section 2 Wide-Area 700 / 800 MHz Trunked Radio System

2.1 General System Overview

- 2.1A The City of Houston has outgrown its current Police, Fire / EMS, and Public Works & Engineering radio systems and is in the process of replacing these systems. The new radio system developed through this project will represent a new start, a new system, and a new era in wireless communications for the City of Houston. This RFP outlines the requirements for the City's new trunked radio system. Proposers submitting a proposal in response to this RFP shall at a minimum submit a Primary Proposal that addresses RFP requirements, particularly system infrastructure coverage requirements.
- 2.1B The City recognizes that system costs will be substantial and is therefore also encouraging Proposers to submit an Alternate Proposal in addition to the Primary Proposal that utilizes other creative methods to achieve the required levels of radio coverage and system features. Coverage requirements for Alternate Proposals shall remain the same as the Primary Proposal with the exception that the infrastructure baseline coverage can be reduced from 20 db to 15 dB. In-building and tunnel system coverage requirements remain unchanged, however alternative methods may be used to meet the in-building & tunnel system coverage requirements. Note, it shall not be acceptable to propose a 15 dB baseline infrastructure and then state that the City of Houston will be responsible for installing bi-directional amplifier systems in all required buildings to meet coverage requirements.
- 2.1C Alternate Proposals shall be clearly marked as such, shall be bound separately, and shall be delivered at the same time as the Primary Proposal. The same level of detail shall be provided in the Alternate Proposal.

2.1.1 Design Concepts

2.1.1A The system must be developed in concert with the following:

- ◆ User needs and requirements
- ◆ Radio coverage requirements
- ◆ System capacity and modular expandability requirements
- ◆ System features, functions, and capabilities to be provided by the network
- ◆ Robust radio interoperability
- ◆ Robust system reliability to help maintain system operation during a wide range of adverse conditions which may include but not be limited to powerful Gulf Coast hurricanes, industrial accidents, terrorist events, and day-to-day operations
- ◆ Maintainability

- ◆ Long term useful lifetime
- ◆ Short and long-term cost effectiveness, and
- ◆ Compliance with FCC rules and regulatory actions that impact a system of this nature.

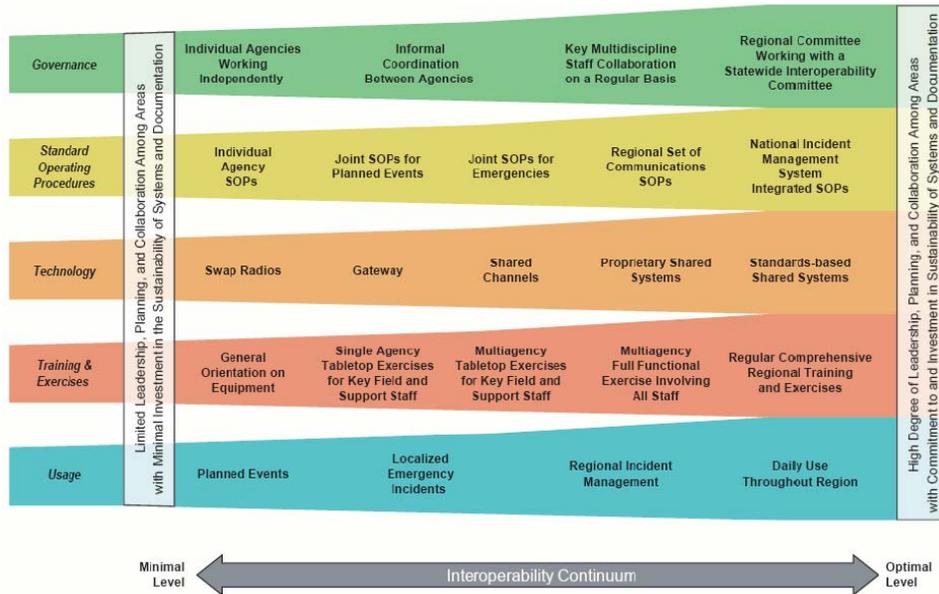
- 2.1.1B The City of Houston is seeking full-system proposals from qualified firms having large-scale system development experience. Large-scale means systems of similar size and complexity in the public safety sector. System cost is a significant concern to the City. After reviewing proposals, the City may elect to take on certain aspects of the project on its own to reduce costs, such as site development, which will include the site preparation, the tower, equipment shelter, power systems, and microwave connectivity. A final decision about the City taking on some or all of the site development effort will not be made until an analysis of the proposals and proposed costs has been completed. Proposed pricing for the site development work shall be quoted separately in Volume 2 Section 14 so that the City team can evaluate those costs. To make such an assessment, the City will need pricing for site work to be listed by site in the Pricing Section.
- 2.1.1C The City's new trunked radio system will replace most of the existing radio systems in use by City agencies. The new system shall be IP based and shall be capable of full featured operation in both the 700 and 800 MHz frequency bands. The new system will be developed to specifically replace the systems currently in use by the Houston Police Department, Houston Fire Department (Fire and EMS), the Public Works & Engineering radio system, and potentially Houston Airport System.
- 2.1.1D With approximately 19,000 radios in operation today, the new system must be developed, installed, and tested in a manner that provides for continued, uninterrupted full-featured communications via the current systems during system cutover. The new system must be installed while the current systems are still in place and operating. Most of the City's radio equipment shelters are full and due to their age, are not suitable for use in the new system. A carefully thought out and detailed design and system cutover plan must be developed to ensure the continuous operation of both systems throughout system cutover. A thorough training period will follow the installation period, where the dispatchers, technical support staff and radio users are to become familiar with the new system's operations prior to system cutover.
- 2.1.1E The City will defer taking delivery of the user radio equipment until the implementation of the radio infrastructure is nearing completion. The purpose of doing this will be to help ensure that the user equipment delivered is the latest product available with the latest release of software and fresh batteries.
- 2.1.1F The new system is intended to support the City agencies for at least the next fifteen (15) years following system acceptance without a major overhaul. It must provide ubiquitous radio coverage as outlined in Section 3 of this RFP. The system must provide reliable, automatic user radio roaming throughout the required coverage area so that radio users do not have to change settings on their radios as they move throughout the City.
- 2.1.1G Proposers are responsible for developing and proposing a system that meets City requirements. Final site selection has been left up to the Proposers, so that each Proposer can properly develop its system configuration. Section 3 – Coverage Requirements, provides a listing of existing City tower sites and potential City properties that may

potentially be utilized for new site development. Section 4 – Communication Sites, provides information about site requirements.

- 2.1.1H System size, capacity, functionality and flexibility must be sufficient to support the City's growth and changing needs for this period. The proposed design approach shall have the flexibility to accommodate additional users who may enter the system at a later time. The system must also be modularly expandable to easily accommodate City growth and expansion. The system must be designed in a manner so that the key elements of the system are not at or near full capacity at system cutover, later requiring a major reconfiguration or equipment replacement to accommodate normal growth. For example, providing a Master Network Controller (MNC) with all ports in use on day one is not acceptable.
- 2.1.1I To ensure reliable operation, the trunked radio system shall be configured with redundant equipment in key areas that impact the delivery of wide-area system operation and trunked radio operation between personnel in the field, and between field personnel and their dispatch or office personnel. A single point of failure shall not inhibit or interrupt wide-area trunked operation and shall not inhibit trunked console operation.
- 2.1.1J Specifically, the system shall incorporate primary and backup Master Network Controllers at two geographically different locations to help minimize the chance of a controller failure forcing the system into a site-trunking mode. For the purposes of your proposal development, the location of the primary Master Network Controller (MNC) shall be at the Houston Emergency Center (HEC) located at 5320 North Sheppard in Houston. The location of the backup MNC has not yet been determined.

Project 25 Operation

- 2.1.1K The new 700 / 800 MHz radio infrastructure shall be based on the Project 25 suite of standards to help foster competition in the initial and long-term equipment procurement process and to enhance radio interoperability within and around the City of Houston. The City recognizes that the Project 25 standards development process is on-going and will continue to unfold as time goes on.
- 2.1.1L The City of Houston is surrounded by other agencies operating in the 800 MHz band, many of which utilize the Harris County Regional Radio System infrastructure. After spending many millions of dollars to develop a new radio system, the City expects to have Level 5 Interoperability, standards based shared systems with all of the adjacent 700 / 800 MHz radio systems in the area, as defined by the SAFECOM Interoperability Continuum below.



2.1.1M The City currently holds a license for twenty (20) 800 MHz channels which are utilized in the PW&E trunked radio system, three (3) 800 MHz channels recently acquired by HFD, and fifteen (15) channels which are utilized by HAS for their new system deployment. Due to the lack of additional available 800 MHz frequencies in the Houston area, the City’s new system will almost certainly utilize new 700 MHz radio channels from the Region 51 700 MHz Plan along with the twenty channels from the PW&E system. Region 51 has performed their own “sort” of these 700 MHz channels, which provides Harris County entities with a proper proportion of channels relative to population. Proposers should use this Region 51 “allotment” to design their system.

2.1.1N FCC rules that regulate the use of 700 MHz channels mandate that 700 MHz systems meet certain spectral efficiency standards beginning with the equivalent of one voice channel per 12.5 kHz of bandwidth today, and increasing to the equivalent of one voice channel in a 6.25 kHz bandwidth in a few years. In complying with this FCC requirement down the road, the City has no interest in purchasing a new system that will require major overhaul of either the radio infrastructure or the user radios to comply with FCC rules.

Spectrum Efficiency - Future Migration Paths

2.1.1O The City has followed the development of the Project 25 Phase I and Phase II standards development process and is interested in acquiring the latest available Phase II technology as soon as possible to help ensure a long system life. Proposers are required to thoroughly discuss their plans for implementing Phase II technology either initially or in the future and how those plans figure into the City’s project. If Phase II technology is not proposed for initial installation, the proposal shall provide a detailed explanation of the system offering including:

- ◆ Type of infrastructure proposed initially and the system’s ability to meet the Project 25 Standards including but not limited to the 12 kb open-air interface, ISSI

standards to facilitate system interoperability and CSSI for dispatch console operation.

- ◆ Whether or not the infrastructure is upgradeable to Phase II operation, and if so, specifically what must be done to the infrastructure to facilitate full operation in a P25 Phase II mode. This explanation must include a description of any new equipment expected to be required, any “hardware refreshment” needed and exactly what that means to the City in terms of timing, operational impact, and expected costs. Your response must also identify expected software upgrades, or replacement needed, and when they might be needed.
- ◆ P25 Phase II impact on the user radio equipment, specifically whether or not the radios your firm is proposing to sell the City are currently P25 Phase II capable, or are upgradeable from Phase I to Phase II. If they are upgradeable to Phase II, you shall thoroughly describe the process required to upgrade them to Phase II operation, whether it is a simple software update, requires modification to the radios or required replacement of the radios. If the radios require modification, describe the modifications and whether or not the City will receive the same radios back that it sent in for those modifications.
- ◆ P25 dictates that backward compatibility be maintained between Phase I and Phase II technologies. The proposed system must meet this requirement. The Proposer shall describe how their system meets this requirement. In addition, the Proposer shall describe how both Phase I and Phase II radio units and talkgroups co-exist on the system, how calls are processed, limitations regarding mixed talkgroup members, etc. For both the infrastructure equipment and the radio units, the Proposer shall also state the system’s “forward compatibility” features.

Multiple Manufacturers and Dealers of Subscriber Equipment

- 2.1.1P The City is interested in having multiple sources of user radio equipment for the new radio system. Identify any other radio equipment manufacturers that offer user radio equipment that is known to be fully compatible with the Project 25 features and capabilities of your proposed system infrastructure

System Capacity

- 2.1.1Q The City requires a new system capable of supporting the current and forecasted traffic loading generated by its user agencies including HPD, HFD (including EMS), PW&E (all users on the PW&E system), and the Houston Airport System (HAS). In addition, the City is currently in discussions with the Houston Independent School District (HISD) and with the Metropolitan Transit Authority (METRO) about the possibility of utilizing the City’s new radio system for some or all of their operations. While these discussions are not yet completed, HISD and METRO user loading shall be factored into the initial system design. As the project progresses, and information involving the HISD and METRO participation becomes better defined, the system capacity requirements will be adjusted as needed.
- 2.1.1R It should be noted that the Police and Fire Departments share a large scale Motorola RD-LAP mobile data system that is interfaced to the Police & Fire CAD and RMS systems. Calls for service are dispatched by the CAD system via the mobile data system. Both departments utilize the data system extensively.

2.1.1S To assist Proposers in sizing their proposed system and in developing a realistic traffic loading analysis, the City is providing the following information to the Proposers:

- ◆ A map of the geographic areas of the City including recent Police and Fire “Calls for Service” associated with those areas (see Figure 2.1.1B)
- ◆ A standardized call transaction for HPD, HFD, and Public Works radio calls (see Figure 2.1.1A)
- ◆ Estimated growth factor in radio user population by department (see Figure 2.1.1A)
- ◆ A listing of local and wide-area talkgroups for Police, Fire, and Public Works (see RFP Section 1 – *Current Environment*)

2.1.1T A common tool used in determining the number of radio channels to include in a trunking system is the Erlang C calculation. In two-way radio applications, it is based on the following parameters:

- ◆ Grade of Service (GOS) required (% of call requests that are busied)
- ◆ Average Queue Time (avg. duration of a busy)
- ◆ Number of radio push-to-talk (PTT) calls per hour (call rate)
- ◆ Average call time (seconds)

2.1.1U Using the information provided in this RFP and their own experience in designing “mission critical” Public Safety radio systems, the Proposers shall perform traffic loading analyses and design a trunked system which provides a Grade of Service of 1% or better for all segments of the system. The Average Queue Time for the calls that receive busies shall be 2 seconds or less.

2.1.1V Figure 2.1.1A below contains the call transaction information as well as an estimated growth factor for the Proposers to use in their calculations. Please note that this call transaction information is for a typical peak hour within a peak day. It does not represent activity that would be expected during an unusual event or disaster. Proposers are expected to use their own experience in designing critical public safety/service radio systems to devise their own estimated “event factor”.

2.1.1W Proposers should use a typical call profile to account for H.I.S.D. and Metro radio unit quantities.

Figure 2.1.1A - System Capacity Sizing Information

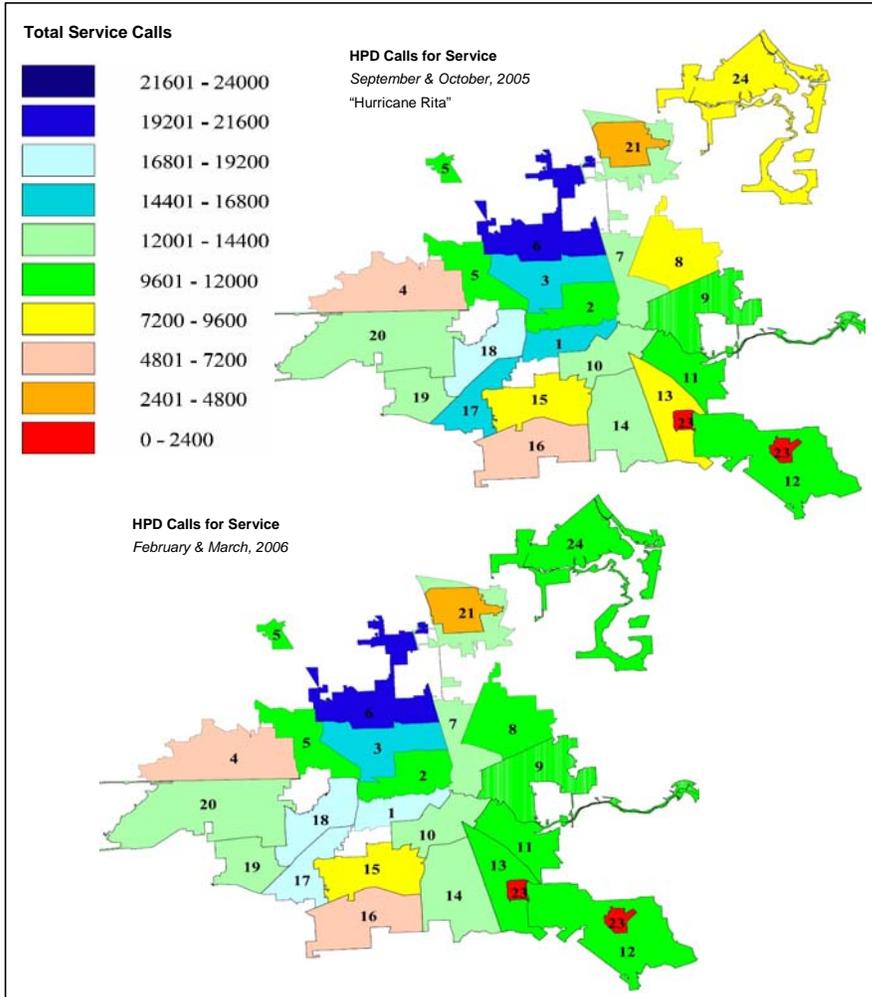
	Peak Hr PTTs/Hr	Avg Call Time (sec)	Growth Factor (not included in PTTs/Hr)	Event Factor (not included in PTTs/Hr)
Houston Police Dept	3,000	2.75	25%	To be devised by Proposer
Houston Fire Dept	1,100	4.75	25%	To be devised by Proposer
Public Works	4,000	5.0*	25%	To be devised by Proposer
Houston Airport System	600	4.0	25%	To be devised by Proposer
	No. Radio Units Requiring Covg Similar to	No. Radio Units Requiring Covg Similar to PW&E	Growth Factor	Event Factor (not included in PTTs/Hr)

	HPD, HFD			
H.I.S.D.	500	2,750	25%	To be devised by Proposer
Metro	400	1,250	25%	To be devised by Proposer

* Public Works Average Call Time includes a 1 second call set-up and knock-down time.

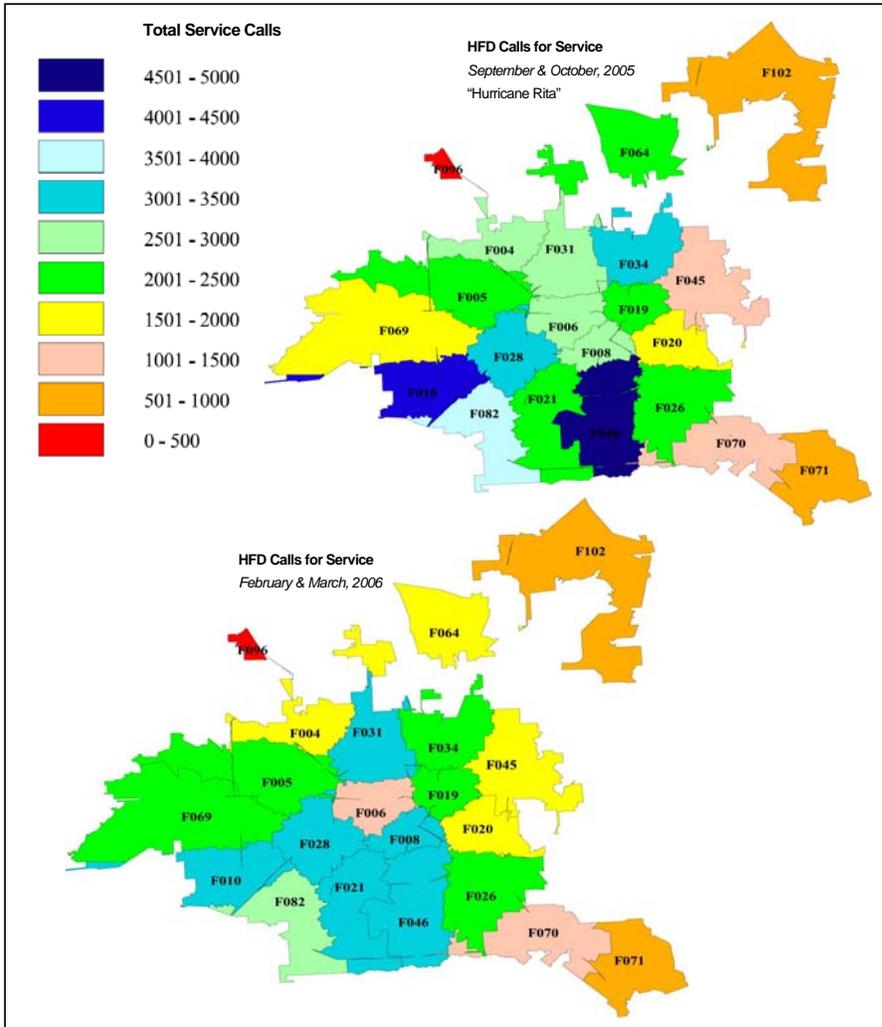
2.1.1X Figure 2.1.1B and Figure 2.1.1C below provide "Calls for Service" information for both HPD and HFD by geographic area. This information may help the Contractors proportion the total call rate activity across the service area.

Figure 2.1.1B HPD Calls For Service



2.1.1C – HFD Calls for Service

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2.1.1Y Due to the fact that the City operates over 19,000 radios in an urban environment, and requires high levels of in-building portable radio coverage performance, simulcast system technology will be needed to help meet system requirements. Certain areas of the City with reduced call volumes may be supported by non-simulcast trunked sites as long as adequate capacity is installed at the low-density sites..

System Connectivity

2.1.1Z For the purposes of your proposal, system connectivity shall be provided by a new robust digital microwave system to be provided as part of your system design. Specific requirements for the microwave subsystem have been provided in Section 5 – *Digital Microwave System*. All of the high-density repeater sites shall be linked to the network by at

least two microwave paths, preferably in a ring configuration. Where ring protection is not practical, "spur" links will be considered. Any spur links proposed shall be configured as hot standby, hot switchover microwave links. The ultimate configuration of the microwave system will be left to the Proposers since the final constellation of repeater sites and their location are unknown at this point.

- 2.1.1AA The City recognizes that building an extensive microwave network within the City may be difficult. Once a final system design has been selected and the quantity and location of the actual repeater sites are known, the City will examine potential opportunities to supplement the microwave system with existing or possibly new optical fiber facilities. In the final system configuration, the point-to-point connectivity system may consist of a combination of microwave and fiber links. Your proposal must be developed in a manner to facilitate the City making potential changes to the point-to-point connectivity network as needed.
- 2.1.1BB The proposed system design shall consist of a configuration of simulcast and possibly multicast repeater sites networked together as required to provide the specified level of radio coverage and channel capacity. Trunked radio systems have a limitation in the number of radio channels that can be supported by a single site controller. There are also site separation limitations imposed by simulcast technology that will limit the maximum separation between repeater sites within a simulcast cell. Your proposed system design must address both of these design considerations clearly and shall explain how your particular solution will allow the City to grow the radio coverage footprint and channel capacity of the system on an "as needed" basis over the next 15 years from the date of system acceptance.
- 2.1.1CC When developing a new system of this nature, there are a number of different system strategies that can be utilized. For example, the simulcast subsystem can be developed as single layer or multi-layer simulcast subsystem. There are advantages and disadvantages to each approach, and they vary by equipment manufacturer. For example, there are limitations in the number of radio channels that can be accommodated at a site in a single simulcast layer. There are also cost issues involved. These factors must be carefully considered in your system design and thoroughly discussed in the proposal.

Dispatch Facilities

- 2.1.1DD The City of Houston's public safety answering point (PSAP) and Police and Fire dispatch centers are located at the Houston Emergency Center at 5320 North Shepherd Street. Public Works & Engineering (PW&E) operates a dispatch center at the intersection of Renwick and Jessamine streets. There are also many control stations located in office or shop facilities throughout the City that operate on the PW&E radio system.
- 2.1.1EE The Houston Emergency Center is equipped with a large sophisticated redundant IPC (formerly Orbacom) conventional T-5 console system which has been upgraded from time-to-time as needed. This system will need to be replaced with a new IP based trunked console system that is fully compatible with the new proposed trunked radio infrastructure. The new console system must be configured with a redundant architecture so that a failure of one of the console switches does not disable more than 50% of the operator positions. There are currently redundant mirror-image equipment rooms in place for the console infrastructure electronics. Grounding facilities in these rooms has recently been upgraded to meet Motorola's R-56 grounding standards.

- 2.1.1FF The HEC facility is relatively new and the dispatch console furniture currently in place will remain in use after the new radio system is installed. Transitioning from one console system to another will require careful planning. Due to good planning during the design of HEC facility, there is rack space available in the HEC equipment rooms to accommodate the new console infrastructure electronics. A site visit will be scheduled by City staff to provide Proposers to review the facilities.
- 2.1.1GG After cutover to the new radio system, the City plans to develop a new Police / Fire backup dispatch center. A new backup console system shall be proposed and shall have a user-interface which closely resembles the proposed primary console system for HEC.
- 2.1.1HH The Public Works & Engineering dispatch center is equipped with a relatively new Motorola Gold Elite console system which is linked to the PW&E radio system by control stations. The PW&E console system can be reused in the new system configuration.
- 2.1.1II The Houston Airport System operates two communication and dispatch centers, one at George Bush Intercontinental Airport and the other at William P. Hobby airport.

Project Phasing

- 2.1.1JJ The new system shall be installed in two phases. Phase I shall include the complete installation and optimization of the 700 / 800 MHz radio infrastructure which is comprised of multiple repeater sites consisting of base repeater radios, microwave system, power and grounding systems, towers, shelters, trunked system controllers and audio switches and associated equipment. Phase I will also include the installation of Police, Fire, and PW&E radio dispatch center equipment and the associated console electronics equipment for the system.
- 2.1.1KK Phase II will consist of the installation of the City agencies onto the radio infrastructure. Final system acceptance will not be considered until all City agencies have been successfully installed on the new network, Phases I and II.

2.1.2 Analog/Digital Operation

- 2.1.2A The City recognizes that Project 25 systems are digital systems. It also recognizes that under certain circumstances analog radio operation may provide clearer audio performance, particularly in high noise environments. If your proposed P25 system supports both digital and analog operation that capability should be clearly explained whether it holds true for the radio user equipment, the radio infrastructure, or both.

Fully Compliant Partially Compliant Non-Compliant

2.2 Simulcast Operation

2.2.1 Transmitter Simulcast

- 2.2.1A Wide-area coverage is defined as operation over an area that cannot be covered by a single repeater site. Simulcast subsystems shall meet the following requirements.



- 2.2.1B Any simulcast design shall be GPS synchronized and shall have the capability to connect audio and data between the prime control site and transmit sites via DS-1 or higher microwave circuits or via fiber based T-1 circuits. A new City owned digital microwave system shall be proposed by the Proposer to link the system repeater sites and Public Safety Communications Centers.
- 2.2.1C The trunked system shall be capable of automatically adjusting the path delay and amplitude of any one or all DS-1 or T-1 circuits utilized in the system to maintain high simulcast audio quality in the talk-out direction. The automatic adjustment shall compensate for any change in microwave or optical fiber paths or T-1 provider paths. The system shall be capable of maintaining a phase delay (launch time) to ensure that the system's delivered audio quality meets the coverage and audio requirements outlined in Section 3 – *Radio Coverage Requirements*.
- 2.2.1D A written response to these items shall be included in the Proposer's response:
- ◆ **Renetting Interval** - The recommended interval and means by which the system is to be "renetted" or verified with respect to adjustment of frequency, modulating signal amplitude and phase, shall be specified.
 - ◆ **Simulcast Time Delay Control** - Once the path delays have been measured, the method by which audio path time delay will be automatically controlled and equalized shall be specified. The maximum amount of path delay compensation shall be specified.
 - ◆ **Frequency Stability** - The method by which the frequency of base station transmitters is maintained within the required tolerance for satisfactory simulcast operation shall be specified, and this value shall be provided.
 - ◆ **Addition of Sites** - The procedure and equipment required for the addition of base repeater or receiver sites shall be specified. Also, the maximum site capacity of a single simulcast "Site" or "Prime" controller shall be specified.
 - ◆ **Addition of Channels** - The procedure and equipment required for the addition of base repeater or receiver channels shall be specified.
 - ◆ **Control of Sites** - The method by which the simulcast remote sites are controlled and interfaced with the trunked system controller shall be described. Link type and bit rate shall be specified.
 - ◆ **System Architecture** - The trunked simulcast system architecture shall be described in detail, with written descriptions of all major system components and their functions. System and site block diagrams shall be provided to show the interconnection and the detailed audio/logic signal flow (e.g.; tx audio, keying, etc.) between system elements (components/equipment racks).

2.2.2 Voting Comparator and Audio/Data Distribution Equipment

General Requirements

- 2.2.2A Receiver voting will be employed as part of any proposed trunked simulcast system. The Proposer shall provide a means of selecting the best quality received signal from each of

the proposed repeater sites. The voting comparator shall act as the system-wide collector, voter and distributor of (voice) signals for its associated RF channels. The comparator shall extract the best quality audio signal from the multiple signal sources and provide the means to deliver it to a single or multiple destination(s). For digital voice operation, the comparator shall incorporate frame diversity to utilize the best data frames of all of the inputs to construct a better output signal.

- 2.2.2B A comparator shall be provided for each trunked RF channel and equipped for, at a minimum, each proposed simulcast repeater site. The comparator shall be modular in construction and allow the addition of radio sites (inputs) and the addition of RF channels. The Proposer shall state how the equipment being proposed will accommodate future expansion.
- 2.2.2C The Proposer shall include a detailed description of the methodology used in the voting process including the method of programming or otherwise configuring the comparator shall be described. Alarm reporting and/or diagnostic capabilities of the device, if any, shall be described along with the need of modems or other such devices to allow the remote accessing and/or monitoring of the comparator(s).
- 2.2.2D If the proposed trunked system is a P25 Phase I system, the equipment being proposed shall allow for the future integration of P25 Phase II digital operation. The Proposer shall explain how this type of operation will be accommodated by the system being proposed.
- 2.2.2E If additional equipment is required for the processing and/or routing of audio signals from the comparators and trunked consoles and/or for the processing and/or routing trunked signaling originating from the trunked controller(s), this equipment shall be identified and described. A block or pictorial diagram shall be provided that illustrates the general configuration and interconnection of the equipment.
- 2.2.2F The Proposer shall provide any other information they feel is pertinent to the understanding and evaluation of the equipment being proposed.
- 2.2.2G A general floor plan of the voting equipment layout shall be provided. The floor plan shall include an overhead view, as well as front and rear block or pictorial representation of the equipment mounting configuration.

Fully Compliant Partially Compliant Non-Compliant

2.3 Trunked Operation

- 2.3A The trunked repeaters shall be managed by the Master Network and/or Primary Site Trunked Controller (MNC) that selects the communications channel. When a request for communications from a field unit occurs, the controller shall acknowledge the request and assign an idle channel for communications. The proper talkgroup also shall be assigned.
- 2.3B The system shall allow a transmitting unit access to an available channel and unmute a receiving unit's speaker with the transmitting unit's audio within 1.5 seconds for digital operation and 0.75 seconds for analog operation, of the transmitting unit's Push-To-Talk (PTT). Should system traffic be at a level where all channels are busy, the system will

automatically give preference to higher priority units attempting access. The system shall indicate to the user that channels are busy, that the unit is placed in queue, and will be offered a channel in a call back mode. The Proposer shall describe the extent of priority the system offers.

- 2.3C User defined quantities of mobile and portable units shall be equipped with a dedicated switch or function that allows emergency access. The switch shall be easily accessed, but designed to minimize the chances for accidental activation. Upon emergency activation, the field unit shall transmit the Unit I.D. and/or alias and emergency message on a periodic basis until acknowledged by the console operator (dispatcher).

2.3.1 System Operating Modes

- 2.3.1A The new trunked radio system shall be capable of operating in the following modes:

Trunked Mode

- 2.3.1B Day-to-day communications by all users occur using this mode. While in the trunked mode, the system should initially provide for the control of trunked channels at all sites. Expansion capabilities to support additional channels and dispatch consoles that may be required in the future must be incorporated into the basic system design. Proposers shall discuss expansion capabilities and limitations of the hardware being supplied, detailing maximum number or combinations of simulcast sites, non-simulcast sites/sub-systems, channels, dispatch positions and subscriber units.

Talk-Around Mode

- 2.3.1C The mobile, portable and control station radios shall be capable of transmitting and receiving on the repeater's transmit frequencies for localized communications. The talk-around mode, which shall be user selectable, shall provide simplex radio channels for direct communications between subscriber units.

Encrypted Mode

- 2.3.1D All channels of the trunked simulcast system shall be installed and equipped to repeat digital AES voice encryption. All subscriber units properly equipped with encryption shall be able to scan between and converse on encrypted and clear talk groups. All City Public Safety dispatch positions shall be capable of utilizing the encrypted channels. The range of the system in encrypted mode must equal the range of the system in clear mode.
- 2.3.1E The encryption process shall not degrade the audio quality of the system. Encryption shall be available in trunked, conventional and talkaround modes. Proposers shall state the number of encryption algorithms available in their system and the encryption algorithm capacity of their radio units. Multiple keys must be provided.
- 2.3.1F The Proposer shall describe their methodology for key management of their encryption.

Over-The-Air Rekeying (OTAR)

- 2.3.1G The system shall be capable of Over-The-Air-Rekeying (OTAR) of the encryption algorithm. If the system does not meet this requirement by the start of the field acceptance test, the Proposer shall provide a time frame for implementation, and identify the cost of an upgrade to provide rekeying of the encryption algorithm over-the-air.
- 2.3.1H The Proposer shall describe the system's capability for OTAR, including any limitations that rekeying subscribers over-the-air has over traditional methods. The Proposer shall describe the process by which the rekeying takes place and the timeframe required to rekey an individual radio and a group of 500 radios.

Failure Mode Analysis

- 2.3.1I One of the most essential elements of a complex wide-area radio system is how the system performs during various failure conditions. Such conditions may arise through direct equipment failure or as a result of external events that may disable certain system components or the facilities that support them. The system must be designed with robust levels of redundancy, and the ability to provide continued trunked communications in the event that failures occur.
- 2.3.1J It is the City's intent that that wide-area communications remain intact to the extent possible during failures. System architectures in which single points of failure would disable seamless wide-area communications shall be avoided.
- 2.3.1K All critical components or subsystem interface links at the Houston Emergency Center (HEC) primary master site must be redundant. These critical components must remain online continuously with parallel updating of critical system databases to provide minimal interruption of service in the event of failure. Switching from primary to standby operation must be fully automatic, including a manual override capability. An audible and visual indication of the switchover and current system status shall be provided. Proposers must specify the amount of time between component failure and the resumption of normal operation under the standby system. The backup master site (location to be determined) must be configured identically to the primary master site.
- 2.3.1L Proposers shall include a comprehensive analysis of failure scenarios and reliability features. The structure with which the proposal must address system failures and reliability is addressed in Table 2.3.1. The Proposer is required to provide a thorough failure mode analysis. A narrative approach in conjunction with high-level block diagrams (with failure marked / identified) is preferred for this analysis.

Figure 2.3.1 - Structure for Comprehensive Failure Analysis & Reliability Features

<p style="text-align: center;">Failure</p>	<p>Impact to Radios How do radio units react and adapt to failure, how is normal operation hindered</p>	<p>Impact to Dispatch How does HEC dispatch react and adapt to failure, how is normal operation hindered</p>	<p>City of Houston Protection Proposed protection components, fallback modes of operation, radio unit "failure friendly" features, estimated restoration time</p>	<p>Detection Where and how is failure detected, indication to radio units and dispatchers, indication to system manager</p>	<p>Probability of Failure</p>
<p>Master Site(s) Describe all master site component failures individually. Please include all LAN/WAN equipment and servers. Please include failures affecting system operations but not related to system components</p>					
<p>Dispatch Describe all system component failures related to dispatch individually. Include failures affecting dispatch operations but not related to system components</p>					
<p>Site Equipment Describe all system component failures related to site equipment individually. If the proposed design dictates varying site configurations, ensure that the analysis comprises all configurations. Please include failures affecting system operations but not related to system components</p>					
<p>Connectivity Provide a thorough analysis of the results of connectivity link failures, proposed channel bank/WAN switch component failures, etc. Please provide this for all link scenarios (to tower sites, dispatch sites master sites, etc.). Please include an analysis of the proposed system's "weak links".</p>					

2.3.1M Describe circumstances that have the potential to create long outages or would cause large system segments to malfunction. In these cases describe estimated times that system users would be affected.

Automatic Unit Log-In or Registration

2.3.1N Whenever a user radio identifies and locks on to a new control channel at a repeater site, it shall transmit its logical I.D. and group setting to the Master Network Controller via the control channel at that repeater site. This log-in capability will allow the Master Network Controller to track unit and talkgroup distributions across the network. This capability will be provided whenever a radio locks on to a new control channel, changes talkgroups, when it is initially turned on, manually switch between repeater sites, or when wide-area roaming and scanning successfully locates a repeater site with significantly better coverage.

2.3.1O The user registration or login information shall be recorded in the Master Network Controller database. The controller will determine which sites are to be conferenced and illuminated for each wide-area call. The user tracking mechanism will allow the Master Network Controller to limit wide-area calls to only those sites on which a member of the talkgroup is active. The purpose of this capability is to help improve channel efficiency by not assigning repeaters at sites that have no recipients for a particular radio call.

Unit Deregistration or Log-Out

2.3.1P In order to properly manage the network, the Master Network Controller shall provide a feature called Unit Deregistration or Log-Out. The purpose of this capability will be to reduce "phantom loading" generated by units that have been turned off or roamed out of the coverage area. Unit Deregistration will automatically log-out all units that are inactive on the network for a user defined period of time. When a radio is turned back on or roams back into the network, it shall automatically register or log-in to the network, and will be tracked by the Master Network Controller.

2.3.2 Master Network Controller and Associated Subsystems

2.3.2A The Master Network Controllers (MNC) are critical components of the system. The design shall provide for high reliability under extreme emergency conditions and redundant network controllers in geographically diverse locations are required.

2.3.2B If a Proposer's design requires an additional site or sub-system controller to be slaved off of the MNC, the MNC will have complete control of wide-area call processing and assignments until its failure, or failure of another critical network component. At that time, the redundant Master Network Controller should take over system control, utilizing the same user database and functionality. In the event that neither the main nor the redundant MNC is controlling the system, all subscribers shall be provided audible and visual indications.

Reliability and Redundancy

2.3.2C It is the intent of this specification to provide a trunked system that will not suffer the loss of trunking or wide-area operational capability as a result of the failure of a single system component, in particular the Master Network Controller and/or Primary Site Controller. Should any component of the MNC fail, sufficient redundancy shall be incorporated in the system design so that full trunking operation continues without interrupting existing communications. Trunking capability is defined in this context as the ability of the system to assign voice channels to independent talkgroups, as required, and the ability of the system user groups to remain functionally independent (i.e., full APCO 16 feature set with no loss of features). A single MNC failure that reverts the system to site trunking mode is unacceptable.

2.3.2D ANY SYSTEM COMPONENT ENCLOSURE OR POWER DISTRIBUTION DESIGN THAT COULD RENDER THE SYSTEM OR 25% OF ITS CHANNEL RESOURCES USELESS FOR COMMUNICATION FROM A SINGLE POINT OF FAILURE, SHALL INCORPORATE REDUNDANCY. This may be in the form of a redundant component/enclosure or a distributed redundant design which distributes single points of failure among multiple card cages, cabinets or housings each operating on its own dedicated power circuit.

2.3.2E In the case of redundant MNC controllers, both controllers shall remain on line continuously with parallel updating of the system data base to provide minimal interruption of service in the event of failure of the primary controller. Switching from main to standby operation shall be fully automatic, with audible and visual indication of the switchover provided to the supervisory console positions in the Public Safety dispatch centers at the Houston Emergency Center. These positions are further defined in Section

6 - *Dispatch Radio Consoles*. Proposers shall specify the amount of time between main controller failure and the resumption of trunked operation under the backup system.

- 2.3.2F Manual switching from main to standby MNC controller operation shall be provided at the Public Safety supervisory consoles as a manual override to automatic switchover. Proposers shall specify the period of time required and the procedure for manual switchover to a redundant central controller.
- 2.3.2G Switching between controllers (manually or automatically) shall not require more than ten (10) seconds, and shall not cause subscriber units to attempt to roam away from a site or simulcast subsystem they are currently on. Also, subscriber units shall not have to re-affiliate themselves with the system after a controller switch has occurred. This is to prevent inbound signaling overload of the controller or control channel.
- 2.3.2H It is understood that all systems that meet the intent of this specification must suffer multiple system element failures before a site trunking or reduced capability operating mode is encountered. Proposers are nonetheless required to describe such a failure mode, regardless of how unlikely its occurrence.

System Features and Functions

- 2.3.2I Software and firmware to provide functions and features described shall reside in the Master Network and/or Primary Site trunking controller and associated computer software/hardware. The controller and its associated computer software/hardware shall provide the following functions:

Alarm Monitoring and Diagnostic Functionality

- 2.3.2J Monitoring of the operational status of all system devices and providing alarms when subsystems fail. Diagnostic functions shall allow an operator to view current status and status history of the system. It shall also allow for diagnostic tests to be performed on network devices (i.e. site controllers, base stations, comparators, etc.) to verify component and path integrity.

Signaling (Control) Channel Backup

- 2.3.2K Automatic transfer of signaling functions to another channel in the event of transmitter or receiver failure or interference on the signaling channel shall be provided. Each system shall have one active and a minimum of three backup signaling channels for simulcasted and non-simulcasted subsystems/cells. Backup is defined as a channel of different frequency. Hot standby backup of a signaling channel to a station of the same frequency is not acceptable.

Disabling of Failed Voice Channels

- 2.3.2L Automatic disabling of defective voice channels due to subsystem failure shall be provided. Failures must be detected prior to the channel being assigned by the controller. Subsystem failures to be detected shall include, at a minimum:
- ◆ Low forward power
 - ◆ High reflected power
 - ◆ Unidentified carrier on unassigned voice channel

- ◆ Signaling interface failure between base and controller
- ◆ Audio circuit failure between controller and base
- ◆ Voter receiver failed
- ◆ Voter receiver disabled

System Usage Reports

2.3.2M Collection and processing of data with regard to system usage. Proposers shall describe how the data is parsed for displaying at the System Manager's terminals. Also, at a minimum, data to be routed to a printer shall include the following:

- ◆ Error Event Log
- ◆ # PTT's per talkgroup per interval of time
- ◆ # PTT's per system per interval of time
- ◆ # of calls by type/interval
- ◆ Call duration by type of call
- ◆ # of system busies/interval of time
- ◆ Total busy time/interval of time

System configuration

- ◆ Configuration information for all components in the system
- ◆ Functional configuration of controllers, channels and sites

Subscriber Management

- ◆ Manager database (list of system managers)
- ◆ Logged on managers
- ◆ Regrouped radios
- ◆ Inhibited radios
- ◆ Storm plans
- ◆ Commands (tasks)-in-Progress (regroups, inhibits)
- ◆ Subscriber configuration and attributes (by individual, talkgroup and multigroup)

Channel Usage

- ◆ Identification of calling units by talkgroup and unit identification number
- ◆ Time of channel access
- ◆ Duration of transmission
- ◆ Classification of call
- ◆ Channel assigned
- ◆ Site or Sub-system involved in a call

Fault Management

- ◆ Current alarms
- ◆ Alarm history (daily, weekly, monthly)

- ◆ Alarm history (by component)
- ◆ Technician notes

2.3.2N Proposers shall include sample copies of these reports in their submitted proposals and state the data storage capacity of system in days and/or number of alarms.

Channel Access Priority Levels

2.3.2O As a minimum requirement, the system shall provide user definable levels of access priority and such levels of priority shall be variable from any dispatch console in the system to allow assignment of specific talkgroup members to a higher system access priority for the duration of a special event or tactical operation. Access and control of priority levels shall be partitioned so as to allow separate control by the respective agency.

Dynamic Talkgroup Reconfiguration

2.3.2P Dynamic regrouping of mobile and portable radios shall be provided. This function shall allow units from different talkgroups to be regrouped into a common talkgroup via the signaling channel. Preprogramming of regrouping functions to allow rapid implementation of emergency plans by the City shall be provided.

2.3.2Q The time required for such regrouping, both for preprogrammed groups and individual units, shall be specified by the Proposers. Proposers shall also specify any limitations on group size and the number of preprogrammed groups that can be accommodated by their systems.

Selective Disablement of Field Units

2.3.2R Selective disablement of individual mobile or portable radios shall be provided. Reactivation of such radios, which have been disabled, shall also be provided. These functions shall be performed on the signaling channel. Control of this feature is to be partitioned by manager user name.

Control of Time Out Parameters

2.3.2S Control of time out parameters shall be provided at any manager user terminal. Any valid manager logged in with this capability shall be able to control at a minimum:

- ◆ Channel Hang Time (message trunking)
- ◆ Interfering Carrier Time (length of time channel remains enabled with an interfering carrier)
- ◆ Remote Link Failure Time (length of time site remains enabled without a remote site data link)
- ◆ Channel Fade Time (length of time channels remains assigned without a carrier or low speed data present)

- ◆ Emergency Call Time (length of channel hang time when an emergency call is initiated)

Channel Partitioning

- 2.3.2T Channel partitioning shall allow talkgroup and individual calls to be directed or steered to a single channel or group of channels within a site or subsystem. The partitioning capability shall not prohibit any group from being allowed access to all channels. Channel partitioning shall be definable at the "subsystem" level. Subsystem partitioning means that if multiple subsystems are networked together by a Master Network controller/switch, partitioning "tables" shall be defined in each subsystem.

System Programming

- 2.3.2U Programming of system operational parameters shall be provided by operator terminals controlled by the trunked system management computer. These terminals shall provide for "user friendly" operation by trained personnel. Access to system programming functions shall be protected by hierarchical password security. Hard copy printout of programming functions or data is desired. Printers shall be an HP Color LaserJet 3600 dn or approved equivalent.
- 2.3.2V System Manager partitioning shall allow different City agencies to control their user database independently of one another. The system shall allow the partitioning of subscribers and sub-system infrastructures. Partitioning shall be defined and protected by a user name and a respective password. Partitioning shall allow access to as well as prohibit users from, different sub-systems, programming and system management areas, and subscriber ID ranges (talkgroup and individual ID ranges).

Over-The-Air-Programming (OTAP)

- 2.3.2W City requires that all subscribers be capable of being "reprogrammed" over the air. Both the infrastructure equipment and all proposed subscribers shall be equipped with Over-The-Air-Programming (OTAP). The Proposer shall describe the system's capability for OTAP, including any limitations that programming subscribers over-the-air has over traditional methods. The Proposer shall describe the process by which the reprogramming takes place and the timeframe required to reprogram an individual radio and a group of 500 radios.

SIGNALING AND SPECIAL FUNCTIONS

Unit Identification

- 2.3.2X A real time display of push to talk unit identification at the dispatch positions shall be provided in a plain English alphanumeric alias format. Proposers shall specify the maximum number of alias ID's per console operator position and system wide.

Signaling (Control) Channel Updating

- 2.3.2Y The signaling channel shall continually transmit the current channel assignments of the system. This feature is intended to insure that radios "signing on", coming into

range, or switching talkgroup modes are directed to calls in progress on their selected talkgroup.

Voice Channel Embedded Signaling

- 2.3.2Z Embedded or sub audible signaling shall be transmitted on assigned voice channels in order to prevent subscribers from being misdirected or allowed to transmit on an improperly assigned channel.

Emergency Alarm and Call

- 2.3.2AA A display and an audible alert to the dispatcher (on the dispatch operator console) upon activation of an emergency switch on portable or mobile radios shall be provided. The response time to display the emergency condition at the console position shall not exceed 3 seconds. The display shall identify the unit ID and/or alias of the radio initiating the emergency alarm. Automatic translation of this unit identification to correlate to "Plain English" equivalent is required.
- 2.3.2BB Upon activation of the "emergency unit's" PTT, a channel shall be assigned for a predetermined amount of time. The emergency call hang time shall be adjustable by the system manager.
- 2.3.2CC In the event all voice channels are occupied, the system shall be capable of functioning (via programming) in at least the following two (2) modes:

Emergency Priority Queuing

- 2.3.2DD If all voice channels are occupied when an emergency call is made, then the unit initiating the emergency shall be placed at the top of the busy queue list and allowed access to the next available voice channel. The "emergency unit" shall be given the highest level of priority regardless of how many units are already in queue or what their priority is.

Emergency Preemption

- 2.3.2EE If all voice channels are occupied when an emergency call is made, then the unit initiating the emergency shall be allowed access to the voice channel with the lowest priority user currently assigned. It is understood that until the current user de-keys, there will be RF contention between the emergency user and the current transmitting unit. However, once the "non-emergency" user de-keys, that unit should be transmission trunked back to the signaling channel so the voice channel can belong to the emergency user. The City understands the implications of this contending audio, but also realizes the possible advantages of having immediate access in an emergency situation.

Talkgroup Call Priority Interrupt

- 2.3.2FF If the proposed system provides a feature which allows a talkgroup member with a higher priority involved in a call to "interrupt" a talking member with a lower priority, the Proposer shall describe in detail how this works. It is preferred that users with the same priority levels not be able to interrupt one another.

Private Call

- 2.3.2GG Selected users and dispatchers shall have the ability to selectively communicate “privately” with another individual on the system regardless of what talkgroup either unit is in. The call shall allow the two users to utilize a single channel resource to communicate without the participation of other units in their respective talkgroups.
- 2.3.2HH If the recipient of a private call has a display-type radio, the radio shall display the plain English ID of the calling party. Respectively, the calling party shall be able to determine if the recipient did not receive or is not available for the call (i.e. recipients radio is turned off, out of range, etc.) by hearing a distinctive tone and receiving a message in their display.
- 2.3.2II The subscriber units on the system shall be programmable for at least the following modes of operation:
- ◆ Subscriber units shall be capable of Unlimited Private Call capability if desired.
 - ◆ Subscriber units shall be programmable to hold a specific list of users that can be privately called. The list shall be able to hold at least eight (8) individual ID's. Proposers shall specify the maximum size of this list and if this list is independent of the call alert list.
 - ◆ Subscriber units shall be programmable to only receive private calls from other users. These units shall never be capable (unless programmed otherwise) of initiating a private call.
 - ◆ Subscriber units or the system shall be programmable with private call time-out timers.

Call Alert (Paging)

- 2.3.2JJ Selected users and dispatchers shall have the ability to selectively alert another individual user on the system regardless of what talkgroup either unit is in. The call shall allow an individual to alert another user with a distinctive tone and their individual ID/alias (on display radios only). The alert shall be accomplished over the signaling (control) channel and should not affect any voice channels on the system.
- 2.3.2KK If the recipient of a call alert has a display-type radio, the radio shall display the plain English ID of the alerting party. Respectively, the alerting party shall be able to determine if the recipient did not receive or is not available for the alert (i.e. recipients radio is turned off, out of range, etc.) by hearing a distinctive tone and receiving a message in their display.
- 2.3.2LL The subscriber units on the system shall be programmable for at least the following three (3) modes of operation:
- ◆ Subscriber units shall be capable of Unlimited Call Alert capability if desired.
 - ◆ Subscriber units shall be programmable to hold a specific list of users that can be call alerted. The list shall be able to hold at least eight (8) individual ID's.

Proposers shall specify the maximum size of this list and if this list is independent of the private call list.

- ◆ Subscriber units shall be programmable to only receive private calls from other users. These units shall never be capable (unless programmed otherwise) of initiating a call alert.

Multi-Group Call

2.3.2MM Multi-Group talkgroups shall allow multiple talkgroups to be affiliated to a single multi-group. When a call is placed on the multi-group talkgroup, all talkgroups associated with the multi-group shall be assigned to a single voice channel for the conversation. Every user involved in the multi-group call shall have talk-back capabilities for the duration of the call (if message trunked). The system shall be programmable to allow for the following two (2) modes of operation:

Ignore Mode

2.3.2NN If a user initiates a multi-group call, the call will immediately ignore calls in progress on affiliated talkgroups. The multi-group call will not wait for units in those talkgroups to de-key and therefore those transmitting units will not hear the multi-group call until they de-key.

Wait Mode

2.3.2OO If a user initiates a multi-group call while calls are in progress on affiliated talkgroups, then the multi-group call will wait (busy-queued) until all participating talkgroups have finished their transmission. Initiating a multi-group call should transmission trunk all calls in progress on affiliated talkgroups in order to facilitate the multi-group call.

System-Wide Call

2.3.2PP Shall allow a Police or Fire Supervisor to initiate a call that will transmit on all talkgroups on all sites or sub-systems.

Site-Wide Call

2.3.2QQ Shall allow a unit or dispatcher to initiate a call that will transmit on all talkgroups on a particular site or sub-system. For this type of call, a simulcast sub-system or non-simulcast site is considered a single site.

Scan

2.3.2RR This function shall provide the ability to scan through multiple modes (talkgroups) within the same system. It shall also contain the capability to store and scan a list of conventional frequencies. Subscriber units shall be provided with at least one (1) scan list per system. Each list shall contain at least ten (10) talkgroups or frequencies. The scan function shall allow individual users to add or delete talkgroups from the list.

Priority Scan

- 2.3.2SS This feature shall provide the ability to apply two priority levels to a defined scan list. While in the scan mode, a Priority One transmission shall be received regardless of the activity on the Priority Two (or other non-priority modes). A Priority Two message is heard over all (except Priority One messages) non-priority modes.

System Expansion Capabilities

- 2.3.2TT The Master Network Controller and any auxiliary controllers shall provide for a minimum of 50% expansion of subsystems without major hardware modifications. Modular construction with plug-in circuit cards is considered desirable. A subsystem is defined as a console system, telephone interconnect or a console system, telephone interconnect, or a simulcast layer or individual trunked "filler" site as may be required for unusual coverage areas.

Subsystem Expansion Capabilities

- 2.3.2UU Each subsystem controller and any auxiliary controllers shall provide for expansion to 15% additional repeater sites at a minimum without major hardware modifications.
- 2.3.2VV Modular construction with plug-in circuit cards is considered desirable.

Radio Channel/Site Expansion Capabilities

- 2.3.2WW Each site controller and any auxiliary controllers shall provide for expansion to 30 radio channels of operation at a minimum **without major hardware modifications**.
- 2.3.2XX Modular construction with plug-in circuit cards is considered desirable. The maximum number of channels that can be supported by a site controller shall be provided in your system description.

Data/Control Interfaces

- 2.3.2YY All necessary interfaces with base repeaters, peripheral computer hardware or the radio interconnect system shall be provided by the Successful Contractor. Interfaces shall include cabling and modems, all of which shall be identified by the Proposer's functional diagrams of the system.

Alarms and Diagnostics

- 2.3.2ZZ The Master Network Controller and its associated subsystems shall provide alarms for key operational parameters, and shall provide for remote inquiry, display, disablement and diagnostic functions via LAN connections and dial-up modem.

Fully Compliant Partially Compliant Non-Compliant

2.4 System Manager/Information Management System

2.4A The system shall incorporate a graphical user interface (GUI) system manager/information management system to set selected parameters and allow the supervisory personnel to control and analyze system operation.

2.4.1 System Management

2.4.1A The System Management/Alarm Terminals shall include a personal computer, 21" color LCD Flat Panel monitor with keyboard and mouse. Required system manager capabilities at a minimum shall include:

- ◆ **System Configuration** - shall be able to control all of the programmable features of the trunking controller and radio infrastructure.
- ◆ **Subscriber Management** - shall allow an operator to view, set, or modify the talkgroup ID's, and the unique ID permission.
- ◆ **Manager Partitioning** - System subscriber management functions shall be capable of user (agency) partitioning. Manager partitioning shall allow a user to view, set or modify subscriber information pertaining to a particular agency while restricting access to other agencies. The highest level manager shall be capable of viewing all subscriber information. Partitioning shall allow access to, as well as prohibit users from, different sub-systems, programming and system management areas, and subscriber ID ranges (talkgroups and individual ID ranges).
- ◆ **Diagnostic Management** - shall allow an operator to view current status and status history of the system, sub-system or component. It shall also allow for diagnostics to be performed on network devices (i.e. site controllers, base stations, comparators, etc.)
- ◆ **Dynamic Radio Commands** - regrouping of system users, including the ability to predefine, store, and implement regrouping plans as needed. Sending and receiving of status messages to and from subscriber units. Selective radio status information regarding radio's operating status (i.e. on/off, inhibited), last talkgroup affiliation and last site registration.
- ◆ **Selective inhibit/uninhibit** of control stations, mobile and handheld radios and trunked repeaters. Field equipment shall be equipped to respond to the system manager commands.
- ◆ **Activity reporting** by unit, talkgroup, department (if available), and system wide.
- ◆ **User database maintenance** partitioned by agency, with automatic sharing of data and updates between the console electronics and the trunking system. Unit I.D.s and aliases shall be programmable from the terminal and communicated to all equipment with unit I.D. display. **A single electronic database shall be shared by the console dispatch and trunking systems.**
- ◆ **Activity monitor** to display the status and activity of all RF channels within the system.
- ◆ Capability of automatically updating the backup MNC controller when data base changes are made.

- ◆ Eight user terminals shall be provided. One terminal shall be installed at each of the following locations:
 - the Master Control Point at HEC
 - the Police Supervisor's position in the HEC
 - the Police Radio Shop
 - the Fire Supervisor's position in the HEC
 - Fire Radio Shop
 - Emergency Operations Center at HEC
 - Public Works & Engineering Radio Shop
 - HAS – George Bush Intercontinental Airport - RACOM

2.4.1B A printer for printing activity reports or other outputs produced by the System Manager/Information Management system is required at each location. The printers shall be an HP Color LaserJet 3600 dn or similar. One will be located with each of the user terminals.

2.4.2 Alarm System

2.4.2A An alarm monitoring package shall be provided to monitor system parameters and alarms.

2.4.2B It shall display alarm conditions of board level failures of all network elements to single 21" color LCD Flat Panel terminal. The system architecture shall be displayed using graphical icons. Selecting an icon such as a site shall reveal the next level of system detail, allowing the user to then select the equipment shelter or tower, and then a repeater or other piece of equipment, down to the board level. Alarms shall appear as flashing icons, representing the component and sub-systems affected. Flashing icons shall alternate between red and their normal appearance.

2.4.2C The system shall allow the manager to view historical data on selected performance characteristics, such as transmitter power output of any repeater, per transmission, along with a graphical representation of that parameter's history (such as a bar chart showing Transmitter Power per Transmission). Access to the management system shall be controlled through the use of an encrypted password (not displayed on the screen).

2.4.2D The system shall be capable of supporting a remote system manager user terminal without degradation of terminal performance. A remote user terminal shall be capable of performing / accessing all the same functions / information that a local can. The speed at which the remote terminal operates shall be equivalent to that of a local terminal and the accessing of information shall not be noticeably different in physical appearance or access time. The remote terminal shall be capable of interfacing with the system via LAN connectivity or dial-up. The remote terminal shall be implemented so that a user cannot determine whether they are using a local or remote terminal.

2.4.2E Proposers shall detail what alarms, conditions and parameters can be controlled and/or displayed through the System Management/Alarm Terminal. At a minimum, the following alarms/conditions shall be displayed:

Radio Equipment Alarms

- ◆ Low forward power
- ◆ High reflected power
- ◆ Unidentified carrier on unassigned voice channel
- ◆ Signaling interface failure between base and controller
- ◆ Audio circuit failure between base and controller
- ◆ Voting receiver failed
- ◆ Voting receiver disabled
- ◆ Station major alarm
- ◆ Station minor alarm
- ◆ Controller major alarm
- ◆ Controller minor alarm
- ◆ GPS receiver alarm

Dispatch Center Alarms

- ◆ Logging Recorder Full
- ◆ Logging Recorder Alarm
- ◆ Master Time Source Loss of Sync
- ◆ Console Electronics Power Supply Failure
- ◆ Console Electronics Major Alarm
- ◆ Console Electronics Minor Alarm

Power System Alarms

- ◆ Surge protection alarm
- ◆ UPS/Battery Power Systems
- ◆ Low battery voltage
- ◆ High battery voltage
- ◆ Automatic bypass operation
- ◆ Emergency operation (UPS on battery)
- ◆ Rectifier/inverter failure
- ◆ Common trip alarm (form "C" contacts)
- ◆ Generator System
 - Generator running
 - Generator on-line
 - Failure to start
 - Over speed
 - Low oil pressure
 - High engine temperature
 - Low oil pressure pre-warning
 - High coolant temperature pre-warning
 - Low coolant
 - Low fuel
 - Surge protection alarm

Microwave Alarms

- ◆ As listed in Section 5 – *Digital Ring Microwave System*

Site Alarms

- ◆ Fire/Smoke Detector
- ◆ Intrusion alarm (door open, each door)
- ◆ High temperature alarm
- ◆ Low temperature alarm
- ◆ Loss of utility power
- ◆ Generator run
- ◆ Generator on-line
- ◆ UPS alarm
- ◆ Perimeter alarm (on fence perimeter)
- ◆ Tower light failure
- ◆ Tower mounted receiver pre-amp failure (backup on/off)
- ◆ Spare alarms (10)

2.4.2F The Contractor shall be responsible for interconnecting and testing all alarm points to the proposed alarm systems, including but not limited to:

- ◆ Sensors
- ◆ Contacts
- ◆ Wiring
- ◆ Programming
- ◆ Installation

2.4.2G Five (5) alarm system display / control terminals shall be proposed. One (1) each is planned for location at the Police and Fire dispatch supervisors' consoles. The remaining three (3) terminals will be assigned at a later date.

2.4.2H All remote alarm units will pass information to the Master units. Provision shall be made for the master alarm units to selectively inhibit the audible alarms or initiate an automatic timeout in 30-second intervals up to 3 minutes. When an audible alarm has been silenced but not cleared, new failures shall reactivate the alarm.

2.4.3 Software and Programming Accessories

2.4.3A Ten (10) complete sets of programming software, cables, and required interface devices shall be provided for each model of software programmable equipment included in the system.

2.4.3B All PC-based software utilized in the new radio system shall be Windows based. Proposers are required to identify each software package that will not be compatible with this requirement. Proposers shall identify the proposed version of the Windows operating system provided in all windows based system computers.

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Section

3

Radio Coverage Performance

3.1 Overview of Required Coverage

- 3.1.A Reliable two-way radio coverage is the foundation of any Public Safety and Local Government radio communications system. The City of Houston has outgrown its current Police, Fire / EMS, and Public Works & Engineering radio systems and is in the process of replacing these systems. The new radio system developed through this project will represent a new start, a new system, and a new era in wireless communications for the City of Houston.
- 3.1.B The purpose of this section of the RFP is to clearly articulate the City's radio coverage requirements for the new system so that proposers can develop their system offerings with a clear understanding of the City's expectations and requirements. There are many aspects of radio coverage performance addressed in this Section of the RFP so that proposers can have relevant, factual information upon which to develop their system designs. It is important to note that the Public Works & Engineering Department has a significantly reduced coverage requirement from that of the Police and Fire Departments. The City does not require a separate radio system or separate sites to provide radio coverage to the Public Works Department. The Proposer can address these different coverage requirements in the manner they feel best meets the needs of the City while meeting all other functional requirements specified in this document.
- 3.1.C It is also important to note that the information that follows may have changed from the earlier preliminary release of the radio system RFP Radio Coverage Performance document.
- 3.1.D Some of the topics contained in this release include:
- An updated description of the City's required coverage areas
 - The type of coverage required i.e. mobile, portable on street, portable in light structures, portable in medium / heavy structures, and coverage in special areas such as the City's downtown tunnel system and selected buildings
 - Use of portable radios (head level / belt level, speaker mics, radio carrying devices such as swivel attachments for belt use)
 - Delivered audio quality performance (TIA/TSB-88 DAQ–voice sound quality required for the system)
 - Coverage reliability throughout the defined coverage areas
 - A description of coverage acceptance testing requirements that will be used to verify coverage performance once the system has been constructed
- 3.1.E Each of these issues is addressed in detail in the following pages of this Section.
- 3.1.F The City of Houston understands that one of the more challenging aspects of system development involves site selection and the number of sites needed for use in developing a

system configuration. Any new system implemented by the City must comply with FCC regulatory requirements, including spectral efficiency. It is important that the system proposed for this project be capable of meeting radio coverage and spectral efficiency requirements. The City understands that Project 25 Phase II operation will likely result in a reduced level of coverage relative to Phase I operation.

3.1.G To assist Proposers in system development, several helpful pieces of information have been included in this Section of the RFP.

3.1.H This information includes the following:

- A listing of existing City radio tower locations
- A listing of City water towers
- A listing of City properties that may potentially support the development of new additional tower sites needed to meet coverage requirements
- A detailed listing of required buildings in which coverage is mandatory including a supplemental map of the Houston area with the buildings plotted on the map.
- A map of the Downtown underground tunnel system which must be covered

3.1.1 Coverage Definition

3.1.1A Coverage is defined as the ability to successfully complete inbound (field to dispatch) outbound, (dispatch to field), and radio to radio voice communications in a repeat mode via the system infrastructure throughout the designated areas, standing still, and while in motion, with at least the minimum required level of audio quality (per TIA / TSB-88B or latest approved version DAQ) and with at least the specified level of propagation reliability stated in this Section. This level of performance is required for analog (if proposed), digital, and digitally encrypted modes of operation.

Audio Quality

3.1.1B For informational purposes, proposers are required to submit with their proposals their recorded samples of analog and digital voice messages for the following DAQ levels:

- ◆ DAQ 2.0
- ◆ DAQ 3.0
- ◆ DAQ 3.4
- ◆ DAQ 4.0
- ◆ DAQ 5.0

3.1.1C Audio samples may be submitted in the .WAV file format on CD-R media and will be reviewed by the City's evaluation team. For reference, the DAQ definitions, as defined in Bulletin TSB-88 are listed below:

Figure 3.1.1A – Delivered Audio Quality Scale Definitions

Delivered Audio Quality	Subjective Performance Description
DAQ 5.0	Speech easily understood.
DAQ 4.5	Speech easily understood. Infrequent Noise/Distortion.
DAQ 4.0	Speech easily understood. Occasional Noise/Distortion.
DAQ 3.4	Speech understandable with repetition only rarely required. Some Noise/Distortion.
DAQ 3.0	Speech understandable with slight effort. Occasional repetition required due to Noise/Distortion.
DAQ 2.0	Understandable with considerable effort. Frequent repetition due to Noise/Distortion.
DAQ 1.0	Unusable, speech present but unreadable.

Coverage Reliability

3.1.1D All references to coverage reliability in this document refer to area reliability. For example, the phrase "95% coverage" indicates that 95% of the bounded areas described shall exhibit the specified coverage resulting in a DAQ 3.4 at least 95% of the time. It will not be acceptable to provide a design where two or more adjacent failed grids exist, that is, failed points shall not be unique to any one vicinity, while still meeting the overall coverage reliability goals.

3.1.2 Mobile Radio Coverage

3.1.2A Mobile radio coverage will likely be limited by the Region 51 700 MHz plan guidelines which are undergoing finalization at this time. Mobile coverage performance will be expected to exceed and extend beyond the range of portable radios.

3.1.3 Portable Radio Coverage On-Street

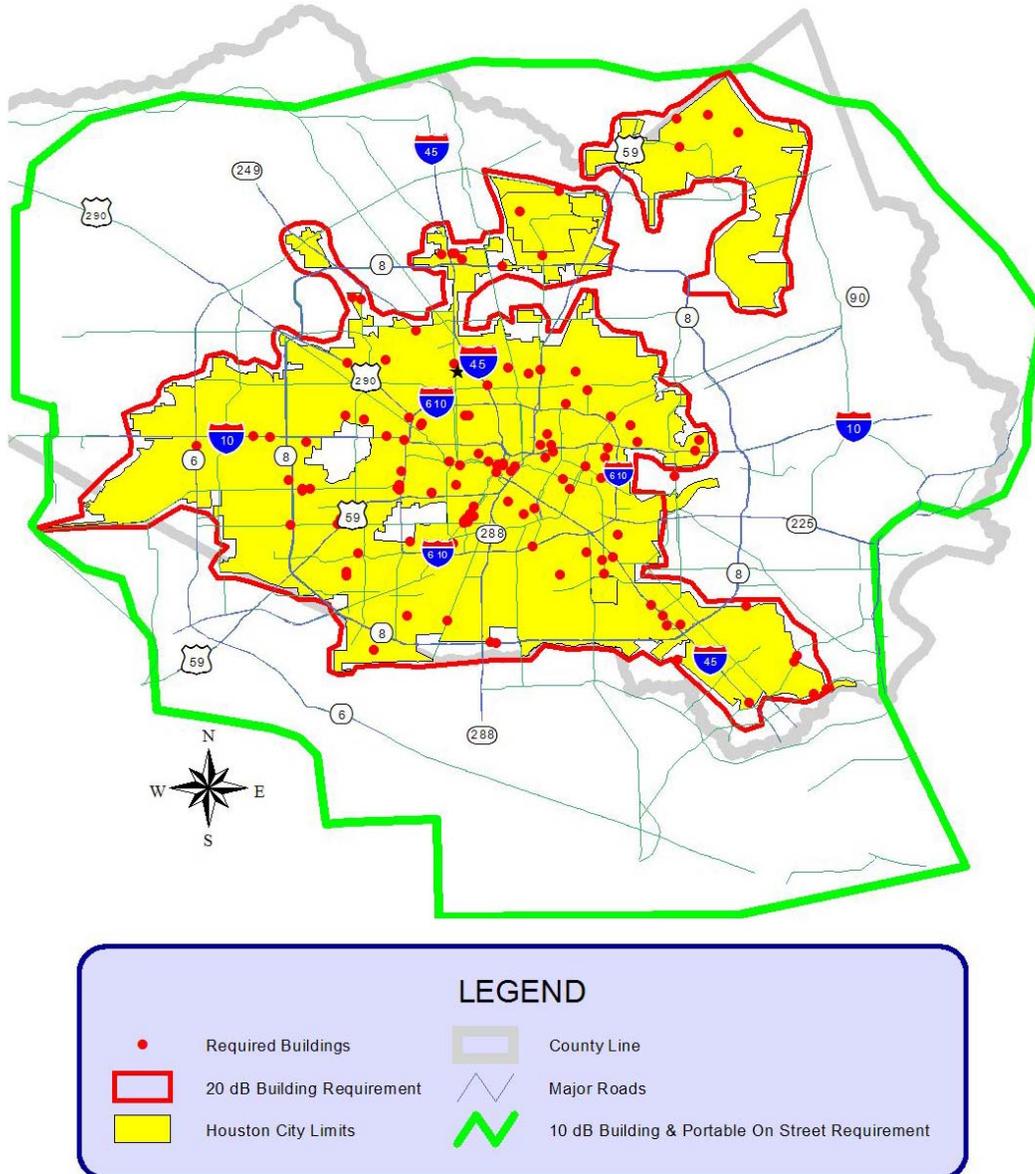
3.1.3A Portable radio coverage on-street shall be provided with the portable radio and antenna worn on the waist (3' AGL) throughout the designated areas in Figure 3.1.3A that follows. For day-to-day operation, some user agencies may use speaker/microphones with antennas, however for system design, radio coverage prediction, proposal development and system acceptance testing, speaker/ microphones with antennas on the mic shall not be used. The radio will be positioned at belt level with the antenna.

3.1.3B Unusually large portable radio antennas may present operational problems for some user personnel. Proposers must clearly identify the specific antenna proposed for this project and must provide sample radios with the proposed antenna at their oral presentation after submission of a system proposal. Other portable radio antennas that are not proposed shall not be shown at the oral presentations.

3.1.3C Some Proposers state that their portable radio carrying devices impact coverage performance. To eliminate ambiguity in this area, the City is requiring that the system design be based on a "belt clip" carrying device. If the carrying devices for your portable radio (leather case with swivel attachment, etc.) have an impact on coverage performance,

such impact shall be clearly described in the section of your proposal that includes your proposed coverage maps. It is important that the system design be based on real-world operational characteristics and a “worst case” carrying device which will be defined as the belt clip device.

Figure 3.1.3A – Required Coverage Areas for Portable Radios (Excludes 30 dB)



In-Building Coverage – 10 dB Structures (Typically residential structures)

- 3.1.3D Coverage is required for portable radios worn on the belt within residential or other structures, defined as buildings with 10 dB or less penetration loss, within the area depicted in Figure 3.1.3A. The City Public Works Department requires coverage in 4 specific buildings as designated required buildings list Figure 3.1.4A that follows but does not have a specific wide-area coverage requirement for 10 dB structures.

In-Building Coverage - 20 dB Structures (Typically medium to heavy structures)

- 3.1.3E A system infrastructure baseline of 20 dB in-building coverage is required for portable radios worn on the belt while operating within structures having up to 20 dB of penetration loss within the areas depicted in Figure 3.1.3A on the previous page. The City Public Works Department requires coverage in specific buildings as designated required buildings list Figure 3.1.4A that follows but does not have a wide area coverage requirement for 20 dB structures.

Downtown Area In-Building Coverage - 30 dB Structures (Typically heavy structures)

- 3.1.3F A system infrastructure baseline of 30 dB in-building coverage is required for portable radios worn on the belt while operating within the bounded area of downtown Houston depicted in Figure 3.1.3B and the Medical Center area depicted in Figure 3.1.3C that follow. Heavier coverage is required in these two areas due to the type and nature of structures. The City Public Works Department requires coverage in specific buildings as designated on the required buildings list that follows but does not have a specific wide-area coverage requirement for 30 dB structures.

Tunnel Systems

- 3.1.3G Portable radio coverage is required in the downtown tunnel system and in the accompanying underground business locations that are directly attached to or at the intersections of tunnels. Portable radio coverage is also required in the B1 and B2 underground levels of the Texas Medical Center. The City Public Works Department does not have a specific requirement for coverage in either of the tunnel systems.

Figure 3.1.3B - Bounded area for Downtown Houston 30 dB In-Building Coverage

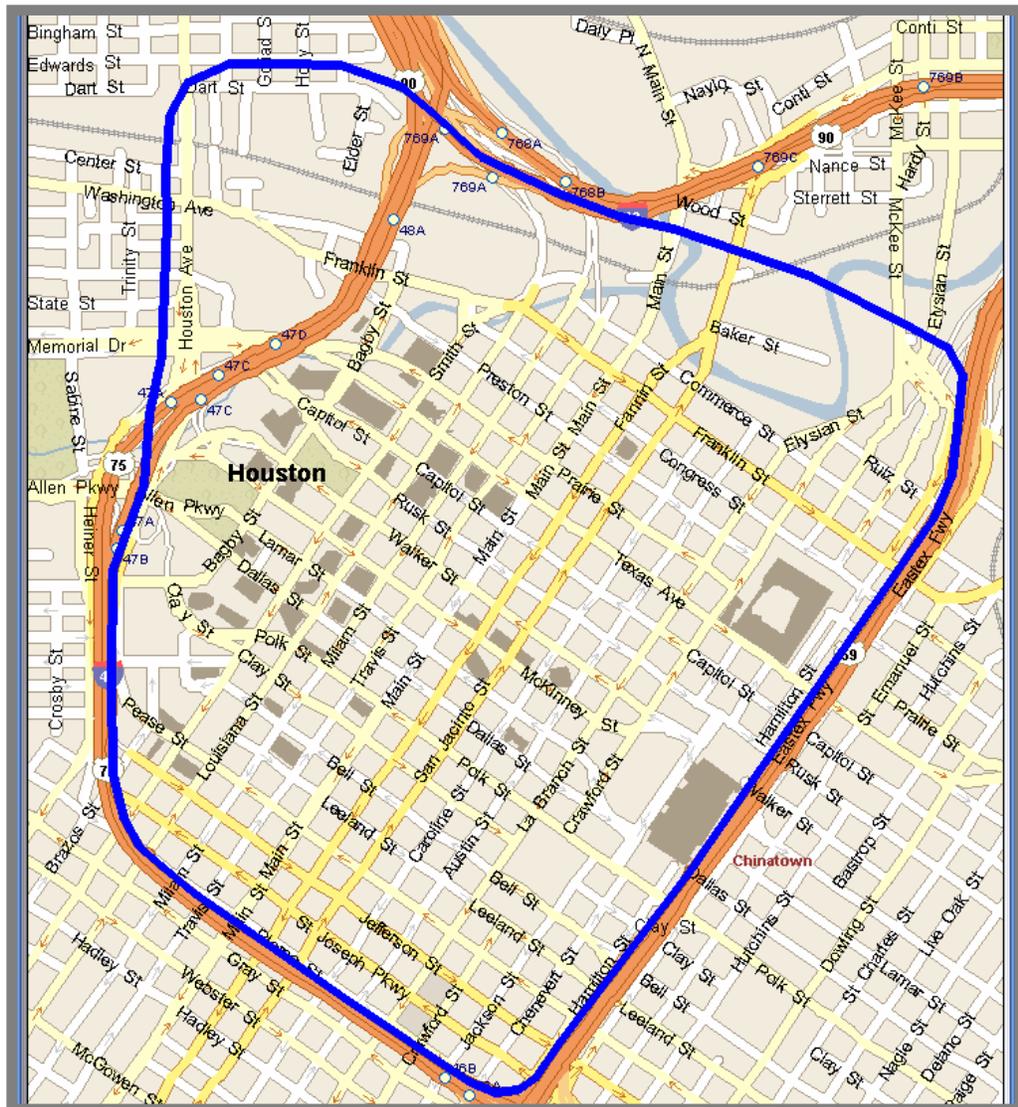
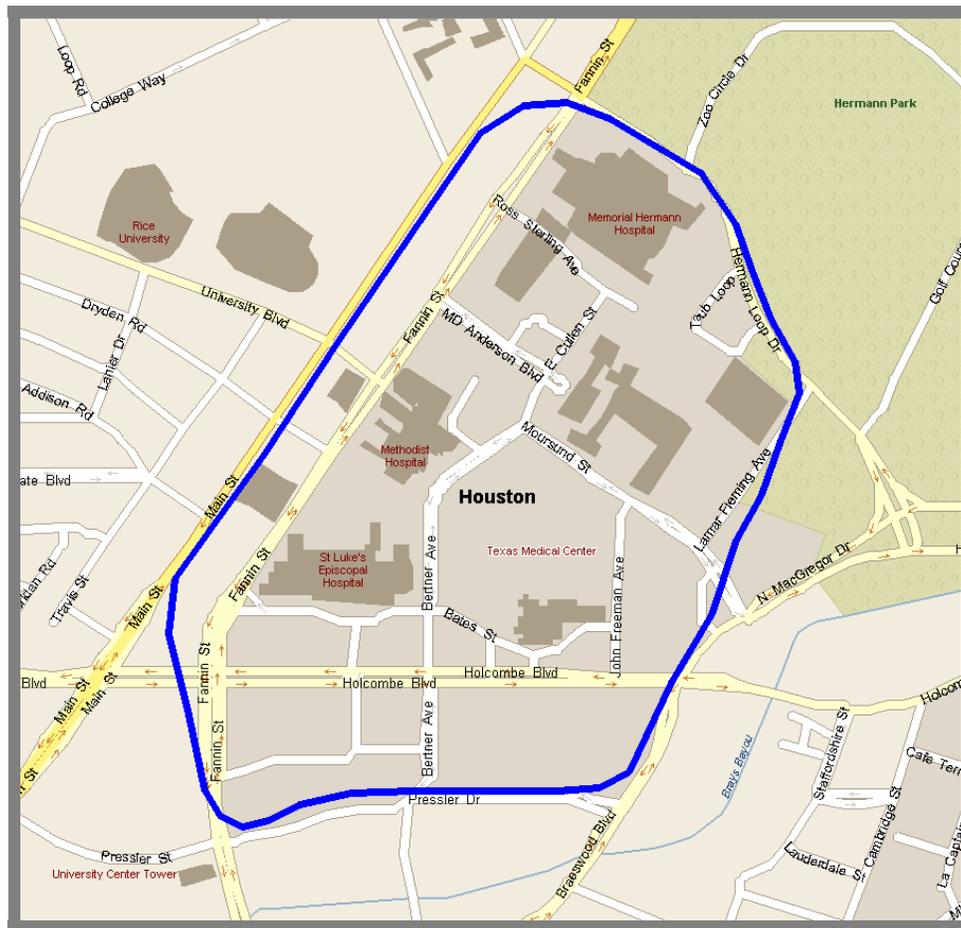


Figure 3.1.3C – Bounded area for Medical Center 30 dB In-Building Coverage



3.1.4 Specific Buildings in which In-Building Coverage is Required

3.1.4A In-building portable radio coverage is required within the facilities listed below for all City Departments except Public Works. The 4 buildings highlighted in yellow in Figure 3.1.4A (reference #29, 54, 62 & 142) require radio coverage by all City Departments including the City Public Works Department. It is important to note that coverage is required within all areas of each required building including basements, elevators, parking garages, and stairwells. As part of proposal development, proposers are expected to evaluate each facility to determine its associated building loss. Proposals shall include the listing of facilities that follows with a statement indicating whether each facility is covered, partially covered, or not covered at the proposed system cost. If the response is partially covered, a detailed description of expected coverage limitations must be provided on a case by case basis as well as a percentage of the facility that is expected to be covered.

3.1.4B Figure 3.1.3A provides a high level view of the locations of required buildings. A set of ESRI ArcView .shp files is available on CD from City Purchasing to facilitate a more in-depth review of required coverage areas and buildings.

Figure 3.1.4A Required Building List

Ref. #	Address	Building Name	Occupancy	Hazard Type
1	13430 NORTHWEST FWY	The Granite Tower	High Rise Office	Life/Fire/EMS
2	6001 ANTOINE DR 12221 N HOUSTON	Akzo Nobel International Paint	Industrial	Fire/HM
3	ROSSLYN RD	Vetco Gray Inc	Industrial	Fire/HM
4	8615 GOLDEN SPIKE LN	In Line Plastic Co	Industrial	Fire/HM
5	7225 FM 1960	Willow Brook Mall	Retail Shopping	Life/Fire/EMS
6	8850 LONG POINT RD	Spring Branch Medical Center	Hospital	Life/Fire/EMS
7	1615 HILLEDAHL	Sam Houston Gardens	Elderly Care	Life/Fire/EMS
8	777 N POST OAK RD	The Forum	High Rise Elderly	Life/Fire/EMS
9	921 GESSNER DR	Memorial City Hospital	Hospital	Life/Fire/EMS
10	7810 KATY FWY	IKEA Houston	Warehouse Store	Life/Fire/EMS
11	5300 MEMORIAL DR	The Shanks Law Firm	High Rise Office	Life/Fire/EMS
12	5400 MEMORIAL DR	Memorial Towers	High Rise Residence	Life/Fire/EMS
13	6900 OVERMEYER DR	Goodman Manufacturing	Warehouse	Fire/HM
14	6867 WYNNWOOD LN	Morrison Plumbing Supply	Warehouse	Fire/HM
15	4400 W 18TH ST	HISD Headquarters	Office	Life/Fire/EMS
16	3000 WASHINGTON AVE	Sunbeam Bakery	Large Bakery Plant	Fire/HM
17	1500 ALLEN PKWY	Federal Reserve Building The Center Mental Health Complex	Govt Office	Life/Fire/EMS/Terror
18	810 MARSTON ST		Hospital	Life/Fire/EMS
19	6100 MAIN	Rice University Complex Admiral Linen and Uniform Service	University	Life/Fire/EMS
20	2030 KIPLING ST		Industrial	Fire/HM
21	501 CRAWFORD ST	Minute Maid Park	Stadium	Life/Fire/EMS/Terror
22	1510 POLK	Toyota Center	Stadium	Life/Fire/EMS/Terror
23	1600 LAMAR 1001 AVENIDA DE LAS	Hilton Americas	High Rise Hotel	Life/Fire/EMS/Terror
24	AMERICAS	George R. Brown	Convention Center	Life/Fire/EMS/Terror
25	600 TRAVIS	Chase Tower	High Rise Office	Life/Fire/EMS
26	1000 LOUISIANA ST	Wells Fargo Plaza	High Rise Office	Life/Fire/EMS
27	1111 BAGBY ST	Texaco Heritage Plaza	High Rise Office	Life/Fire/EMS
28	1600 SMITH	Continental Building	High Rise Office	Life/Fire/EMS
29	611 WALKER	611 Walker Annex	COH High Rise Office	Life/Fire/EMS
30	333 CLAY	Three Allen Center	High Rise Office	Life/Fire/EMS
31	1919 SMITH	Mickey Leeland Fed. Bldg.	Federal Office	Life/Fire/EMS/Terror
32	400 NORTHLINE MALL	Northline Mall	Shopping Center	Life/Fire/EMS
33	5850 N SHEPHERD DR	Montalbano Lumber	Lumber Yard	Fire/HM
34	330 W 19TH ST	Houston Heights Tower	High Rise Elderly	Life/Fire/EMS
35	1635 N LOOP W	Memorial Herman NW Hospital	Hospital	Life/Fire/EMS
36	1950 HEIGHTS BLVD	Heights House	High Rise Elderly	Life/Fire/EMS
37	4514 LYONS	Barbara Jordan Health Center	Health Facility	Life/Fire/EMS
38	4100 CLINTON DR	KBR / Halliburton Engineering	Industrial	Life Hazard
39	1701 BRINGHURST ST	E.O. Smith Elementary School	School	Life/Fire/EMS
40	4801 PROVIDENCE	Wheatley High School	School	Life/Fire/EMS
41	4202 LIBERTY RD	Dogan Elementary School	School	Life/Fire/EMS
42	9111 EASTEX FWY	Harris County Annex # 60	High Rise	Life/Fire/EMS
43	8826 HARRELL	Leo Daniels Towers	High Rise Elderly	Life/Fire/EMS
44	5656 KELLEY	LBJ Hospital	Hospital	Life/Fire/EMS
45	9400 IRVINGTON BLVD	Sam Houston High School	School	Life/Fire/EMS
46	9000 HOMESTEAD RD	Fm Tidwell N. on Homestead to	Open Area	

City Limits				
47	7201 KIRKPATRICK BLVD	Rail Yard at Kirkpatrick and Ley Rd	Industrial	Fire/HM
48	520 MERCURY	Furr High School	School	Life/Fire/EMS
49	3100 FEDERAL RD	Washburn Tunnel	Transportation	Life/Fire/EMS
50	816 CIMARRON	Cimarron Elementary School	School	Life/Fire/EMS
51	13111 EAST FWY	East Houston Medical Center	Hospital	Life/Fire/EMS
52	10044 WALLISVILLE RD	Oates Elementary School	School	Life/Fire/EMS
53	8800 CITY PARK LOOP	Michelin North America	Storage	Fire/HM
54	2300 FEDERAL RD	East Water Purification Plant	Plant	Life/Fire/EMS/Terror
55	775 GELLHORN	Anheuser Busch	Industrial	Fire/HM
56	1431 PLEASANTVILLE	Pleasantville Elementary School	School	Life/Fire/EMS
57	2800 N TERMINAL RD	Bush Intercontinental Airport IAH Including Underground Tunnels	Airport	Life/Fire/EMS/Terror
58	208 GREENS RD	Greenspoint Mall	Retail Shopping	Life/Fire/EMS
59	15747 JOHN F KENNEDY BLVD	Double Tree Hotel	High Rise Hotel	Life/Fire/EMS
60	12450 GREENSPOINT DR	Six Greenspoint Plaza	High Rise Office	Life/Fire/EMS
61	16825 NORTHCHASE DR	Two Greenspoint Plaza	High Rise Office	Life/Fire/EMS
62	1212 N SAM HOUSTON PKWY E	North East Purification Plant	Plant	Life/Fire/EMS/Terror
63	515 W GREENS RD	One Commerce Green	High Rise Office	Life/Fire/EMS
64	4015 WOODLAND HILLS DR	Kingwood Park High School	School	Life/Fire/EMS
65	22999 N US 59	Kingwood Hospital	Hospital	Life/Fire/EMS
66	2701 KINGWOOD DR	Kingwood High School	School	Life/Fire/EMS
67	4104 APPALACHIAN TRL	Hidden Hollow Elementary	School	Life/Fire/EMS
68	2910 HIGH VALLEY DR	Riverwood Middle School	School	Life/Fire/EMS
69	4503 BEECHNUT ST	Beechnut Police Station	Police Station	Life/Fire/EMS
70	8299 KIRBY DR	Reliant Stadium	Stadium	Life/Fire/EMS/Terror
71	6410 FANNIN	Herman Hospital Complex	Hospital	Life/Fire/EMS
72	6431 FANNIN	UT Medical School	Hospital / School	Life/Fire/EMS
73	1502 BEN TAUB LOOP	Ben Taub Hospital	Hospital	Life/Fire/EMS
74	1709 DRYDEN RD	Medical Towers	Hospital	Life/Fire/EMS
75	1 BAYLOR PLAZA	Baylor College of Medicine	School / Office	Life/Fire/EMS
76	1100 HOLCOMBE BLVD	M.D. Anderson Cancer Center	Hospital	Life/Fire/EMS
77	6540 BELLOWS LN	Favrot Tower	High Rise Dorm	Life/Fire/EMS
78	6565 FANNIN	Methodist Hospital Complex	Hospital	Life/Fire/EMS
79	1101 BATES AVE	St. Lukes Heart Institute/TCH	Hospital	Life/Fire/EMS
80	10 GREENWAY PLAZA DR	Lakewood Church	Public Assembly	Life/Fire/EMS/Terror
81	24 GREENWAY PLAZA DR	24 Greenway Plaza	High Rise Office	Life/Fire/EMS
82	4200 PORTSMOUTH	Twelve Oaks Hospital	Hospital	Life/Fire/EMS
83	1200 POST OAK BLVD	1200 Post Oak Bldg.	High Rise Residence	Life/Fire/EMS
84	2800 POST OAK BLVD	Williams Tower	High Rise Office	Life/Fire/EMS
85	2929 POST OAK BLVD	The Hampton House	High Rise Elderly	Life/Fire/EMS
86	5011 WESTHEIMER RD	The Westin Oaks Hotel	High Rise Hotel	Life/Fire/EMS
87	5060 WEST ALABAMA ST	The Westin Galleria Hotel	High Rise Hotel	Life/Fire/EMS
88	5015 WESTHEIMER RD	The Galleria	Retail Shopping	Life/Fire/EMS
89	2700 POST OAK BLVD	2700 Post Oak Building	High Rise Office	Life/Fire/EMS
90	6200 N BRAESWOOD BLVD	Seven Acres Retirement Home	Elderly Care	Life/Fire/EMS
91	10909 FONDREN RD	Goldberg Towers	High Rise Elderly	Life/Fire/EMS/Terror
92	11168 FONDREN RD	Fondren Police Station	Police Station	Life/Fire/EMS
93	7737 SOUTHWEST FWY	Southwest Memorial Hospital	Hospital	Life/Fire/EMS

94	7225 BELLERIVE DR	Bellerieve Apartments	High Rise Elderly	Life/Fire/EMS
95	7575 BELLAIRE BLVD	Conquistador	High Rise Elderly	Life/Fire/EMS
96	9301 SOUTHWEST FWY	Memorial Herman Prof. Bldg.	Hospital	Life/Fire/EMS
97	7400 CLAREWOOD DR	Clarewood House	High Rise Elderly	Life/Fire/EMS
98	7500 BELLAIRE BLVD	Sharpstown Mall	Retail Shopping	Life/Fire/EMS
99	738 S SH 6	Memorial 6 Bldg. 11111 Katy Freeway High Rise Office	High Rise Office	Life/Fire/EMS
100	11111 KATY FWY		High Rise Office	Life/Fire/EMS
101	11757 KATY FWY	Kirkwood Atrium Office Park	High Rise Office	Life/Fire/EMS
102	14703 PARK ROW	Holiday Inn Houston I-10 West	High Rise Hotel	Life/Fire/EMS
103	16225 PARK TEN PL	Park Ten	Office / Industrial	Fire/HM
104	2101 CITYWEST BLVD	BMC Software Bldg.	High Rise Office	Life/Fire/EMS
105	2900 BRIARPARK DR	Marriott Westchase	High Rise Hotel	Life/Fire/EMS
106	10200 BELLAIRE BLVD	Halliburton Complex	Office / Industrial	Life/Fire/EMS/Terror
107	9801 WESTHEIMER RD	Westchase Bank	High Rise Office	Life/Fire/EMS
108	9999 WESTHEIMER RD	Westchase Hilton	High Rise Hotel	Life/Fire/EMS
109	235 N GREENWOOD ST	Sara-Lee Food Service	Industrial	Fire/HM
110	6745 HARRISBURG BLVD	AT&T Terminal Switching Station	Industrial	Fire/HM
111	7299 CLINTON DR	Port Terminal Railroad Assoc.	Industrial	Fire/HM
112	111 E LOOP N	Port of Houston Office Bldg.	Office	Life/Fire/EMS
113	1717 TURNING BASIN	Port Way Plaza	Office	Life/Fire/EMS
114	7810 BELLFORT ST	Shopping Center	Retail Shopping	Life/Fire/EMS
115	7990 BELLFORT ST	Apartment Complex	Residential	Life/Fire/EMS
116	8600 PARK PLACE BLVD	Goodyear Chemical Plant	Industrial	Fire/HM
117	8200 BROADWAY ST	Center America Capital Partners		
118	8900 BROADWAY ST	Hobby Airport (HOU)	Airport	Life/Fire/EMS/Terror
119	8300 MYKAWA	S.E. Police & Jail Building	Police Station	Life/Fire/EMS
120	6000 TELEPHONE	Houston Housing Authority	High Rise Elderly	Life/Fire/EMS
121	4800 CALHOUN RD	U of H Moody Towers	High Rise Residence	Life/Fire/EMS
122	4800 CALHOUN RD	U of H M.D. Anderson Library	University	Life/Fire/EMS
123	4600 CULLEN BLVD	U of H Science and Research	University	Life/Fire/EMS
124	6720 BERTNER AVE	St. Lukes Hospital	Hospital	Life/Fire/EMS
125	1200 MOURSUND	Baylor College of Medicine	Hospital	Life/Fire/EMS
126	3100 CLEBURNE ST 2901 S SAM HOUSTON PKWY E	Texas Southern University	University	Life/Fire/EMS
127	3250 S SAM HOUSTON PKWY E	Wayne's Landscape Supply	Industrial	Life/Fire/EMS
128	6400 MARTIN LUTHER KING BLVD	Industrial Polymers Inc.	Industrial	Life/Fire/EMS
129	11800 ASTORIA BLVD	Welch & Sackett Properties	Office	Life/Fire/EMS
130	12301 KURLAND DR	Memorial Herman Southeast	Hospital	Life/Fire/EMS
131	12200 GULF FWY	Centerpoint Energy Houston	Office	Life/Fire/EMS
132	12200 GULF FWY	Macy's Dept. Store	Retail Shopping	Life/Fire/EMS
133	9598 ROWLETT	Walmart Dept. Store	Retail Shopping	Life/Fire/EMS
134	11101 FUQUA ST	Sam's Club Retail Outlet	Retail Shopping	Life/Fire/EMS
135	2101 NASA PKWY 16600 SPACE CENTER BLVD	NASA Bldg. 17	Industrial	Life/Fire/EMS/Terror
136	18000 SPACE CENTER BLVD	NASA Bldg. 338	Industrial	Life/Fire/EMS/Terror
137		NASA Bldg. 207D	Industrial	Life/Fire/EMS/Terror
138	3000 NASA PKWY	NASA Bldg. 232	Industrial	Life/Fire/EMS/Terror
139	500 BAYBROOK MALL	Baybrook Mall	Retail Shopping	Life/Fire/EMS
140	3400 BAY AREA BLVD	U of H Clear Lake Campus	University	Life/Fire/EMS
141	18300 ST JOHN DR	St. John's Hospital	Hospital	Life/Fire/EMS

142	3100 GENOA RED BLUFF RD	Southeast Water Purification Plant	Plant	Life/Fire/EMS/Terror
143	2929 BAY AREA BLVD	Clear Lake High School	School	Life/Fire/EMS
144	13131 ALMEDA RD	Allpoly National Container	Industrial	Life/Fire/EMS
145	14000 STANCLIFF ST	Dowling Middle School	School	Life/Fire/EMS
146	16111 CHIMNEY ROCK RD	Station 80	Fire Station	Life/Fire/EMS
147	9455 W MONTGOMERY RD	North Police Substation	Police Station	Life/Fire/EMS

3.1.4C The listing of buildings is substantial. The City prefers that in-building coverage be provided directly by the radio infrastructure. The City also recognizes that even with a baseline system providing 20 dB of in-building coverage, (30 dB in the downtown area) and the Medical Center area, there will still be some buildings within the City that have much greater penetration loss. Additional measures may be required to facilitate coverage in those facilities.

3.1.4D To extend coverage beyond the 20 and 30 dB levels, the City will consider secondary methods of providing heavier coverage within such structures. Such methods might include:

- ◆ Increasing the baseline coverage of the infrastructure in a particular area of the City to support higher levels of building penetration as was done in the immediate downtown area.
- ◆ Installation of multi-band channelized bi-directional amplifier systems in selected buildings where building access is permitted. Costs for such solutions shall be provided on a case by case basis so that the City can utilize available funding in a manner that best meets the City's needs.
- ◆ Installation of a fiber optic based in-building RF distribution system
- ◆ Utilization of vehicular repeater systems or other similar systems to extend tactical on-scene radio coverage into heavy structures

3.1.4E Hi-rise buildings present significant communication problems for the Police and Fire Departments when working events inside such facilities, particularly when trying to communicate between the lower floors and upper floors of the facility. It is the intent of the City to resolve such problems to the extent feasible as part of this project.

3.1.5 Downtown Underground Tunnel System

3.1.5A The City of Houston downtown tunnel system consists of a number of underground walkways that allow people to travel throughout many parts of the downtown area under the streets and from building to building. The system consists of the following tunnels:

- ◆ Main Tunnel Loop (One Shell Plaza)
- ◆ S. Louisiana Tunnel
- ◆ W. Dallas Tunnel
- ◆ W. Walker Tunnel
- ◆ N. Louisiana Tunnel

- ◆ N. Travis Tunnel
- ◆ E. McKinney Tunnel
- ◆ Harris County Tunnel

3.1.5B All of the tunnels are interconnected with the exception of the Harris County Tunnel.

3.1.5C The 6-mile network of tunnels connects most major buildings. Originally designed for individual businesses, the tunnels were extended bit by bit to connect over 82 buildings. Now more than 100 shops, restaurants, cafes and galleries have been built into the tunnel system. The tunnels themselves are generally narrow (10-15 ft) walkways, as seen in Figure 3, that open into larger areas where shops and restaurants or food courts are located (Figure 3.1.5B).



Figure 3.1.5A Typical Downtown Tunnel Walkway



Figure 3.1.5B Tunnel Shop/Restaurant Area

3.1.6 Texas Medical Center Underground Tunnel System

3.1.6A The Texas Medical Center system consists of a multiple levels of underground walkways that allow people to travel under the streets and between the various hospitals that comprise the Texas Medical Center. The system consists of the B1 level and the B2 level. The appendices section of this document contains maps of the underground tunnels at the Texas Medical Center.

Fully Compliant Partially Compliant Non-Compliant

3.2 Listing of City Owned Radio Facilities

3.2A The list in Figure 3.2A provides a listing of City radio site resources that will likely be available for use in development of the new radio system infrastructure. Additional new sites will likely be required. A separate listing of City properties that may potentially be used for site development has been provided in Section 3.3 that follows.

Figure 3.2A City Radio Site Resources

Site Name	Address	Latitude	Longitude	Site Height
Teague Tower Site	5850 Teague Road	29:51:19 N	95:32:21 W	500 ft.
Tomball Tower Site	1600 Brown Road	30:05:46.8 N	95:39:22.8 W	500 ft.
Huffman Tower Site	Huffman Eastgate Road	30:02:09 W	95:04:17 W	500 ft.
Lake Houston Tower Site	13501 Aqueduct Road	29:54:47 N	95:08:47 W	500 ft.
Clodene Tower Site	21002 FM 1093	29:42:17 N	95:44:54 W	500 ft.
Beechnut Tower Site	4503 Beechnut	29:41:15 N	95:27:05 W	300 ft.
Police Communication Center (PCC)	61 Riesner	29:45:12 N	95:22:12 W	470 ft.
Police Academy Site	17000 Aldine Westfield	29:57:57 N	95:21:47 W	140 ft.
Reed Road Tower Site	4000 Reed Road	29:39:27 N	95:22:08 W	300 ft.
COMFAC Tower Site	5711 Neches	29:48:43 N	95:20:15 W	250 ft.
Westside Command Center Site	3203 Dairy Ashford	29:43:43.6 N	95:36:19.8 W	75 ft.
DPS Tower Site	10110 Northwest Freeway	29:48:28 N	95:27:17 W	300 ft.
Coleto Tower Site	8201 Dalton	29:42:07 N	95:16:25 W	300 ft.
Houston Fire Department				
HFD Logistics-	1205 Dart St.,	29:46:10.4 N	95:22:09 W	50 ft.
HFD Station 5	2020 Hollister Road	29:48:36 N	95:30:21 W	60 ft.
HFD Station 10	6600 Corporate Drive	29:42:23 N	95:33:06 W	100 ft.
Station 56	5820 Little York Road	29:52:11N	95:18:20 W	120 ft.
Station 44	675 Maxey Road	29:46:40 N	95:13:04 W	75 ft.
Station 70	11410 Beamer Road	29:36:06 N	95:13:45 W	110 ft.
Station 72	17401 Saturn Lane	29:33:29 N	95:26:28 W	90 ft.
Station 102	4102 W. Lake Houston	30:03:56 N	95:11:16 W	100 ft.
Station 96-	7409 Willow Chase	29:58:09 N	95:32:26 W	100 ft.
Station 64	3000 Greens Road	29:57:02 N	95:20:30 W	80 ft.
Station 82	11250 Braesridge Drive	29:39:26 N	95:30:40 W	140 ft.
Station 4	6530 West Little York	29:51:58 N	95:29:21 W	150 ft.

Fully Compliant Partially Compliant Non-Compliant

3.3 Listing of City Owned Properties for Potential Site Development

3.3A Where a physical address is not available (undeveloped land) an HCAD account number is given as reference.

- ◆ Fire Station #36, 7720 Airport Blvd., 77061; Lat:29:39:28, Long: 95:16:47
- ◆ 0 Cullen, HCAD account # 0410070120006
- ◆ 10150 Old Katy Rd, 77043; HCAD #0583030000023
- ◆ 0 Lumpkin Rd, 77043, HCAD # 0401590000182
- ◆ 0 E. Little York Rd, 77093; HCAD # 0420540000261
- ◆ 10677 Homestead Rd, 77016, HCAD # 0420540000196
- ◆ 0 Seneca Rd., 77016; HCAD #1173580010003
- ◆ 0 Homestead Rd., 77016; HCAD #1173580010002
- ◆ 2855 Bay Area Blvd, Houston, TX 77062; HCAD # 1170200010004
- ◆ Fire Station # 73, 9640 Wilcrest Dr., 77099 – Lat: 29:40:22, Long: 95:34:14
- ◆ Fire Station #90, 16525 Park Row, 77084 – Lat: 29:47:20, Long: 95:40:14

Fully Compliant Partially Compliant Non-Compliant

3.4 Listing of City Owned Water Towers

3.4A The following table provides a listing of City water towers that may potentially support a repeater site. Grey shading denotes sites that may already have a utility microwave system on the tower, which will likely not be available for radio system use.

Figure 3.4A Elevated Storage Tanks

Ref. #	Structure No.	Address	Key Map	Coordinates		Elev. (ft)	Type
				Latitude	Longitude		
1		10711 Silkwood	530W	29°39'49"N	95°32'12"W		
2	030ET1	8619 Bellaire Blvd.	530E	29°42'16"N	95°32'14"W	228.1	Composite
3	042ET1	3835 W.Orem	572J	29°37'39.73"N	95°26'05.77"W	201.8	Spheroidal
4	071 ET1	11900 Plaza Verde	372U	29°56'10.73"N	95°25'02.73"W	218.4	Spheroidal
5	087ET1	7501 Langley	415W	29°52'01.44"N	95°17'32.99"W	202.1	Spheroidal
6	090ET1	16335 Hillcroft	610D	29°35'22.65"N	95°30'28.23"W	221.4	Composite
7	099ET1	306 Bluetail	338L	30° 1'37"N	95°6'56"W	207.4	Spheroidal
8	102ET1	11330 West Hardy	373T	29°56'1 2.58"N	95°22'55.52"W	229.3	Spheroidal
9	102ET2	15960 West Hardy	373P	29°56'55.13"N	95°23'05.35"W	226.7	Spheroidal
10	103ET2	10602 1/2 Braewick	530Z	29°39'57.42"N	95°29'50.13"W	210.7	Spheroidal
11	106ET1	12705 Brantrock	528D	29°42'54.27"N	95°36'25.44"W	227.8	Spheroidal
12	107ET1	1642 W.Greens Blvd.	372Q	29°57'05.89"N	95°25'27.42"W	253.7	Fluted Column
13	108ET1	12844 Westheimer	488U	29°44'14.62"N	95°36'40.99"W	216.1	Spheroidal
14	124ET1	1455 Baybrook	617Z	29°32'38.37"N	95°09'04.70"W	170.0	Fluted Column
15	125ET1	3710 Eldridge	528B	29°43'04.36"N	95°37'27.17"W	218.4	Fluted Column
16	127ET1	10903 Ella Blvd.	372T	29°56'20.28"N	95°26'02.12"W	244.7	Spheroidal
17	128ET1	14315 Park Row	448W	29°47'1 9.61"N	95°38'25.04"W	245.9	Fluted Column
18	128ET2	18324 Addicks Levee	447W	29°47'34.28"N	95°41'41.20"W	250.9	Fluted Column
19	132ET1	7203 W.Greens Blvd.	370K	29°57'17.68"N	95°32'05.69"W	266.0	Spheroidal
20	140ET1	900 Tristar	617B	29°35'20.37"N	95°10'46.90"W	172.4	Composite
21	154ET1	1110 Mustang Tr.	336F	30°02'24.87"N	95°14'20.58"W	235.3	Fluted Column
22	156ET1	2802 Kingwood Dr.	336C	30°03'10.36"N	95°13'35.77"W	228.6	Fluted Column
23	156ET4	1500 Woodland Hills	336G	30°02'00.65"N	95°13'01.87"W	227.9	Composite
24	157ET2	3211 Appalachian Tr.	297N	30°04'42.23"N	95°11'28.48"W	227.6	Fluted Column
25	158ET3	2903 High Valley	297Z	30°03'33.41"N	95°09'22.79"W	227.5	Fluted Column

Fully Compliant Partially Compliant Non-Compliant

3.5 Radio Coverage Prediction

3.5A For the purposes of your proposal, radio system coverage shall be predicted through the use of a radio wave propagation model which has been developed on the basis of theoretical and

empirical data, and which will take into account channel bandwidth, modulation schemes, delivered audio quality, coverage reliability, terrain irregularity, foliage, land use / land cover, building penetration losses, noise, and long- and short-term signal variations. The model used for the purposes of the coverage prediction process shall be identified in your proposal, and the rationale for system gains and losses used must be provided in your proposal. A table of system coverage parameters such as gains and losses utilized in each propagation analysis must be provided. A terrain database with a minimum of 3 arc-seconds of resolution is required. You must identify the terrain data model used in your coverage predictions. Your propagation analysis system must utilize both vertical and horizontal antenna patterns.

3.5B Coverage maps for individual site analyses shall be presented on 11" x 17" media using a USGS 1:250,000 scale topographical maps. The scale on the finished map shall be 1" = 4 miles. Each coverage analysis shall include a legend with the following information:

- Type of coverage displayed on the map, mobile, portable on-street, portable in 10 dB buildings, portable in 20 dB buildings, portable in 30 dB buildings.
- Location of portable radio (radio and antenna at belt level – 3ft. AGL)
- Delivered Audio Quality (DAQ)
- Analog (if proposed), digital clear mode, digital encrypted mode.
- Radio coverage reliability shown, percent reliability and type of reliability (area vs. contour)
- Type of carrying device used with portable radio (belt clip)
- RF signal levels in dBm corresponding to the coverage colors displayed on the map
- Simulcast capture ratio in dB and targeted propagation delay in microseconds for simulcast sites
- Square mileage of each type of proposed coverage shown on the coverage analysis or on an accompanying parameter sheet

3.5C To streamline the evaluation process, the City is requiring that all Proposers use the same map format as shown below:

- On-Street portable coverage with portable radio worn at hip level (3' AGL) using a speaker microphone without antenna (coverage shown in green)
- In-building portable coverage, radio worn at belt level (3' AGL):
 - ◆ Inside standard structures, up to 10 dB penetration loss (blue)
 - ◆ Inside heavy structures, up to 20 dB penetration loss (red)
 - ◆ Inside downtown area structures, up to 30 dB penetration loss (yellow)
 - ◆ Mobile coverage, trunk mounted blade type antenna, centerline at 4' above ground (purple)

- 3.5D Unless the proposed Public Works & Engineering coverage is the same as that for Police and Fire, the Proposer shall provide separate coverage maps for the proposed sites used to provide on-street portable radio coverage for the Public Works & Engineering Department. The maps shall also depict the resulting 10dB, 20dB and 30dB In Building coverage levels using the exact same parameters and colors used for all other coverage maps as previously specified.
- 3.5E Portable coverage maps shall be prepared for the limiting case (talkout vs. talkback). A mobile talkout coverage map shall also be provided along with the bit error threshold for DAQ performance. All RF coverage maps shall be provided to the City in both printed and electronic formats. The electronic versions shall be provided in a common GIS format for further coverage analysis by the City. The following map file formats are acceptable.
- ESRI shape files
 - ESRI export files
 - Mapinfo Mif or Mid

Land Use / Land Cover Data

- 3.5F A separate map exhibit must be provided showing your land use / land cover data used for this project. The source and publication date of your land use / land cover database must be provided. The latest available data is preferred along with a color land use map showing where each use category was used. A table that describes each use category and lists the loss value associated with it shall accompany this map.

Simulcast Time Delay Interference

- 3.5G In the event that your proposed system configuration utilizes simulcast technology, your proposed coverage maps must account for (display) any harmful time delay interference (TDI) that may occur in your proposed system configuration. This means that forecasted areas of TDI must be clearly shown on your coverage maps in (black) or be shown as “non-covered” areas and a separate TDI map shall be provided depicting areas with potential TDI in (black).
- 3.5H If you are proposing a simulcast configuration, you must identify the delay threshold in microseconds and capture ratio in dB on which the City’s system design is based.

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3.6 Overview of Radio Coverage Testing

- 3.6A Coverage testing shall be conducted as part of the System Acceptance Testing process to verify that the appropriate levels of coverage performance have been provided. The following provides a brief preliminary listing of tests that shall be performed to verify coverage performance.
- 3.6B The City of Houston will supervise the entire coverage testing process. Test teams will be equipped with City provided digital camcorders to record the testing process. For test purposes, with the exception of the downtown area, the City shall be divided into uniform

square grids of approximately ½ mile by ½ mile in area. For better testing resolution downtown, the downtown area as shown in Figure 3.1.3B will be divided into 1/10 mile by 1/10 mile grids.

- 3.6C The City and Contractor will test coverage in all accessible grids. Grids that are not accessible by the test teams shall not be counted in the reliability calculation. The City may elect to pass certain grids if it is obvious that they are adequately covered.
- 3.6D The portable radio voice testing shall be performed using random sentences read from daily, periodicals. Both analog (if proposed) and digital (clear and encrypted) voice modes will be tested. Extrapolation of results from tests in one direction to reach conclusions about the other direction will not be acceptable. This is a two-way radio system. A failure in the inbound, outbound, or radio to radio mode, either moving or stationary at a test location, will constitute a failed test location, which will be subject to a test retry.

Test Retry

- 3.6E In the event that the first test call (inbound, outbound or radio to radio) is unsuccessful, the field team will be allowed to move up to 5' and a retry will be permitted. If the second attempt to communicate fails (no access or audio quality below DAQ 3.4), that test location will be deemed a failure.
- 3.6F All retries will be counted. No more than 5% of the retries will be allowed to pass this portion of the coverage testing process.

Roaming Software

- 3.6G If your proposed system utilizes roaming software in the user radios to change sites as the user radio moves throughout the City's service area, that software must be properly installed, calibrated, and optimized prior to radio coverage testing. If proposed, site roaming will be an important part of day-to-day operation and will be factored into the coverage testing process. This means that if a radio fails to affiliate with or roam to the proper repeater site and the test calls are unsuccessful as a result, the test call fails.

Portable Radio Coverage Testing

- 3.6H Portable radio coverage will be thoroughly tested as follows:
- On-Street Voice Quality Tests throughout the specified area
 - In-Building Voice Quality Tests
 - ◆ Random buildings with up to 10 dB of penetration loss
 - ◆ Random buildings with up to 20 dB of penetration loss
 - ◆ Downtown buildings with up to 30 dB of penetration loss
 - ◆ Downtown underground tunnel system
 - ◆ All required buildings

- 3.6I The City of Houston understands that the radio coverage testing portion of the system acceptance test plan will require significant time and effort from the City's staff, its consulting firm, and the selected Contractor. Accordingly, to avoid false starts, radio coverage testing process will not begin until the radio system infrastructure has been properly installed, tested,

and fully optimized. Prior to initiation of the coverage testing process, the Contractor shall provide the City with written certification that the system has been properly installed and fully optimized so that radio coverage testing may begin.

- 3.6J Once radio coverage testing has been initiated, system modifications such as replacement or reorientation of base station antennas or other factors that impact radio coverage, including software roaming parameters, shall not be changed without the City's written approval unless the radio coverage testing process is restarted from the beginning.
- 3.6K The Contractor shall keep thorough records during the equipment testing process and shall provide a permanent record of the testing results to the City and its consulting firm prior to the initiation of the coverage testing process.
- 3.6L In addition to the normal system infrastructure testing that will be conducted as part of the equipment acceptance test plan, the following items must be addressed and documentation of successful results provided to the City prior to the initiation of radio coverage testing:
- Repeater / transmitter output power and deviation for each channel
 - Receiver sensitivity for each channel
 - Transmit and receive frequency noise floor sweeps for each channel to identify harmful interference prior to the test
 - Repeater antenna time delay reflectometry (TDR), VSWR and return loss sweeps for each antenna
 - Measured insertion loss for the entire repeater transmit and receiver path from each repeater to the associated transmit and receive antennas
 - Measured tower top amplifier system gain as configured
 - Detailed description of test procedures used to provide the test results
 - Current certification of test equipment calibration for all equipment used to verify system performance
- 3.6M The Contractor shall record and track the make, model, and serial numbers of all radio equipment used during the radio coverage testing process. This documentation shall include the versions of software and settings programmed into each of the radios, along with the type of battery (nickel-cadmium, nickel metal hydride, intrinsically safe) used for testing purposes.

3.6.1 Test Methodology

- 3.6.1A The portable radio DAQ voice testing shall be performed using random sentences read from daily periodicals. Both analog (if proposed) and digital voice modes will be tested. For portable testing, 50% of the test calls will be portable to portable based and 50% will be portable to & from dispatch.
- 3.6.1B To qualify as a successful test point, delivered audio quality of at least DAQ 3.4 shall be provided in both the inbound and outbound direction for both radio to radio and radio to dispatch console operation. For testing purposes, all accessible grids intersecting or contained within the defined coverage area will be tested with a portable radio.

- 3.6.1C **A failure in either the inbound, outbound, or radio to radio direction, will constitute a failed test call, subject to the retry allocation. All retries will be counted. No more than 5% of the retries will be allowed to pass this portion of the coverage testing process.**
- 3.6.1D In the event that the first test call is unsuccessful, the field team will be allowed to move up to 5' and a second (final) attempt will be permitted. If the final attempt to communicate fails (no access or audio quality below DAQ 3.4), that test location will be deemed a failure.
- 3.6.1E The outbound test for the portable radio must be graded based on the test message from the dispatch console or radio used to initiate the test message. The simultaneous use of multiple radios at a test location or dispatch point to analyze audio quality will not be permitted. There shall be only one radio at the test location with the receive audio volume turned up for monitoring the delivered audio quality.
- 3.6.1F Test teams shall be staffed as follows:
- Monitor Team**
- Dispatcher or other person - Provided by City
 - Test Monitor - Third party, such as the City's consultant
 - Test Monitor - Provided by Contractor
 - Observers – Provided by City (Optional)
- Field Teams**
- Driver - Provided by City (typically a representative from the Police or Fire Department)
 - Test Monitor - Provided by the Contractor
 - Record Keeper - Third party, such as the City's consultant
 - Observers – Provided by City (Optional)
- 3.6.1G To reduce the time required for the coverage test, more than one test team will operate at a time, and a single Monitor Team may support more than one field team. Tentatively, the City will provide staff for up to eight field test teams.
- 3.6.1H The "Monitor Team" comprised of the Contractor, the City and its consultant shall monitor the test at the dispatch facility in order to assist in test coordination as necessary.
- 3.6.1I A test vehicle shall be provided by the City for each field team. The vehicle will be equipped by the Contractor with a test radio from the stock to be supplied to the City, along with any test instrumentation required.
- 3.6.1J The Contractor must present the design for all test instrumentation to the City for approval at least 8 weeks prior to starting the test. The City and its consultants reserve the right to disapprove any instrumentation or procedures that do not comply with the RFP requirements or that do not provide valid test results. The Contractor has sole responsibility to provide instrumentation and procedures that are acceptable to the City. During these tests, the repeater base station output power shall be monitored and no adjustments made to the repeaters, mobile units, portable units, or test instrumentation without City approval in writing once the City has observed appropriate calibration of all units.

3.6.1K The City and Contractor shall test coverage in all accessible grids. Grids that cannot be accessed will not be counted in the reliability calculation. In addition, in-building tests shall be made in random buildings selected by the City and in those buildings identified as required buildings.

3.6.1L All portable coverage testing shall use a radio with the proposed flexible whip antenna, worn on the belt (3' AGL), and equipped with a speaker/microphone. If your coverage guarantee requires City staff to use any special carrying devices such as leather cases with swivel attachments, they must be clearly outlined and described in your radio coverage description.

3.6.2 Portable Radios On-Street

3.6.2A The defined coverage area is the same for portable on-street and portable in 10 dB buildings. Testing of both modes of operation shall be conducted.

3.6.3 Portable Radios Inside Buildings

3.6.3A The in-building coverage test will be conducted for four categories of buildings:

- Randomly selected 10 dB buildings (small buildings or residential)
- Randomly selected buildings with penetration losses up to 20 dB
- Randomly selected buildings within the required 30 dB contour downtown
- Required buildings

3.6.3B Typically, one building per grid shall be chosen within the required areas except for required buildings.

Table 3.6.3A – Coverage Service Areas & Acceptance Criteria

Portable Indoor Service Area Definition	Building Loss Category (dB)	Service Area Reliability % Acceptance Criteria
The required portable indoor (standard building, 10 dB building loss) coverage in random buildings & within the coverage area of the City of Houston	10 dB	95%
Portable indoor (up to 20 dB loss) within defined contour	20 dB	95%
Portable Indoor (up to and including 30 dB loss) within defined contour	30 dB	95%
All required buildings as listed in this section		95%

➤ Results Presentation

A test report, two (2) copies minimum, is provided for each random building that includes:

- ◆ the number of test grids and the location tested within each grid

- ◆ a copy of Figure 3.6.3B inbound and outbound analog voice and digital voice grading templates used by each grader for each test
- ◆ the PASS/FAIL score for each test grid/location for each test
- ◆ the percentage analog voice and digital voice PASS calculation for the building
- ◆ a statement of overall test acceptance or failure of each random building.

Fully Compliant Partially Compliant Non-Compliant

3.6.4 RF Coverage - In-Building Voice Quality Test

- 3.6.4A This Coverage Test Procedure (ATP) shall be used for verification of portable indoor coverage and is based on the evaluation of voice quality at the specified reliability level.
- 3.6.4B This test process is in agreement with the DAQ definitions set forth in the Telecommunications Industry Association (TIA) Telecommunications Systems Bulletin TSB88-A. These DAQ definitions are provided in Figure 3.1.1A
- 3.6.4C RF coverage using this test is verified by evaluating the voice quality of test calls placed between a dispatcher and a field radio user and between two portable radios, one of which is inside of the building under test. In each tested building, test calls are placed to and from a dispatcher and field radio user and from one portable user to a second portable user. Both portable radio users must successfully transmit and receive test messages in order to complete the test.
- 3.6.4D Four separate test calls will be conducted at each test location:
- Dispatcher/field inbound & outbound – analog
 - Dispatcher/field inbound & outbound – digital
 - Portable to portable – analog
 - Portable to portable - digital
- 3.6.4E If a building fails the DAQ test, additional tests will be conducted to determine if the loss characteristics of the failed test locations within the building exceed the building losses specified by the City of Houston

Test Equipment and Preparation

- 3.6.4F Portable radios from the City of Houston's ordered equipment will be used for the DAQ voice quality test. The portable unit and antenna will be worn on the belt (approximately 3' AGL) and equipped with a shoulder speaker/microphone.

Test Planning

- 3.6.4G A statistically significant number of random test locations uniformly distributed throughout the building will be tested.
- 3.6.4H An equal number of points on the first floor of each required building will be tested. The first floor shall be divided into a number of grids in order to evenly distribute the test points. The number of grids will depend on the size of the building and the area of the floor tested. The DAQ voice quality test is conducted using a portable radio at each test point. The City may pass a building prior to completion of its testing if it is obvious that the building is adequately covered.
- 3.6.4I In Building test points shall include all areas of the building, elevators, basements, multi-level basements, stairwells and parking garages will all be included as test valid test locations.

- 3.6.4J If the City and Contractor are denied access to a required building to perform coverage acceptance, then that required building will not be counted when computing Required Building coverage acceptance. If the City decides not to test a required building for convenience, it will be scored as a PASS when computing Required Building coverage acceptance. The City shall have final review and approval of any test buildings PASSED without testing by any City testing team.

Grading of Buildings

- 3.6.4K A voice quality test requires at least one Contractor representative and two City representatives. The test team will enter each test building and will perform the required test calls.

Analog Voice Quality Grading

- 3.6.4L The City and Contractor representatives enter a building and select distributed test locations

- 3.6.4M Each portable test call is graded by the Contractor and City representatives at their respective locations using the DAQ definitions in Figure 3.1.1A

- 3.6.4N At each test location, each test team will make the required portable radio test calls. If a test call is unsuccessful, the portable user will be allowed to move one time up to 5 feet in any direction to optimize the signal performance. A repeat (2nd final PTT) will be allowed and will be annotated on the grading template. **A second attempt will be accepted in no more than 5% of the test locations.**

- 3.6.4O The portable test message shall consist of a short message representative of typical public safety call durations and shall include the identification of the location being tested. The suggested test message is "TEST TEAM ONE, TESTING BUILDING YYY, GRID NUMBER XXX, followed by a short sentence or two (Approximately 8-20 words total) from a newspaper or periodical such as the Houston Chronicle.

To ensure that the message is understood, the test message is repeated by the dispatcher or other portable radio user who will then make a similar test call. The suggested response test message is "TEST TEAM TWO, CONFIRMING BUILDING YYY, GRID NUMBER XXX, followed by a different short sentence or two from a newspaper or periodical such as USA Today". The dispatcher or test team 1 will then repeat the message transmitted by test team 2. Either test team may report the test results to the monitoring team at the conclusion of the test for each location.

- 3.6.4P Each of the test representatives marks the test score for each test location using the template in Figure 3.6.3B. PASS or FAIL determination is made based upon successful messages in the inbound, outbound, and radio to radio directions from both test teams. If both graders agree that the voice quality does not meet the defined DAQ 3.4 criteria, then that test location fails. If a DAQ score differs between testers on the same test team and results in a failing score from only one tester, that location will need to be tested again to determine the cause of the discrepancy. If the discrepancy cannot be rectified, then that grid will be set aside for discussion & evaluation. If a member of the test team exhibits bias, he or she may be replaced.

3.6.4Q **Digital Voice Quality Grading** will follow the same procedures described above, performing tests at the same locations as were used for the analog voice quality tests, and grade the test calls using the DAQ definitions in Table 3.1.1A

Individual Building Test Analysis and Acceptance

3.6.4R The City may elect not to test all planned test locations or grids within a required building. Grid locations that are not tested for convenience of the City will be recorded as a PASS in the percentage calculation. The City reserves the right to pass a required building in which the City staff determines that adequate coverage has been provided, even if all test points have not been completed. Both conditions will be annotated in the data record and in the final test report.

3.6.4S The analog voice quality test is deemed to meet the coverage requirements in a building if: (a) the percentage of test locations that receive a PASS score equal or exceed the City's 95% acceptance criteria; and (b) the number of manual repeats is no more than 5% of the total number of tested grids.

3.6.4T The digital voice quality test is deemed to meet the coverage requirements in a building if: (a) the percentage of test locations that receive a PASS score equal or exceed the City's 95% acceptance criteria; and (b) the number of manual repeats is no more than 5% of the total number of test locations.

3.6.4U The coverage in a specific building is deemed to meet the coverage requirements if both the analog voice and digital voice test results equal or exceed the City's 95% acceptance criteria.

3.6.4V If a building does not pass the coverage test, then additional audio quality tests will be made outside the failed building with the appropriate attenuated radio to determine if the loss characteristics of the failed building exceed the 10 or 20 dB building loss specified by the City. The PASS/FAIL acceptance of the building will then be finalized based on the supplemental findings.

Building Loss Measurements

3.6.4W Building loss measurements will not be conducted as part of the acceptance test.

Required Building RF Coverage Acceptance

3.6.4X The Required Buildings coverage is deemed to meet the coverage requirements if all of the required buildings are scored as pass.

Results Presentation

3.6.4Y Test results (2 copies minimum) shall be provided for each tested building that includes:

- ◆ the number of test grids and the location tested within each grid
- ◆ a copy of Figure 3.6.3B analog voice and digital voice grading templates used by each grader for each test

- ◆ the PASS/FAIL score for each test grid/location
- ◆ the percentage analog voice and digital voice PASS calculation for the building
- ◆ Results of buildings measurements if conducted
- ◆ a statement of overall test acceptance or failure of each tested building.

Building Loss Verification Procedures

Portable Radio Configurations for Building Loss Verification

3.6.4Z In the event that the Field Test Team conducts a portable radio coverage test within a specified building, and the test fails, it will be necessary to determine if the building loss for that particular facility exceeds either the designated building loss threshold. The City recognizes that conducting signal measurement testing throughout a building can be very time consuming and costly. Accordingly, the following process shall be utilized to determine whether the trunked radio system passes or fails the coverage test within a particular facility.

3.6.4AA Instead of actually measuring signal levels within the building, the City will allow the use of a modified attenuated portable radio for testing outside of the building to simulate 10, 20, or 30 dB building loss factors for the facility. This process basically involves modification of a portable radio of the same model as those purchased by the City for the project. The purpose of the modifications will be to reduce the portable radio's transmitter power by 10, 20 or 30 dB to simulate the performance degradation that would be encountered operating within a building having those loss characteristics. On the receive side, the radio's receiver sensitivity would be reduced by either 10, 20, or 30 dB to simulate degradation that would be encountered on the talk-out leg of the communications path. While there are a variety of methods available to alter a radio or the system infrastructure to simulate these losses, there are two methods that will be considered for use by the City. Both methods are described in below.

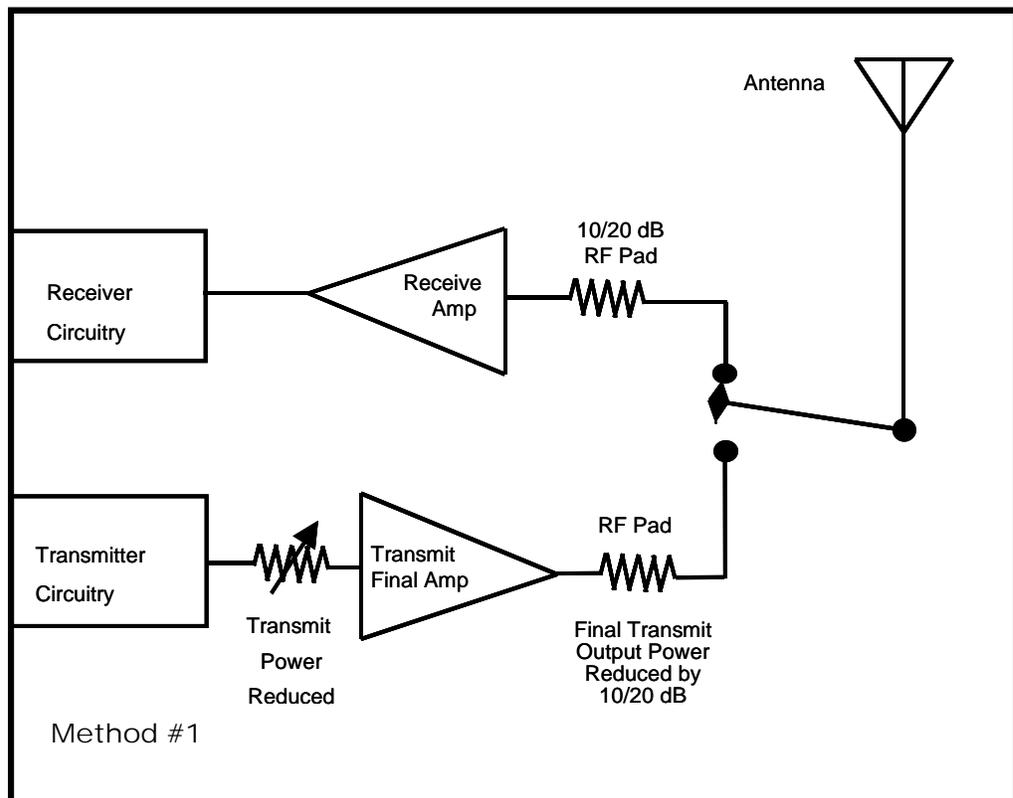
Method #1—Internal Modification of the Portable Radio

3.6.4BB In this first approach, the system Contractor would modify a number of portable radios of the same make and model as purchased by the City, to add the needed attenuation into the transmit direction for the portable radio. These modifications would be internal to the radio and would most likely consist of the installation of an array of small surface mount resistors configured in a manner to provide appropriate power dissipation and attenuation of the transmitted signal. Due to the limited power dissipation characteristics of these devices, it may be necessary to reduce the transmitter power of the radio from 3 Watts to 1 Watt to help achieve the desired effect. On the receive side, a similar attenuator would be installed between the antenna and the receiver input to degrade the receiver sensitivity by the amount needed.

3.6.4CC It is envisioned that separate radios would have to be modified to accommodate the 10, 20, or 30 dB change. This will make the modification of the radio significantly simpler.

- 3.6.4DD A diagram of the test setup is provided below in (Figure 3.6.4A) Prior to testing and at the end of each day of coverage testing, each portable radio will be bench tested to ensure that its effective radiated power and receiver sensitivity are actually degraded by the specified amount. This test process should not take more than 10 minutes per radio if organized properly. Once the radio's performance has been verified, the modified radios will be assigned to the Test Team to help determine whether the losses in a particular facility exceed the loss thresholds.
- 3.6.4EE At a particular test location, after failing the traditional circuit merit voice test within a building, the Test Team will utilize the modified radios to conduct the same test at a variety of locations outdoors around the exterior of the building. The exact number of test locations around the building will be agreed to by both the City and the Contractor prior to execution of a contract. It should be noted that a single test location on one side of the building exterior will not be considered acceptable, because it does not provide realistic results. The Test Team will be expected to conduct multiple tests around the perimeter of the building to help obtain a more accurate assessment of coverage performance with at least one test per side, preferably centered on the side of the building. Test points around the exterior of the building will be located no more than 15' from the building to help ensure realistic results.

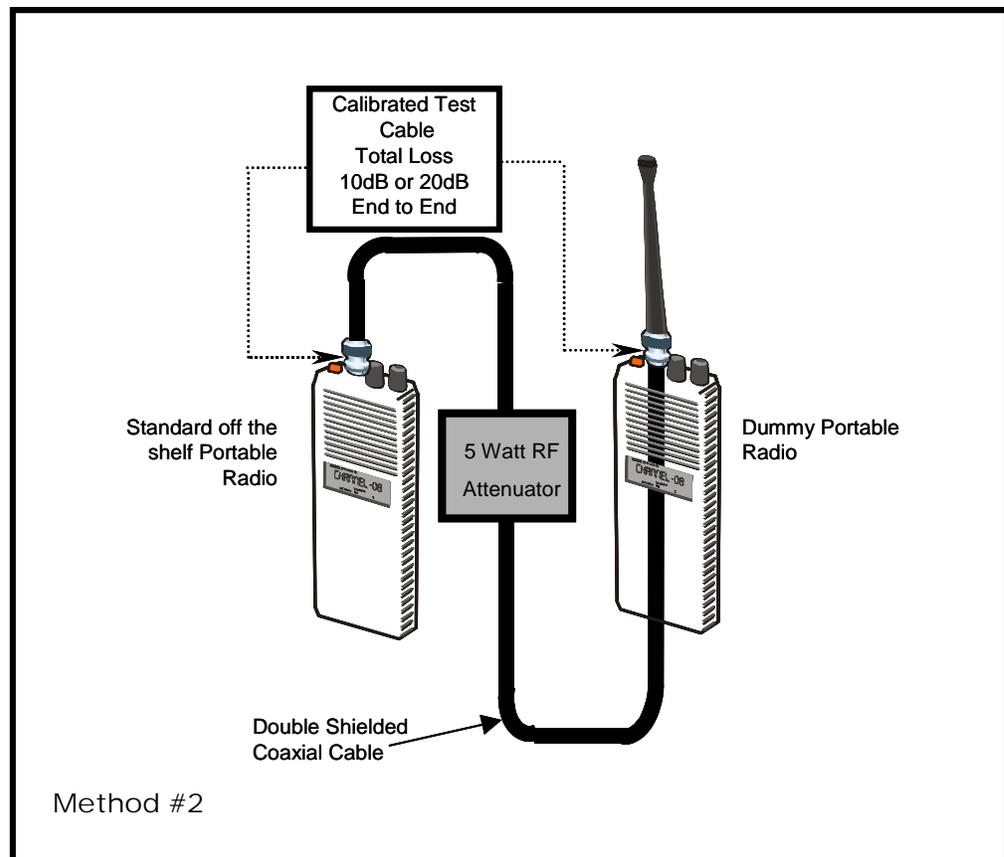
Figure 3.6.4A



Method #2—Cable & Harness Test Methodology

- 3.6.4FF This test approach will utilize a standard off-the-shelf portable radio purchased by the City as part of the project. A test apparatus will be developed utilizing the chassis, case, and antenna of an identical portable radio. The test radio chassis will be linked to the off-the-shelf radio via a calibrated cable assembly with a known loss factor. In this configuration, the off-the-shelf radio will actually provide the transmitter and receiver for the test, which will be coupled to the “dummy radio” through the calibrated cable. A diagram of the test setup is provided below in (Figure 3.6.4B) This will allow the Contractor to attenuate the transmitted and received signal by the amounts needed, but not impact the location of the radio on the body or alter the antenna characteristics of the portable radio itself.
- 3.6.4GG An individual participating in the Test Team will wear both the test radio and the “dummy radio” on the belt, as specified in the Request for Proposals. The real radio will do the actual transmitting and receiving through the calibrated cable harness using the antenna on the “dummy radio”. By applying the appropriate loss in the cable assembly, it should be possible to simulate the effects of 10, 20, or 30 dB of building loss. A diagram of this test configuration is provided below. Proposers may choose either test method they feel would best meet their needs. Your proposal to the City must clearly explain which approach your company prefers and provide a thorough description, including block diagrams of the proposed test setup. The methodology that will be used with the test setup in Method #2 will be the same as the methodology outlined in Method #1 above.

Figure 3.6.4B



Mobile Radio Coverage

- ◆ Automated Outbound Signal Strength Measurement and Bit Error Rate tests shall be conducted throughout the required areas
 - ◆ DAQ Voice Quality Tests (stationary, and vehicle moving up to 80 MPH)
-

Fully Compliant Partially Compliant Non-Compliant

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SECTION

4

Communications Sites

4.1 General Conditions

- 4.1A The City of Houston currently own numerous radio towers, and other potential repeater sites that may be considered in your proposed system design. These facilities may or may not be capable of supporting microwave and two way radio antennas for your proposed radio system but are available for consideration. The City would prefer to reuse existing City owned infrastructure whenever possible but your system design may include construction of new tower facilities, or commercially available facilities if absolutely necessary to meet the design goals. A list of City owned facilities that may be considered is included in Volume 2 Section 3 of this RFP.
- 4.1B The information contained in this Section is intended to provide guidance to Proposers to assist in the development of the required site development documents. This information is to be combined with system specific information including but not limited to:
- Actual proposed repeater and microwave site locations
 - Equipment shelter requirements for space, commercial electrical power, HVAC, surge protection, and security
 - Auxiliary electrical power
 - Steel tower and appurtenances
 - Site preparation and fencing
- 4.1C After reviewing proposals, the City may elect to take on certain aspects of the project on its own to reduce costs, such as site development, and tower and shelter procurement. A final decision about the City taking on a portion of the system development effort will not be made until an analysis of the proposals and proposed costs has been completed.
- 4.1D In the event that the City handles a portion of the site development work itself. The Proposer shall include an appropriate level of support to coordinate with the City and approve the site construction process such that it is successfully integrated into the overall radio system project schedule.
- 4.1E In summary, the City may elect to perform certain parts of the site development for the following:
- Site preparation work, leveling, grading, etc.
 - Radio towers and installation
 - Equipment shelters, foundation, and auxiliary power system and installation
 - Site fencing
- 4.1F The Contractor shall provide 3 printed copies and 3 complete electronic copies of all site development documents to the City.

- 4.1G A fully complete and operational radio communications system is required by this procurement. The Contractor shall perform all work necessary to provide site development documents for approval by the City Engineer and City Council for radio base station or microwave sites which meet all City, State or Federal requirements, and which provide the necessary antenna mounting structures, equipment rooms or shelters and all required environmental conditioning, security, power, standby power, access roads, foliage control, lighting, and cable support structures.
- 4.1H The Contractor shall be responsible for preparing specifications and site development documents for a complete and fully operable installation which is in compliance with the latest version of the National Electrical Code (or local electrical code, if applicable), local building codes, environmental laws, zoning and planning regulations or ordinances, land use restrictions, Federal Aviation Administration and Federal Communications Commission rules and regulations, State or City regulations governing road access and entry, OSHA guidelines and all other applicable local, state or Federal codes, regulations, laws and/or ordinances. The Contractor shall prepare all specifications, plans, documents, and required forms and exhibits required to obtain the necessary approvals from each of the above entities.
- 4.1I Materials specified by the Contractor shall be new and of first quality as defined in industry standards. The Contractor shall not make substitutes unless prior approval has been obtained from the City project manager.
- 4.1J The City will conduct limited number of facility tours to provide Proposers an opportunity to view the existing radio tower sites and other designated facilities. Each Proposer wanting to tour the facilities must sign up and provide the City with a list of facilities they wish to tour within 15 days after the issuance of this RFP. The Proposer shall also provide a list of attendees for the site tours. The City contact for the site tours is Mr. Doug Moore (713) 247-1073. Each Proposer will be limited to no more than five (5) personnel for the tours.
- 4.1K Each Proposer (prior to submitting a proposal will be provided the opportunity to conduct site visits and examine the sites so as to fully understand all the existing conditions relating to the work. Mr. Doug Moore (713) 247-1073 will assist in scheduling site visits.
- 4.1L The Contractor will be required to assume full responsibility for the specification of materials and equipment employed in construction of the project and agrees to make no claims against the City for damages to such materials and equipment except for that which is caused by the City, their employees or agents. The Contractor shall be responsible for managing the storage of all materials purchased and turned over to him by the City and shall receive all delivered items by suppliers at the job site or at a staging area to be furnished by the Contractor.
- 4.1M The Contractor shall oversee clean up and remove from the work site on a daily basis (or sooner if directed by the City project manager) all rubbish and construction debris, resulting from his own and from the site development contractor's work. The Contractor shall supply a dumpster or similar trash storage/ removal device where a substantial amount of construction debris is generated. Upon completion of all work, the entire job site areas shall be left clean and free of trash, debris, mud, dirt, dust, scrap materials, and excess materials. Floors in radio equipment shelters and rooms shall be mopped

and polished to the satisfaction of the City project manager upon completion of installation and construction work.

- 4.1N The Contractor shall coordinate the work of the site development contractor(s) to insure that interference between electrical conduits, cable support trays, grounding wire, structural members, and radio system work shall be avoided so that the project is completed within budget and on schedule.
- 4.1O The Contractor shall keep up-to-date marked-up prints of the Project Drawings. Markings indicating changes to the drawings shall be red or green and clearly visible. Two (2) sets of "As-Built" drawings shall be furnished to the City project manager at the completion of the project. Project Drawings shall also be supplied on diskette reproducible in AutoCAD in both DXF and DWG formats. (latest Release).

4.1.1 Flood Plain Information

- 4.1.1A The Proposer shall evaluate all proposed site locations included in their trunked radio system design to determine the site location in relation to the following:
- 4.1.1B **1% Floodplain**-Also known as the 100 year floodplain, Base Flood or Special Flood Hazard Area, it is an area of land that has a 1% chance of being inundated by flood waters from a bayou or creek in a given year.
- 4.1.1C **0.2% Floodplain**-An area of land that has a 0.2% chance of being inundated by flood waters from a bayou or creek in a given year. It is commonly referred to as the 500 year floodplain.
- 4.1.1D **Floodway**- For most waterways, the floodway is where the water is likely to be deepest and fastest. It is the area of the floodplain that should be reserved (kept free of obstructions) to allow floodwaters to move downstream.
- 4.1.1E **Watershed**-A geographical region of land or "drainage area" that drains to a common channel or outlet, mostly creeks and bayous in Harris County. Drainage of the land can occur directly into a bayou or creek, or through a series of systems that may include storm sewers, roadside ditches, and/or tributary channels.
- 4.1.1F The Proposer shall provide a color Flood Insurance Rate Map (FIRM) for each proposed site with the site location clearly indicated in the map. A brief summary shall be included indicating the name of the watershed in which the site is located, the (FIRM Zone) in which the proposed site is located, whether or not the site is located in the 1% (100 Year) Floodplain, whether or not the site is located in the .2% (500 Year) Floodplain, whether or not the site is located in a floodway. Additionally the elevation of the closest 2 foot contour as depicted on the (FIRM) shall be provided.
- 4.1.1G The most current Revised Preliminary FEMA Flood Insurance Rate Maps can be obtained free of charge at the following web site. <http://www.tsarp.org/products.asp> (Click [HERE](#).)
- 4.1.1H Any maps dated prior to June 9, 2006 has been rendered null and void.

4.1.2 Grounding Systems

- 4.1.2A All new sites shall have a single point internal ground system installed to provide the greatest possible protection against lightning strikes and possible power faults. This includes existing tower sites that will have a new electronics equipment shelter installed as part of the project.
- 4.1.2B Standard requirements for the installation of radio communications sites shall include the adherence to the following standards at a minimum :
- 4.1.2C American National Standard for Telecommunications:
- 4.1.2D **T1.334-2002**, *Electrical Protection of Communications Towers and Associated Structures*
- 4.1.2E **T1.313-2003**, *Electrical Protection for Telecommunications Central Offices and Similar Type Facilities*
- 4.1.2F **T1.333.2001**, *Grounding and Bonding of Telecommunications Equipment*
- 4.1.2G **ANSI-J-STD-607-A-2002**, *Commercial Building Grounding and Bonding Requirements or Telecommunications*
- 4.1.2H **ANSI/NFPA 780-2004**, *Standard for the Installation of Lightning Protection Systems*
- 4.1.2I **NEC**, *National Electrical Code*
- 4.1.2J Site planning shall require that the main electrical service be brought into the shelter at a location as close to the transmission line entry port as practical.
- 4.1.2K All power feeders and branch circuits shall contain an equipment grounding conductor which shall have green colored THWN/THHN insulation or green identifying tape at both ends and which shall be suitably terminated to an equipment ground bus or device screw terminal at both ends.
- 4.1.2L At any site at which building structural members are used for grounds, connections to those main structural steel members shall be made with exothermic "Cadweld", Burndy press or equivalent type connectors. Any paint or fire retardant material shall be scraped away down to bare metal (for good metal contact) before applying the connector. Surface preparation recommendations of the manufacturer of the exothermic welding process to be used shall be followed.
- 4.1.2M All connections to equipment room or shelter internal perimeter grounds shall be made as straight as possible with a minimum number of bends. The minimum bending radius of any ground wire shall be one foot.
- 4.1.2N Grounding of electronic communications equipment, cabinets and all associated equipment within the equipment shelter shall conform to the latest versions of the standards referenced above as well as the radio manufacturers' own company standards or guidelines for site grounding, bonding and lightning protection. Should a discrepancy or conflict arise between manufacturers guidelines or standards

referenced above, the more stringent of the standards shall apply at the City's discretion.

- 4.1.2O A ground ring consisting of a #2 AWG solid tinned bare copper wire shall be installed in a trench at a minimum depth of 24" below final grade at a maximum distance of 3 feet from the foundation of the equipment building where the equipment is installed.
- 4.1.2P The ground ring shall be supplemented with copper clad steel ground rods. The ground rods shall have a minimum length of 10 feet and a minimum diameter of 5/8 inches. All ground rods shall be interconnected, including the AC power service and telephone ground rods, to form a ground grid with resistance of 5 Ohms or less.
- 4.1.2Q If soil conditions do not allow ground rods to be placed, an equivalent supplemental system must be used.
- 4.1.2R The minimum requirements for the quantity of ground rods shall be based on the following:
- ◆ At least one ground rod at each corner of all equipment shelters shall be installed
 - ◆ Self supporting 3 legged towers shall have a minimum of 3 equally spaced ground rods connected to the tower ground ring. A tower grounding conductor shall connect each tower leg to the ground ring.
 - ◆ Self supporting 4 legged towers shall have a minimum of 4 equally spaced ground rods connected to the tower ground ring. A tower grounding conductor shall connect each tower leg to the ground ring.
 - ◆ Guyed towers shall have a minimum of 3 equally spaced ground rods connected to the tower ground ring. Tower grounding conductors shall connect each tower leg to the ground ring.
 - ◆ Guyed towers shall have a minimum of 1 supplemental ground rod installed at each guy wire anchor point. Guy wires shall be bonded to the ground rods with suitable stainless steel clamps and have conductive anti-oxidant compound applied.
 - ◆ Monopoles shall have a minimum of 4 equally spaced ground rods attached to the tower ground ring. Monopoles shall also have 4 equally spaced grounding conductors connected each tower leg to the ground ring.
 - ◆ At least one ground rod shall be installed directly at the AC power service entry point
 - ◆ At least one ground rod shall be installed directly below the transmission line entry port
 - ◆ The top of ground rods shall be 2 feet below grade with a minimum distance of 10 feet between rods.

- ◆ Inspection wells with removable lids shall be installed at the junction points between the tower ground ring and the shelter ground ring, at the shelter ground bus and the grounding electrode system, and at the main AC power service ground rod
 - ◆ The ground rods shall be bonded to the external shelter ground ring using an exothermic welding process such as Cadweld.
 - ◆ It will be left to the discretion of the contractor to determine the type of connector to use in the welding process. The following two restrictions, however, shall be observed.
 - An anti-oxidant compound shall be applied to the connection point after the bond is completed.
 - All connections to the ground ring shall be such that the ground wires are as straight as possible with no sharp bends.
- 4.1.2S The exterior ground ring shall be bonded to a minimum of two 6" wide copper straps descending from the shelter's cable entry bulkhead panel. The copper straps shall be secured to the building exterior so as to eliminate wind vibration or flapping.
- 4.1.2T An internal perimeter ground bus (split halo) shall be installed in all equipment rooms or shelters which consists of #2 AWG tinned bare solid copper conductor, running along the perimeter of the room on each interior wall, at a maximum of 6 inches below the ceiling. The perimeter bus shall not form a continuous loop around the room. It shall have an opening of 12-16 inches on the opposite side of the room from the master ground bus bar. Insulated mounting standoffs shall be installed to provide a maximum separation of 2 feet to accommodate bends and avoid sag. Standoff shall provide 1-2 inches of clearance from the wall.
- 4.1.2U In each equipment shelter or room a transmission line bulkhead entry port(s) shall be installed on the lower 1/3 of the wall with the bottom edge of the entry port frame 12-14 inches above the finished surface of the floor at a point to be mutually agreed upon between the Contractor and the City. The bulkhead cable entry panel shall be watertight (United States Coast Guard A-60) and have a minimum 1 hour Fire Rating (UL1479)The bulkhead cable entry panel shall be manufactured by Roxtec Inc. For new shelter installations the bulkhead cable entry panel shall be a Roxtec, stainless steel, G-frame or equivalent. The frame shall be bolted to the outside of the shelter and bonded to the exterior shelter ground buss bar. The cable entry bulkhead assembly shall be sized to provide 50% expansion capability (based on the use of the largest size coaxial cable used at the site).
- 4.1.2V A Harger Entrance Panel Kit (Harger EPK24 or equivalent) shall be provided and installed with through-wall mounting bars to provide the interior shelter (MGB) master ground buss bar and the shelter exterior ground buss bar. The ground bar may not be integrated with the cable entry panel. The exterior ground bar shall be wall-mounted and shall utilize a minimum of three (3") flat copper ground straps on the exterior ground bar which are exothermically welded to a copper (1/4" x 1" copper bar for connection to the site grounding electrode system. Both the interior and the exterior ground bar shall be predrilled to provide ground connections for equipment.

- 4.1.2W The internal ground bar shall be directly connected to the shelter exterior ground buss bar with the through wall mounting hardware provided in the entrance panel kit. This shall be the single ground connection from the shelter interior ground to the site grounding electrode system.
- 4.1.2X All exposed noncurrent carrying metal parts of fixed equipment which could become energized. The following bonding connections shall be made directly to the internal perimeter ground (split halo) using green insulated #2 AWG stranded copper wire
- Ventilation louvers and sheet metal duct-work
- ◆ Metal doors shall be grounded to the door frames (using 1 inch wide braided copper flexible straps, and door frames shall be bonded to the internal perimeter ground (split halo) with green insulated #2 AWG stranded copper conductor.
 - ◆ All metal racks and cabinets, including tower lighting cabinets, generator transfer switch cabinet, power panel cabinets, metal conduits, fire suppression chemical storage tanks, telco/alarm panel demarcation block covers, metal HVAC lead-lag controller cabinets, cable trays, file cabinets ,metal desks and other exposed metal surfaces
 - ◆ Generator rooms shall have a separate internal perimeter ground (split halo) connected to the shelter interior MGB. Equipment within the generator room shall be grounded as required in the main electronics equipment room of the shelter. If the generator is outside the building, it shall be grounded to the exterior grounding system.
- 4.1.2Y All ground connections to equipment that are not exothermically welded shall use stainless steel 2 hole long barrel compression lugs. Connections between dissimilar metals shall not be made unless the conductors are separated by a material specifically approved for use with the dissimilar metals.
- 4.1.2Z Star or split lock washers shall be placed under the head of the screws or bolts or nuts not between the conductive surfaces of the lug and the metal surface to be bonded. Self tapping sheet metal screws shall not be used for attaching grounding conductors to any surface. Paint shall be removed from any painted surface before ground connections are made and the appropriate antioxidant compound shall be applied to the connection.

4.1.3 Lightning Protection

- 4.1.3A Houston is a lightning prone location, and it is the City's goal to reduce possible system damage and failure due to strikes or induced currents. The Contractor shall adhere to current practices in providing protection to sensitive electronic equipment. At a minimum, the Contractor shall comply with the following lightning protection practices.

Tower Lighting Control

- 4.1.3B All tower lighting controls shall be equipped with gas tube surge arrestors which will prevent a lightning strike to the tower or lighting system from back feeding into the electrical distribution system of the equipment shelter. This device shall shunt surges to the tower grounding system, and shall protect the tower lighting controller. An

acceptable protector is Polyphaser IS-7WFU (single flasher unit) or IS-12WFU (dual flasher unit).

Radio Frequency Transmission Lines

- 4.1.3C Each transmit or receive transmission line shall be protected by coaxial surge/lightning protectors, Polyphaser DSXL Series, or equivalent, between the transmitter combiner output and the antenna. Lightning arrestors shall be grounded to the bulkhead panel.
- 4.1.3D On receiving antennas with a tower-mounted amplifier, a Polyphaser CGXZ series lightning arrestor or equivalent shall be installed in the transmission line.
- 4.1.3E Control stations with outdoor antennas shall be equipped with a coaxial lightning arrestor, Polyphaser DSXL series, or equivalent. These lightning arrestors shall be grounded to a 5/8" X 8 foot driven ground rod by a #2 AWG tinned solid copper wire attached to the rod using exothermic welding. It is preferred that the grounding system used for the control station lightning arrestor shall be connected back to the building ground system at the power service entrance.
- 4.1.3F If GPS receivers are used as frequency/time references in the simulcast system, the antenna line shall be equipped with a coaxial lightning arrestor, Polyphaser DGXZ series, or equivalent.
- 4.1.3G Each coaxial transmission line shall be grounded at a point above the bend required to exit the tower mounted cable ladder to the ice bridge leading to the radio equipment shelter or room. These grounds shall be installed in accordance with the manufacturer's specifications, and shall be sealed against entry of moisture at any location where the outer sheath of the transmission line has been cut or removed.

4.1.4 Surge Protection

- 4.1.4A The surge protection equipment and methodologies used shall be specifically determined for use in "High Lightning Exposure Locations." The Proposer shall maximize efforts to effectively protect all communications site equipment from, power surges and transient voltages.

AC Power Surge Protection

- 4.1.4B Parallel SPDs (Surge Protection Devices) shall be provided with the equipment building to protect the AC main and sub panels. Panel surge suppression devices shall have an IEEE Location Category Rating of C High, Rated for 65kA AIC fault current, have a Response time of <1 Nanosecond and be supplied with metal cabinets.
- 4.1.4C SPDs shall be equipped with primary modules using SAD (Silicon Avalanche Diode) technology and secondary modules using MOV (Metal Oxide Varistor) technology. Primary SAD suppressor modules shall be capable of providing 500 Joules per phase per polarity, minimum energy absorption, secondary modules shall be capable of 5000 Joules per phase of minimum energy absorption.
- 4.1.4D The units shall provide isolated dry contacts for remote monitoring of protector status, replaceable surge protection modules, and offer Normal Mode protection: Transtector

APEX IMAX Series surge protection devices or equivalent shall be provided. All surge protection devices shall be installed in accordance with the manufacturers instructions.

- ◆ Surge protection devices shall be installed between the commercial main AC power disconnect and the automatic transfer switch.
- ◆ AC Main and sub power panels shall each have SPDs (Surge Protection Devices) installed.
- ◆ In addition to the panel type surge suppression devices, individual equipment SPDs shall be installed on all individual loads. Each rack or cabinet that has AC powered equipment shall have a wire-in receptacle outlet SPD installed at the top of each rack or chassis. Transtector OP8 20B Series, Northern Technologies TCS Series or equivalent .

DC Power Surge Protection

- 4.1.4E As previously mentioned the Houston area is considered a high exposure area in terms of lightning strikes. To minimize the potential risk of equipment damage to the electronic equipment at the sites DC surge protection devices shall be provided and installed at the load distribution panel for each different output voltage provided by the DC power system.
- 4.1.4F DC distribution panel SPDs shall be Transtector CB Series, I2R ICP Series or equivalent. The SPD's shall use silicon avalanche diode (SAD) technology, have a visual status indicator and isolated Form-C relays for remote fault annunciation to the site alarm system.
- 4.1.4G Each SPD shall be selected based on the specific application to maximize its effectiveness and shall be installed at the equipment to be protected in accordance with the manufactures instructions.

Leased Telephone and T1 Circuits

- 4.1.4H Fiber optic cable from the telephone company is preferred .
- 4.1.4I All telephone company circuits or other twisted pair cable which may enter an electronic equipment room or shelter shall be equipped for electrical transient protection utilizing a common mode SPD. Transtector TSJ series, Northern Technologies TMC-50, or equivalent. These arrestors shall be installed as close as practicable to the point of entry to the facility. SPDs used on leased telco circuits shall use silicon avalanche diode technology being used, and shall be grounded to the equipment shelter/room ground.

4.1.5 Conduits and Raceways

- 4.1.5A All AC power electrical wiring inside of the building/shelter shall be enclosed in EMT (electro metallic tubing) with compression type fittings (set screw type fittings are unacceptable). EMT shall be surface mounted in a neat, professional like manner. UL approved locknuts and grounding bushings (or EMT box connectors) shall be used at boxes and equipment enclosures.

- 4.1.5B All AC power wiring outside of the building/shelter shall be enclosed in heavy wall galvanized rigid steel conduit with form eight gasketed fittings. Weatherproof grounding type hubs shall be used at boxes and equipment enclosures. All wall penetrations shall be sealed with weatherproof compounds.
- 4.1.5C Telephone Company cable(s) shall be enclosed in GRS conduit.
- 4.1.5D Flexible metallic conduit (UL approved) with UL fittings shall be used as final connections to all mechanical vibrating/rotating machinery (A/C units, heaters, motors, transformers, UPS, and generator set, etc.)
- 4.1.5E All new conduit routings shall be horizontally and vertically straight, neat in appearance, indicative of professional workmanship and shall conform to existing conduit routings. Where existing conduit supports are adequate, they shall be used. If new supports are required, they shall be installed at intervals in accordance with the National Electrical Code (NEC). Only structural members suitable for conduit supports shall be used; piping, HVAC ducts, etc. shall not be used for conduit supports. Conduit support intervals shall be based on the NEC Table 346-12.

4.1.6 Wiring and Devices

- 4.1.6A Power conductor insulation shall be color coded (with tape at each termination end). Identification shall be by color tape (black-phase A, red-phase B, blue-phase C, white-neutral and green-ground). Branch circuit conductors shall be labeled (using Brady or approved equivalent wire markers) at each end with the appropriate circuit numbers. Genset and A/C unit control wiring shall be labeled with the terminal numbers corresponding to the Contractor's wiring diagrams to be furnished with the equipment.
- 4.1.6B All outlet boxes shall be metallic surface mounted types suitable for the quantity of devices enclosed. Faceplates shall match the outlet boxes. The outlet boxes shall be marked with the associated circuit and breaker box numbers. Outlet boxes, which are fed by emergency power, shall be plainly marked and identified. Orange outlets shall be used for circuits protected by both UPS and generator power; red outlets shall be used for any circuits that are protected by generator only.
- 4.1.6C Radio equipment from the 120 VAC and UPS power panels shall contain separate identifiable white neutral conductors. Common or shared neutrals for these loads are unacceptable.
- 4.1.6D All wire for power, lighting, control and grounding systems shall be stranded copper with UL THWN/THHN 600V insulation, sizes as indicated. Minimum size for power shall be #12 AWG and minimum size for controls shall be #14 AWG.
- 4.1.6E Electrical equipment such as UPS, genset, A/C (air conditioning units), heater, etc. shall be wired in accordance with the manufacturers wiring diagrams furnished with the equipment.

Commercial Power

- 4.1.6F The City will assist in arranging for commercial power installation to the meter at each base station/microwave radio site. The City will negotiate a utility easement or right of way, if needed, at each site.

4.1.6G The Contractor is responsible for all power installation on the equipment side of the meter. Power feeds to shelters shall be buried and shall enter the building through conduit and an elbow described in the equipment shelter specification. If a main cutoff switch is required outside of the shelter, this switch shall be padlocked with a Best lock keyed to the City's specification.

4.1.7 Ground Resistance Testing

4.1.7A A component of the system acceptance test plan to be monitored by the Contractor will be the testing of all grounding systems installed, or utilized, for equipment associated with this procurement. This includes grounding at all base stations, control stations, communications centers, and microwave terminal/ repeater sites associated with this procurement.

4.1.7B All grounding systems shall be tested using an AEMC or equivalent clamp-on ground resistance tester or Biddle 500V Null Megger or equal (3-terminal fall-of-potential method). The resistance to ground of all tie-in connections to the building's ground sources shall measure 5 Ohms or less.

4.1.7C Ground tests shall be conducted in the presence of a City installation representative, and results shall be recorded on a form approved by the City project manager. These forms shall be included as a part of the acceptance test documentation and are a component of final acceptance of the radio communications system.

Fully Compliant Partially Compliant Non-Compliant

4.2 Scope of Work

4.2A The Contractor shall be responsible for preparing plans and specifications for the following:

- ◆ Procurement or furnishing of all services, and furnishing and installing all materials, necessary to complete the site development work
- ◆ Submittal for approval, all details, cuts, plans, and drawings of sites, site related equipment, and security/access control systems
- ◆ Monitor disposal and removal from the site, of all debris and refuse that results from performing the work
- ◆ Applications for and obtaining all required permits, including FCC, FAA, building, electrical, soil disturbance, environmental, fire protection, or safety permits.
- ◆ Compliance with all applicable codes, ordinances, or regulations in accordance with the requirements set forth in the specifications

4.2.1 Sites at Which New Construction is Required

4.2.1A The City has provided a list of potential site locations in Volume 2 Section 3 Coverage Requirement. It is the desire of the City to locate sites, to the greatest extent practical, on property or existing tower sites that are owned by City entities.

4.2.1B The standard configuration for sites will be to:

- ◆ Serve as a base repeater site on the trunked radio system and a future wireless data system
- ◆ In some cases, to house NPSPAC mutual aid channel base repeaters
- ◆ To house conventional VHF or UHF base stations used for alerting or mutual aid purposes
- ◆ To support a ring microwave system, TELCO or leased fiber optic transport interface to interconnect the proposed sites
- ◆ To provide sufficient expansion capability to support future growth or new technologies.
- ◆ Sufficient additional space will be provided on the tower and in the radio equipment shelter to allow for future expansion of the trunked radio system and to permit additional uses by the City.

4.2.1C Generally the plans and specifications for site development work to be performed by the Contractor at each site consists of the following:

- ◆ Furnish and install an electronic equipment shelter and foundation
- ◆ Furnish and install a guyed or self supporting communications tower and necessary base and or guy foundations (as needed)
- ◆ Prepare plans for site civil improvements
- ◆ Install electrical service into the radio equipment shelter
- ◆ Construct concrete fuel tank pads, and walkways and ramps to the shelter entrance
- ◆ Perform site preparation and improvements, including road improvement, grading, installation of fencing, installation of grounding system, installation of a fuel supply for the emergency generator to be installed at the site
- ◆ Furnish and install a standby power generator, automatic transfer switch, and full fuel supply
- ◆ Furnish and install an uninterruptible power supply and or DC power system to provide power conditioning and standby service to critical electronic equipment
- ◆ Furnish and install site alarm system including sensors, transducers, detectors and contacts

- ◆ Furnish and install site access control system, closed circuit television system (CCTV)

4.2.2 Available Sites

- 4.2.2A The City prefers to use sites owned by the City with existing towers. If the existing towers will not work at a location that you wish to use in your configuration, then you shall include and detail the costs associated with removing the existing structure, if necessary, and constructing the new tower with your required specifications.
- 4.2.2B If there are no suitable tower sites owned by City entities in an area where a proposed site is needed, Proposers may propose a new site on undeveloped property. City owned properties are preferred in order to minimize cost.
- 4.2.2C Where undeveloped sites are chosen, the Contractor is responsible for preparing plans and specifications for all improvements needed at the sites. Improvements may include clearing, grading, drainage, erosion and sediment control, access road construction, design and construction of foundations for the radio equipment shelter, tower base or foundations, tower guy anchors, generator fuel tank pad, a sidewalk and ramp between the fence gate and the equipment shelter, installation of foliage control measures, and installation of steel gates across access roads. Installation of a chain link fence around the equipment shelter, towers, and around each guy anchoring point is required.
- 4.2.2D If there are no suitable properties owned by the City in an area where a site is required, Proposers may propose a new or commercial site for use. If a commercial site is proposed, the proposal shall include a description of initial and recurring site costs for a period of ten years from system acceptance. These costs will be factored into the proposal evaluation.
- 4.2.2E Site information provided in Section 2 of this document is accurate to the best of the City's knowledge. However, Proposers are responsible for verifying the particulars of any site included as part of their proposed system design.

4.2.3 Renovations and Upgrades

- 4.2.3A Depending on the final site selection and configuration, renovations will be required to support the new trunked radio system and the new ring microwave backbone system at each of the existing locations used in the proposed system.
- 4.2.3B Proposers are responsible for assessing tower suitability, and including necessary upgrade or replacement costs in their proposals. Proposers shall be required to propose new equipment shelters and generators at all sites used in the proposed new trunked radio system.
- 4.2.3C The following sections describe the function of, and intended scope of work at, each of the preferred sites. This information is provided in order for the Proposers to estimate the required effort needed to develop this radio system, and so that the proper Proposers' personnel may accompany the City staff on the site visits.

4.2.4 Electromagnetic Compatibility Studies

- 4.2.4A The Contractor is required to perform an Electromagnetic Compatibility study of each site at which equipment associated with this procurement will be installed. The study shall consider the effects of transmitter and receiver intermodulation, transmitter noise, and receiver desensitization between and among existing and proposed stations. The output of this study and recommendations shall be provided to the City for its review and approval, and shall be factored into the system design.
- 4.2.4B Any isolators, bandpass, band reject, crystal filter, lattice filters, relocation of base station or receiver antennas, or other measures required to minimize the effect of any potential interference shall be provided, including installation, by the Contractor.

4.2.5 Electromagnetic Emissions

- 4.2.5A All sites whether existing or proposed shall be designed, protected and posted by the Contractor to limit exposure to Electromagnetic Emissions (EME) in accordance with the Federal Communications Commission's (FCC) Bulletin OET-65 (Appendix D or most recent regulation adopted by the FCC), the Federal Communications Commission's exposure to Radio Frequency Electromagnetic Emissions.
- 4.2.5B The Proposer shall certify compliance with the Federal Communications Commission's (FCC) Bulletin OET-65 (Appendix D or most recent regulation adopted by the FCC). RF exposure limits at each site shall be evaluated, a paper study of the electromagnetic emissions produced by any or all of the antennas mounted thereon shall be conducted by the Proposer, verified and sealed by a Professional Registered Engineer licensed in the State of Texas who is experienced in non-ionizing electromagnetic radiation protection. The report will be submitted to the City of Houston Project Manager sixty (60) days of contract award. The City of Houston Project Manager will review all site EME studies to establish compliance with the Maximum Permissible Exposure (MPE) requirements of the FCC Bulletin OET-65, the Federal Communications Commission's exposure to Radio Frequency Electromagnetic Emissions.
- 4.2.5C The Proposer's study shall define the total radiation levels possible based on both the proposed and existing antennas at the site. The Proposer's study should verify that the expected levels are within the MPE levels as specified in the FCC Bulletin OET-65, the FCC Exposure to Radio Frequency Electromagnetic Emissions.
- 4.2.5D Should the study establish that the expected levels exceed the MPE, the Proposer shall bring the site into compliance at no additional cost to the City of Houston.
- 4.2.5E Under no circumstances shall the levels outside of the site boundaries (i.e., site fenced area) exceed the minimum exposure levels for public exposure.
- 4.2.5F After implementation, the Contractor shall be expected to provide the services and equipment necessary to their equipment's compliance with EME emission levels as stated in FCC Bulletin OET-65, the FCC Exposure to Radio Frequency Electromagnetic Emissions (RF EME), and the City of Houston Project Manager's RF Radiation Exposure Compliance Plan.

- 4.2.5G It is the City of Houston's position that the Proposer has an obligation to ensure that the equipment design and installation is done in a manner that will ensure compliance with the aforementioned regulations. The City of Houston is aware that the overall compliance with these regulations is their responsibility. However, the Proposer is expected to provide the City of Houston Project Manager with adequate paper study/studies required to make a suitable determination about compliance prior to system implementation.
- 4.2.5H The Proposer's is responsible for posting all required signs for identification of the various threats of exposure. Posting of required signs by the Proposer will be done only after the City of Houston Project Manager's review and approval. The City of Houston Project Manager desires that the Proposer, to the extent reasonably possible, restrict access to areas where the exposure levels warrant such actions.

Fully Compliant Partially Compliant Non-Compliant

4.3 Tower Site Work

- 4.3A The following tasks are specified for any site at which tower erection, modification, or equipment shelter installation is required:

4.3.1 Summary of Work

- 4.3.1A Plans and specifications for site work includes:

- ◆ Clearing, earthwork, excavating, backfilling, compacting and grading
- ◆ Construction of access roads and drainage, including installation of stone base and surfacing and erosion control measures
- ◆ Installation of fencing and security gates , CCTV camera systems and access control systems
- ◆ Foundation design and installation
- ◆ Delivery and installation of shelters, including sidewalks, ramps, grounding systems, security systems, and ancillary equipment.
- ◆ Delivery and installation of generators and fuel tanks, including filling of the fuel tanks.
- ◆ Construction of towers as specified, including soil exploration, geotechnical report, foundation design and construction, tower marking and lighting, grounding, and installation of antennas, transmission lines, cable ladders, waveguide bridges, anti-climbing devices, climbing ladders or step bolts, and related equipment.
- ◆ Coordinate installation of electrical power to the site

- ◆ Permits and approvals required for site work
- ◆ Coordinate telephone line installation

4.3.2 Stone Surfacing

4.3.2A The plans and specifications for site development prepared by the Contractor shall include the installation of stone surfacing within the fenced-in site area. Material shall be 1" broken stone with 10% binder material. Two layers of polypropylene liner shall be installed under the stone for foliage suppression. Prior to laying of any material, an EPA approved defoliant shall be applied over the area.

4.3.3 Fencing

4.3.3A The fence around the radio tower and equipment building will be replaced with fencing and gates as described below depending on the terrain and location.

4.3.3B The Contractor shall supply a perimeter fencing system complete with all hardware, posts, rails, unions, security mesh panels infill panels to be expanded metal, 3/4" x 9 ga, one (1) each walk through swing gate, one (1) each drive through slide gate and accessories necessary for a complete and aesthetically balanced installation. The fencing system and gates must come as a complete unit produced by a single manufacturer, including necessary erection accessories, fittings and fastenings. The perimeter fence must be a minimum of eight (8) feet tall plus coiled razor wire on top.

4.3.3C The slide gate entrances are to be controlled by a Doorking (9150) 110VAC gate operator with entrance gate access controlled by Access Specialties magnetic stripe card reader system.

4.3.3D The Contractor shall provide a fencing system design with the layout, locations, components, materials, dimensions, sizes, weights, finishes of components, installation and operational clearances, gate swings, post sizes, spacing and mesh type, gate details/dimensions, details of post anchorage, and post attachment/bracing. The design shall be certified by an engineer registered in the State of Texas. The fencing system, foundation and installation shall be engineered to withstand 90 mph wind load.

4.3.3E Fence posts shall be bonded to the site grounding system using an exothermic welding process (Cadweld).

4.3.3F The selected installation company must be trained and certified in the installation of all specified brands of equipment. The following specific equipment certifications are necessary:

- ◆ Payne Fence Products (Guardian Fence System Expanded Metal 3/4" #9)
- ◆ Access Specialties (Card Access Systems)
- ◆ Doorking Gates (Slide Gate Operators and Equipment)

4.3.4 Security Equipment Requirements

- 4.3.4A The Contractor shall provide additional security related equipment and services as necessary for the following:

Access Control

- 4.3.4B The sliding drive through entrance gates, the walk through swing gates and the doors entering the radio equipment building shall be controlled by Access Specialties card reader system. The access control system shall be installed in the radio equipment building with a dedicated phone line.

Intrusion Alarm System

- 4.3.4C There shall be motion detectors (Protech) mounted to detect any motion around the base of the radio tower, backside of the building, and fuel storage tanks. The output shall be connected to a timer relay that will sound a horn mounted to the radio equipment building and also trigger an alarm via dry contact closure.

Lighting

- 4.3.4D There shall be dual floodlights with motion detection mounted on all 4 corners of the radio equipment building facing down each side.

CCTV

- 4.3.4E There shall be 5 Pelco cameras (ICS110-CDV39A, High Res, Low Light DSS Color Integrated Mini Dome Surface-Pendant Mount Smoked Dome) with cameras mounted on each corner of the radio equipment building looking down each side and cameras looking at each entrance gate. They shall be recorded on a Sigmax DVR (DER-8120-640) installed in the radio equipment building. A Tripp Lite (UPS Smart 2200 Net) will be used for backup power and filtration of the DVR and the (Altronix) camera power supply.

Fully Compliant Partially Compliant Non-Compliant

4.4 Tower Specifications

4.4.1 Reference Standards

- 4.4.1A Unless otherwise modified herein, materials, design and construction procedures shall be in accordance with Electronic Industries Association (EIA) standard EIA-222-G (latest version), Federal Aviation Administration (FAA) Advisory Circular AC 70/7460-1K or latest version, concrete standards and all applicable local codes.

4.4.2 Submittals

- 4.4.2A The Contractor shall prepare and submit for approval plans, specifications, scale drawings of the tower depicting its overall height, the number and height of sections, the horizontal spread of each section, guy points (if applicable), antenna loading at specified heights and obstruction lighting details.
- 4.4.2B The Contractor shall submit for approval a profile view of the tower, containing structural details and engineering notes. Any documentation on the tower needed by the City for planning approvals shall be supplied in a timely manner.
- 4.4.2C Drawings shall be sealed by a Registered Professional Architect/Engineer (structural) licensed for practice in the State of Texas.

4.4.3 Antenna Towers

Materials

- 4.4.3A All steel materials used in the construction of the towers shall be new, shall be rated for their intended purpose, and shall conform to the provisions of EIA-222G with respect to physical properties, manufacture, workmanship and factory finishes.

Height

- 4.4.3B The Proposer shall identify tower heights, excluding appurtenances.

Loads and Stresses

- 4.4.3C The design of the tower shall take into account dead and live loads induced by the structure itself and all appurtenances, and all stress applied to the tower and its appurtenances by wind forces. The minimum safety factors listed on EIA-222G (latest version) shall apply under the most severe combination of dead load plus live loading.

Appurtenances

- 4.4.3D Appurtenances include, but are not limited to, the following: antennas, antenna mounts, antenna platforms, microwave antennas and radomes, lighting, transmission line, transmission line hangers, cable ladder, climbing ladder and safety device, lightning rods, conduit, waveguide bridge, lighting control, and ice shields.

Antenna & Transmission Line Loading

- 4.4.3E The towers shall be designed to support, at minimum, the antennas and transmission lines required by the system, plus the following:
- a. Two 800MHz BMR12 antennas at top with 1 5/8" transmission line
 - b. Four DB224 antennas mounted 75% to the top with 7/8" transmission line
 - c. Four DB410 antennas mounted 60% to the top with 7/8" transmission line

Wind Loading

- 4.4.3F The structures shall be designed for horizontal wind pressures induced by 120 MPH basic wind speed with all appurtenances installed. Wind loading shall be calculated per EIA-222G (latest version).

Ice Loading

- 4.4.3G The structures shall be designed per EIA-222G (latest version) to withstand additional horizontal wind pressures and dead loading produced by the accumulation of ½" thickness of radial ice.

Tower Twist, Sway and Displacement

- 4.4.3H Each tower shall be designed to meet twist, sway and displacement specifications for all loading conditions as recommended by EIA-222G (latest version) for the antennas specified.

TRANSMISSION LINE SUPPORT**Cable Ladder**

- 4.4.3I Transmission lines shall be installed to minimize tower face wind loading. Andrew Cluster Mount 207030 or equivalent shall be used. The cable support shall be of galvanized steel construction, and shall have mounting hardware of stainless steel or galvanized steel construction. No drilling of the tower legs or cross bracing shall be required to install the cable support device.
- 4.4.3J Transmission lines shall be attached to the transmission line cable support using stainless steel hangers and adapters of the appropriate size for the transmission line supplied. Andrew Model 206706-1,2,3,4 snap-in kits, or equivalent, shall be used to attach the cable to the transmission line support.
- 4.4.3K Transmission line shall be supported on the tower mount or ice bridge at intervals of not more than six feet, or as recommended for the wind speed design of the tower with ½" radial ice. (Andrew LDF5-50A, if used, shall be supported at intervals of 5.5 feet or less; LDF4-50A should be supported at intervals of three feet or less). Larger lines shall be supported per manufacturer's instructions.

Waveguide Bridge

- 4.4.3L A waveguide bridge/ice shield shall be installed between the tower and the equipment room/shelter to support transmission lines and to protect them from ice falling from the tower or antennas. The waveguide bridge shall be designed to accept support devices to properly attach the transmission lines at the intervals specified. The waveguide bridge shall be installed close to ground level, below 3' if practicable. The waveguide bridge shall be designed to match the height of the cable entry port on the equipment shelter. The waveguide bridge shall be supported by pipe columns if any horizontal span is 20 feet or greater, or if so required by local building codes. Galvanized steel construction shall be used for the waveguide bridge and its ancillary components. A grating type of waveguide bridge is required. Microflex waveguide cushions, hangers and crosses are the preferred method of attachment to the waveguide bridge.

LIGHTING AND CONTROLS

Lighting

- 4.4.3M The towers shall be lighted and/or marked in accordance with the applicable chapters of FAA Advisory Circular AC 70/7460-1K, or latest revision, as required by the particular Aeronautical Study performed by the FAA for each tower.

Controls

- 4.4.3N Activation of any required lighting systems shall be via a light sensitive, photoelectric type switch and controller which will activate the lights at dusk (or other cloud darkened condition) and extinguish the lights at sunrise. If a dual lighting system is required at any site, the controller shall automatically switch from red lights at sunrise to strobe lights, and back to red lights when the sky darkens.

Wiring

- 4.4.3O Wiring for the tower lighting shall be provided and installed in conformance with the lighting manufacturer's specifications and in accordance with local electrical codes. All cable ties used on the tower shall be stainless steel or Weather Resistant Black Acetal. Standard White or Black cable ties made of Nylon or Polypropylene shall not be used.

Bulb Failure Indications

- 4.4.3P The lighting control system shall be equipped to provide a single, form "C" dry contact closure alarm indication of bulb failure. Upon bulb failure, the alarm condition shall be reported by the master alarm system.

Ice Shields

- 4.4.3Q Each tower shall be equipped with steel mesh ice shields to be installed above each of the microwave antennas to protect them from falling ice. The ice shield shall cover the width and length of the microwave antenna it is intended to protect.

Climbing Ladder

- 4.4.3R The tower shall be provided with a climbing ladder, safety cable, and climbing belt. The climbing ladder shall be attached to tower legs in a manner that would not interfere with the installation or maintenance of antennas, or installation of additional transmission lines on the cable ladder. Similarly, the placement of cable ladder structures shall not interfere with the climbing facility. It shall be possible to lock-out the climbing facility to preclude unauthorized use. The climbing facilities shall meet all OSHA requirements.

Design Documentation

- 4.4.3S In accordance with ANSI/TIA-222G, complete plans, assembly drawings, or other documentation shall be supplied showing the necessary marking and details for the proper assembly and installation of the components, including the member sizes, design yield strength of the structural members and the grade of structural bolts required. Foundation reactions, when provided, shall be based on factored loads.

- 4.4.3T The tower plans shall detail attachment height, antenna quantity, antenna model or type, mount quantity, mount type and line size that was included in the structural analysis. Alternatively, the total effective projected area representative of all of the antennas and mounts at each elevation may be provided along with the associated line sizes.
- 4.4.3U The tower plans shall detail the following data for the site specified used in the structural analysis:
- ◆ Basic wind speed (3 second gusts, 50 year return period) without ice.
 - ◆ Basic wind speed (50 year return period) with ice.
 - ◆ Design ice thickness (50 year return period).
 - ◆ Exposure category (B, C or D) for the site specified.
 - ◆ Structure classification (I, II or III) used to classify the structure.
 - ◆ Topography category (1, 2, 3, 4 or 5).
 - ◆ Earthquake spectral response acceleration at short periods.
 - ◆ Foundation reactions for the loading combinations considered.
 - ◆ Soil design parameters or source of data.
- 4.4.3V The required tower design documentation shall be approved, signed, dated, and sealed by a registered Professional Engineer qualified and licensed to practice in the State of Texas law.
- 4.4.3W Upon completion of tower construction, the Contractor shall deliver to the City, three (3) complete original copies of the tower and foundation's as-built documentation, and two (3) copies in an electronic format compatible with AutoCAD 2007. Files shall be provided in Adobe PDF format, and in both DWF and DWG file formats.

Tower Manufacturer's Certification

- 4.4.3X All tower materials, hardware, and accessories shown on the plans and drawings shall be certified in writing by the tower manufacturer as being suitable for the purposes shown.
- 4.4.3Y The manufacturer's certification shall include the following statement:
- "These foundation designs meet or exceed all requirements of the City of Houston Request for a Citywide 700/800 MHz Trunked Radio System Request For Proposals No, S29-T22459 August 31, 2007," and ANSI/TIA-222G.*
- 4.4.3Z The foundation designs shall be approved, signed, dated, and sealed by a Registered Professional Engineer qualified and authorized pursuant to State of Texas law.

4.4.4 Scope of Work

Site Development Contractor Responsibility

- 4.4.4A The Contractor shall be responsible for providing the towers, installing suitable foundations and all furnishing and installing all associated hardware and appurtenances, for performing all planning and installation of the tower, and for site restoration and cleanup. The Contractor shall be responsible for ensuring that the tower meets all design criteria, labor services, guarantees and installation

requirements contained in the Proposer's specifications, or in national or industry standards to which such specification refers.

Purchaser's Responsibility

- 4.4.4B The City will provide an installation representative to coordinate field installation activities and to act as a liaison between the Contractor, and the property owner.

Scope

- 4.4.4C The work to be performed shall include site preparation, tower erection, installation of antennas, transmission lines, lighting systems, ice shields, climbing ladders, cable ladders, waveguide bridges, antenna support brackets, platforms, tower foundations, tower lighting controls, lightning rods, grounding systems, guy anchors (if applicable), and touch up of any nicks in the galvanizing or paint.

CONSTRUCTION

Soil Analysis

- 4.4.4D The Contractor is responsible for geotechnical exploration at the locations of each tower leg, tower foundation or guy anchor point. The soil analysis shall include field borings, laboratory testing, and a report containing a summary of the analysis with an evaluation and recommendations for structural foundations. The geotechnical investigation report shall include all information in accordance with ANSI/TIA-222-G, Annex G, Geotechnical Investigations (Normative). The report shall be generated and certified by a Registered Professional Engineer, licensed to practice in the State of Texas and qualified in the area of subsurface investigation and engineering evaluation.
- 4.4.4E The number of field borings to be performed at the site and their depths shall be appropriate for the antenna tower and loads described in this Statement of Work. In accordance with ANSI/TIA-22-G Annex G: Geotechnical Investigations.
- 4.4.4F This Annex contains information that shall be contained in the geotechnical investigation.

Boring logs and report shall provide:

- ◆ Date, sampling methods, number and type of samples
- ◆ Description of the soil strata according to the Unified Soil Classification System
- ◆ Depths at which strata changes occur referenced to a site benchmark elevation
- ◆ Standard Penetration Test blow counts for each soil layer
- ◆ Soil density for each soil layer
- ◆ Internal angle of friction for each soil layer
- ◆ Cohesion for each soil layer
- ◆ Ultimate bearing capacities for each soil layer or at the recommended bearing depth(s)
- ◆ For expansive soil conditions, the active zone of influence and recommendations for design

- ◆ Elevation of free water encountered and the ground water depth below grade to be considered for design
- ◆ Soil electrical resistivity, pH values and corrosive nature of soil
- ◆ Other pertinent soil design data and recommendations
- ◆ Recommendations for alternate foundation types
- ◆ Topographic information for the site
- ◆ Note the location within 1,000 ft (300 m) of the structure of underground pipelines, buried concentric neutral power wires and electrical substations as these may affect electrolytic corrosion.

For drilled piers the following information shall also be provided:

- ◆ Ultimate tip bearing capacity
- ◆ Ultimate skin friction for each soil layer
- ◆ Lateral modulus of soil reaction for each soil layer
- ◆ Ultimate soil strain at 50% of ultimate compression, ϵ_{50} , for each soil layer.

For rock anchors the following information shall also be provided:

- ◆ Type and condition of rock
- ◆ Rock quality designation, RQD
- ◆ Percent rock sample recovered
- ◆ Ultimate bond stress in the interface between the rock and grout
- ◆ Ultimate shear strength.

4.4.4G Three (3) paper copies of the soils report and 3 electronic copies shall be provided to the City.

Submittal Data and Notification Requirements

4.4.4H At no later than fifteen calendar days prior to foundation excavations for the tower, the Contractor shall deliver signed and sealed copies of all required tower structure and foundation design documentation. Three (3) paper copies and 3 electronic copies shall be provided to the City. The documentation shall be delivered to:

Chris Grasso
Radio System Project Manager
I.T. Department, Radio Communications Division
City of Houston
611 Walker, 8th Floor, Suite 938
Houston, Texas 77091
Tel: (832) 393-9613

4.4.4I These submittals are in addition to any documentation submittals that may be required by the local building official. The Contractor shall contact the City's local building official to determine what submittals are required.

Construction Notifications

- 4.4.4J For the tower structure, the Contractor shall notify the City as to construction status at the following times:
- ◆ Ten days prior to start of tower installation - notify as to the start date of construction and estimated completion date of construction.
 - ◆ The day the tower reaches the greatest height.
 - ◆ The day tower installation is completed.
 - ◆ A City of Houston building inspector is required to be present during concrete pours and sample retrieval. The Contractor is required to notify the City in advance when these tasks are scheduled.

Foundation Design

- 4.4.4K Proposed pricing for the foundation design will be assumed to be based on normal soil conditions.

Site Plan

- 4.4.4L A site plan shall be prepared for City approval for each site at which construction of a tower or installation of an equipment shelter is required. The Contractor shall install the tower and shelter in conformance with the site plan. The Contractor shall note that regardless of its size at the base, the tower shall be installed such that a minimum 10 foot spacing is maintained between the building and the tower face nearest the building.

Power

- 4.4.4M The Contractor shall be responsible for connecting to the commercial AC power at the meter. Temporary power may be required for the obstruction lighting on the tower during construction. The Site Development Contractor is responsible for arranging and installing this temporary power. FAA approved/required obstruction lights shall be installed while the tower is being erected.

FAA Notification

- 4.4.4N The Contractor shall be responsible for notifying the FAA of commencement of construction through the filing of appropriate forms. The Contractor is also responsible for notifying the FAA when the tower has reached its greatest height, and when tower construction has been completed. Copies of these notifications shall be provided to the City's Project Manager.

Painting

- 4.4.4O If an FAA Aeronautical Study requires any tower to be painted, the paint shall be applied at the factory and touch up painting is required at the site.
- 4.4.4P Touch-up galvanizing shall be done in dry weather. Galvanizing shall not be applied over wet surfaces.

Site Landscaping

- 4.4.4Q The tower contractor will be responsible for landscape grading and seeding of the disturbed soil.
- 4.4.4R If planning authorities require foliage screening or other plantings at the tower sites, the Contractor shall arrange for professional planting of the required species and quantities of trees or shrubs.
- 4.4.4S The Contractor shall restore the site to its original condition following construction and installation activities.

Fully Compliant Partially Compliant Non-Compliant

4.5 Shelter Specifications**4.5.1 General Description**

- 4.5.1A A prefabricated, bullet resistant, Electronic Equipment Shelter, foundation, and ancillary equipment shall be furnished as specified herein.

4.5.2 Reference Standards

- 4.5.2A Unless otherwise modified herein, materials, design and constructions procedures shall be in accordance with ANSI/NFPA-70, The National Electrical Code and all federal, state and local building codes.

4.5.3 Structural Requirements**Design Loading**

- 4.5.3A The equipment building floor shall be designed per ASCE 7-88 Uniform Distributed Load of 300 pounds per square foot. The equipment building roof shall be designed per ASCE 7-88 Roof Load Specification of 150 pounds per square foot. The equipment building wind loading specification shall be per ASCE 7-88 Basic Wind Speed Specifications of 120 MPH.

Foundation

- 4.5.3B The building foundation shall be concrete slab, and installed in compliance with local building codes. A concrete walkway shall be installed between the shelter entry door and the gate to the fence surrounding the shelter to allow equipment to be brought into the shelter on hand trucks without tracking mud into the building.

Flooring

- 4.5.3C The floor section shall be constructed of steel reinforced concrete. All surfaces shall be smooth. The interior floor surface shall be commercial grade asphalt tile. Base molding shall be installed around all perimeter walls.

Roof Section

- 4.5.3D The roof section of the equipment building shall be concrete with at least a 1/8" per foot drainage slope. Roofing shall be designed to prevent penetration by ice falling from the tower at the site. Proposers shall describe this roof protection in their proposals.
- 4.5.3E The roof shall be sloped to prevent accumulation of water. The roof section shall provide a 2" overhang on all sides. The roof shall be a cap and fit over the walls, leaving no exposed roof to wall joints.

Walls

- 4.5.3F The wall sections shall be steel reinforced solid concrete , 5000 PSI lightweight concrete is preferred. Construction shall be concrete aggregate exterior with Fireproof FRP interior walls. Interior walls shall be designed to allow mounting of electrical and electronic equipment using standard fasteners available from local hardware stores.

4.5.4 Shelter Features

Power

- 4.5.4A AC power shall enter the shelter through an entrance elbow, which can be rotated to accommodate connection to conduit from the power company feed. A main cutoff switch shall be provided inside the shelter, followed by a distribution panel, which provides for a minimum thirty branch circuit breakers.
- 4.5.4B The Equipment Room AC power shall be installed in EMT conduit with two duplex outlets mounted along the overhead cable ladder at the top of each equipment rack space, and at four foot intervals on each of the four interior walls of the equipment shelter (EMT conduit, grounded, duplex outlets). Each outlet shall be served on separate circuits. A minimum of two, or the minimum required by local electrical codes (whichever is greater) duplex outlets shall be installed in the generator room of the shelter. Also, an outdoor duplex outlet supported by the generator shall be provided near the shelter entrance.
- 4.5.4C All electronic equipment in the shelter shall be equipped with transient voltage suppressors. See Section 4.1.4 for detailed requirements.
- 4.5.4D Proposers shall be allowed to choose between a DC Power System or an Uninterruptible Power Supply (UPS) to power the proposed site equipment. In the event that a DC Power System is selected, a "small" UPS will still be required to support electrical outlets mounted at intervals in the equipment shelter. Such equipment might include telephone company provided. Power outlets supported by the UPS shall be orange in color.
- 4.5.4E Outlets protected by the generator only shall also be provided, for tools or test equipment that may be used at the site and potentially cause a UPS circuit to trip because of a ground fault situation. Circuits protected by the generator only shall be clearly marked by red outlets. One quad outlet shall be provided on each "long" wall of the shelter.

4.5.4F All electrical equipment supplied shall be UL listed. The entire electrical installation and wiring shall be in strict compliance with the latest approved edition of the National Electrical Code and all state, city, county and local codes and ordinances.

4.5.5 Specifications

Building Size

4.5.5A Radio equipment shelters shall be sized to house all the trunked radio site equipment and allow for substantial future growth. At a minimum the shelter shall have planned space for five (5) additional full height (19 inch wide equipment racks) or an additional 30% increase in the total number of equipment racks, whichever is greater. Ceiling height shall be a minimum of nine feet. A separate room shall be included for housing the standby generator described in Section 4.6.

Doors

4.5.5B There shall be two (2) exterior doors, which shall be of steel construction with a solid core. A door will be provided for entry into the equipment room and the second door for entry in to the generator room.

4.5.5C The door frames shall be 16 gauge galvanized steel, primed painted, and cast into the wall panel. The door entrances shall consist of an 40"x84"x1³/₄" 18-gauge galvanized steel, insulated, primed, painted brown and installed flush with door check, door stop, weather stripping and stainless steel ball bearing hinges. All exterior doors shall meet UL 752 Level 4 standards. The lockset shall be protected on the exterior by anti-prying plate. Hinges shall be tamper resistant to prevent removal of the pins from outside the building.

4.5.5D A drip awning shall be installed over each door to prevent water dripping into the building.

4.5.5E Both doors shall be equipped with an Access Specialties card reader system, a Best mortise lockset with a Rofu electric door strike and a single cylinder deadbolt lock. The access control system shall be fully configured to utilize the microwave or other T1 circuits at the site to provide remote monitoring and control from the site to the Houston Emergency Center. All radio equipment shelters shall be keyed the same. Five (5) sets of keys shall be provided to the City.

4.5.5F Doors shall be sealed using adjustable weather stripping, and an adjustable saddle.

Lighting

4.5.5G There shall be sufficient interior lighting to provide a level of 75 foot-candles at 3 feet above the floor. Fluorescent fixtures using two standard four-foot tubes per fixture shall provide interior light. The switch for the light fixtures shall be located inside and on the latch side of the entry door. Light fixtures shall be installed to the front and rear of electronic equipment racks to provide sufficient lighting for service personnel to perform equipment maintenance.

- 4.5.5H Exterior lighting shall be provided adjacent to the entry door to the shelter in a manner to avoid shading by the open door. A photoelectric switch that allows automatic illumination and extinguishment at twilight and sunrise shall control this lighting. Exterior lighting shall be heavy duty, shatter and tamper resistant.
- 4.5.5I There shall be four (4) dual weatherproof floodlights with motion detectors installed on the exterior shelter walls. Lights shall be installed so that they are facing down the wall.

A/C Power

- 4.5.5J The AC service shall be sized to accommodate the fully-loaded system (15 years) plus 30% reserve capacity.

HVAC

- 4.5.5K Low ambient temperature air conditioning equipment shall be provided. Electric heat strips or other devices shall be provided which will maintain the interior temperature of the shelter between 55 and 75 degrees Fahrenheit when outside temperatures range from -5 degrees Fahrenheit to 115 degrees Fahrenheit. Relative humidity shall be maintained at a level acceptable to the equipment to be furnished in this procurement, typically a range of 50% to 70% relative humidity
- 4.5.5L Shelters shall be equipped with a minimum of two (2) external vertical air conditioning units installed with a standard lead/lag controller to cycle between the two (2) units.
- 4.5.5M An auxiliary exhaust fan system shall be installed including motorized louvers, thermostat, timer, and hood with permanent expanded metal dust filter and exhaust insect screen in both the equipment and generator rooms.

Alarms

- 4.5.5N The following alarm inputs associated with the site shall be installed and connected to a Bosch Security Systems Intrusion Alarm System. Additional information on the sensors and detectors is provided in Section 4.3.4 (*Security Equipment Requirements*). The alarm system layout will be standardized for all shelters. The same alarm inputs shall also be connected to the separate alarm system described in section 2.4.2 of this document.
- Fire/Smoke Detector
 - Shelter Door Open Alarm (each door)
 - Site Gate Open Alarm (each gate)
 - Site Intrusion Alarm (multiple motion detectors as required)

Waveguide Entry

- 4.5.5O Waveguide openings, with modular wall/roof feed through plates shall be installed in the wall of the shelter adjacent to the waveguide/ice bridge from the tower, and in horizontal alignment with interior cable ladders arranged over the equipment rack space. The entry panel shall be a modular design, have a 1 hour fire rating for floor and wall penetrations, be water and gas pressure rated up to 4 bars. Roxtec G-Frame stainless steel multidiameter cable entry system or equivalent shall be provided. Sufficient entry ports shall be provided to support the proposed system plus 50%

growth. The feed through plate shall be equipped to seal the coaxial transmission lines to be supplied pursuant to this procurement. All unused entry ports shall be sealed.

Cable Tray

- 4.5.5P A cable tray with a minimum width of 12 inches shall be installed over all equipment rack spaces, and to the telephone equipment panel, and to any future equipment expansion space in the shelter. Cable tray sections shall be bonded to one another and to the building perimeter ground (split halo) by #2 AWG copper wire and compression fittings.

Security

- 4.5.5Q Security screens to prevent unauthorized entry shall protect all ventilation openings.

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4.6 Generator Specifications

- 4.6.A Plans and specifications for standby power generators shall be furnished by the Contractor at all sites to be constructed pursuant to this procurement. Generators shall be mounted indoors in a separate room in the electronic equipment shelters in accordance with the manufacturers' specifications for shock and vibration mounting, ventilation, cooling, fuel supply and electrical connections.

4.6.1 General Requirements

- 4.6.1A It shall be the responsibility of the Contractor to provide plans and specifications to install and test a complete and operational standby power generator and automatic transfer switch in each electronic equipment shelter to be supplied pursuant to this procurement. Equipment shall be new, factory tested @ 0.8 power factor for 3 hours, and shall be installed in the radio equipment shelter prior to delivery to the site.

Documentation

- 4.6.1B The following documentation shall be supplied to the City for each generator set and transfer switch supplied:
- ◆ Specification and data sheets for the exact type and model generator and transfer switch supplied pursuant to this procurement, including all options and accessories
 - ◆ Manufacturer's certification of prototype testing
 - ◆ Manufacturer's warranty documents
 - ◆ Shop drawings showing plan and elevation views of the equipment
 - ◆ Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner

- ◆ Manufacturer's installation instructions
- ◆ Operator's and maintenance manuals that outline routine maintenance and trouble shooting procedures
- ◆ Transfer switch manual and wiring diagram.
- ◆ The above documentation shall be included in each copy of the as-built documentation delivered to the City's Project Manager.

Warranty

- 4.6.1C A no deductible warranty, which provides for on site service by a factory authorized service contractor, shall be provided. This warranty shall provide coverage against all defects in materials and workmanship for a period of one (1) year from the radio system's final system acceptance.

Start Up Service

- 4.6.1D A factory authorized service representative shall provide initial start up service and shall conduct acceptance testing at each site at which the equipment is installed. Test records shall be furnished to the City in both printed and electronic format.

Type of Generator

- 4.6.1E The generators shall be driven by an engine that is liquid-cooled and capable of operating on liquefied petroleum gas (LPG). The generator shall be configured for indoor installation and shall be furnished complete with all accessories and equipment needed for the proper operation of the unit. These shall include, but not be limited to, starting batteries, battery racks, battery chargers, battery cables, cooling systems, residential grade exhaust silencers with exhaust pipes and rain caps, automatic load transfer controls, electrical surge protection, automatic frequency regulators, vibration isolators, fuel lines, fuel regulators, fuel filter/water separators, fuel storage tanks, conduits, junction boxes, wiring, instrument panels, remote alarm panels mounted inside equipment buildings, mounting bases, and fuel leakage detectors.

GENERATOR REQUIREMENTS

Ratings

- 4.6.1F Output power rating of the generator shall be sized to support the full forecasted load of the equipment shelter plus 30% reserve capacity.

Site conditions

- ◆ **Altitude**--2000 feet above mean sea level or less at each site
- ◆ **Ambient Temperatures**--Equipment to be mounted in an equipment shelter, which will maintain temperature in the generator room above 32 degrees Fahrenheit and below 120 degrees Fahrenheit.

- ◆ **Voltage Regulation**-- $\pm 2\%$ of rated voltage for constant load between no load and full load
- ◆ **Frequency Regulation**-- .5% from steady state no load to steady state rated load
- ◆ **Single Step Load Pickup**--100% of rated output power, less applicable derating factors, with the engine-generator at operating temperature.

Generator Set Control

4.6.1G The generator shall be an automatic and manual remote start type compatible with the automatic transfer switch to be supplied pursuant to this procurement. Manual starting and stopping shall be provided from the control panel and from the radio system master control site at the Houston Emergency Center.

- ◆ **Cranking control**—Shall provide a minimum of three cranking cycles of at least 15 seconds before lockout and activation of an overcrank alarm condition.

- ◆ **Generator Protection Controls**—(per NFPA 110)

4.6.1H The generators shall shut down and lock out upon:

- ◆ Failure to start (overcrank)
- ◆ Over speed
- ◆ Low lubricating oil pressure
- ◆ High engine temperature

4.6.1I Alarm contacts shall be provided to allow transmission of status on fault alarms for any of the above conditions, plus low oil pressure pre-warning, high coolant temperature pre-warning, low coolant, low fuel, an alarm indication when the generator set is running, and when the generator is on-line under load conditions. These alarm contacts shall be wired into and shall be reported by the alarm system being supplied pursuant to this procurement. Form C alarm contacts shall be provided and connected to the alarm system to report loss of AC power, low battery voltage, high battery voltage, and power on.

4.6.1J Meters shall be provided on the generator to indicate output voltage, output current, running time, frequency/RPM. An AC rheostat shall be supplied for voltage adjustment.

Fuel Supply

4.6.1K The generator set shall utilize liquefied petroleum gas (LPG) as a fuel source. Operation on liquefied petroleum gas shall utilize a liquid withdrawal system. The Contractor shall supply a new, grounded and fully painted, Liquefied Petroleum fuel storage tank to be installed in accordance with applicable codes and ordinances near the equipment shelter and it must be easily accessible for refueling. The fuel tank shall provide sufficient fuel to provide seven (7) days of continuous operation of the generator set at full load under low ambient temperature (0 degrees Fahrenheit). The tank shall be filled before conducting acceptance tests. Proposed fuel systems shall meet all applicable codes, standards and requirements for such systems.

- 4.6.1L All necessary supplies needed for an installation, which meets industry, local fire and building codes shall be furnished and installed. Fuel leak detectors if required shall provide alarm reporting at the Houston Emergency Center.

Exhaust System

- 4.6.1M A residential grade exhaust silencer shall be installed on the generator. The exhaust system shall exit the equipment shelter through a thimble, which protects the shelter from heat and vibration induced by the generator set. The exhaust system shall be protected to prevent radiated exhaust system heat from reaching dangerous levels within the shelter.

Battery and Charger

- 4.6.1N A lead acid starting battery rated for the engine type to be supplied shall be furnished and installed with the generator set. This battery shall be float charged by an appropriate sized voltage regulated charger, which is powered by 120 volts AC. Float, taper, and equalize charge settings shall be provided. The battery charger shall be located in the generator room.

Cooling System

- 4.6.1O A radiator-cooled engine is required. The radiator shall be filled with a water and coolant mixture in accordance with the engine manufacturer's recommendations. A flange shall be provided which shall be attached to a duct to the outside of the equipment shelter to exhaust engine heat. A motor driven air intake vent shall be supplied in the equipment shelter generator room which will automatically open on generator activation to provide cool air intake into the room at a volume sufficient to meet the generator manufacturers specifications.
- 4.6.1P A thermostatically controlled water jacket coolant heater shall be provided and installed in accordance with the manufacturer's recommendations.

Base

- 4.6.1Q The generator set shall be mounted on a heavy duty steel base which is anchored to the floor of the equipment shelter generator room. The base shall maintain alignment between generator set components and shall include vibration isolators.

4.6.2 Transfer Switch

- 4.6.2A An automatic transfer switch, which provides switching of the equipment shelter electrical load between commercial power and generator power, shall be supplied and installed for each generator set. The transfer switch shall be completely factory assembled and shall contain electronic controls designed for surge voltage isolation, with voltage sensors on all phases of both input power sources. Permanently attached manual control handles shall also be installed on the transfer switch. The switch shall provide positive mechanical and electrical interlocking and mechanically held contacts. Quick-make and quick-break contact mechanisms shall be provided for manual transfer under load.

- 4.6.2B The transfer switch shall be installed in a key locking, UL listed, NEMA cabinet to be mounted on a wall in the generator room of the electronic equipment shelter. The switch shall be fully wired and integrated with the engine generator set in accordance with local electrical and fire codes.
- 4.6.2C All transfer switches and accessories shall be U.L. listed and labeled, tested per U.L. Standard 1008 and CSA Approved.

General Specifications

- 4.6.2D Transfer switches shall be double throw, electrically and mechanically interlocked and mechanically held in both positions.
- 4.6.2E Main switch contacts shall be high pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishment. Arc chutes shall have insulating covers to prevent interphase flashover. Form C contacts shall be provided in each position for alarm reporting purposes. These contacts shall be connected to the alarm system for reporting transfer status.
- 4.6.2F The transfer switch shall be rated for continuous operation in ambient temperature ranges of -40 to +50 degrees Celsius. Transfer switches shall be rated to carry 100% of the rated current in the enclosure.

Automatic Controls

- 4.6.2G Transfer switch control shall be solid state and designed for a high level of immunity to power line surges and transients. The device shall be tested in accordance with IEEE Standard 587-1980 (or latest revision). Controls shall have optically isolated logic inputs, and isolation transformers for AC inputs. Relays shall be installed on all outputs.
- 4.6.2H Solid-state under voltage sensors shall simultaneously monitor all phases of the standby power source and the commercial power source. Pick up and drop out voltage settings shall be adjustable. Voltage sensors shall allow for adjustment to sense partial loss of voltage on any phase.
- 4.6.2I Controls shall be provided with solid-state over-voltage sensors, adjustable from 100-130% of nominal input voltage to monitor the source. An adjustable time delay shall be provided.
- 4.6.2J Automatic controls shall signal the engine-generator to start upon signal from normal source sensors. A time delay start, variable from at least 0 to 5 seconds, shall be provided to avoid nuisance start ups. Battery voltage starting contacts shall be gold, dry type contacts, which have been factory, wired to a field wiring terminal block.
- 4.6.2K The switch shall transfer when the emergency source reaches the set point voltage and frequency. A time delay shall be provided for transfer, which is variable from 0 to 120 seconds.
- 4.6.2L The switch shall retransfer the load to commercial power after time delay retransfer. This time delay shall be variable (adjustable) from 0 to 30 minutes to avoid short

engine run times. The retransfer time delay shall be immediately bypassed if the emergency generator fails.

- 4.6.2M A control shall automatically signal the engine generator to stop after a time delay, which shall be adjustable from at least 0 to 10 minutes, the time starting on return to commercial power.
- 4.6.2N Power for transfer operation shall be from the source to which the load is being transferred.
- 4.6.2O Diagnostic indicators shall be provided to allow the last successful step in the sequence of control functions to be pinpointed. The present status of the control functions shall also be indicated. These functions, at a minimum, shall include:
- ◆ Source 1 OK
 - ◆ Start generator set
 - ◆ Source 2 OK
 - ◆ Transfer timing
 - ◆ Transfer complete
 - ◆ Retransfer timing
 - ◆ Retransfer complete
 - ◆ Timing for stop

Front Panel Control Devices

- 4.6.2P A key operated selector switch shall be provided which will provide the following functions:
- ◆ **Test**—to simulate commercial power loss to allow testing of the generator set with or without transfer of the load.
 - ◆ **Normal**—leaves the switch in its normal operating position
 - ◆ **Retransfer**—a momentary position, which will provide an override of the retransfer time delay and cause immediate return to the commercial power source (if available).

Exerciser Clock

- 4.6.2Q The transfer switch shall be equipped with a programmable exerciser clock which allows setting the day, time and duration of a generator set exercise/test period. Tests under load or with no load shall be selectable.

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4.7 DC Power Systems

- 4.7A All repeater sites shall include either a DC Power System or an Uninterruptible Power Supply (UPS). The Proposer shall select between these two options based on the power requirements for their equipment, choosing the most reliable configuration. If a UPS is proposed, the Proposer shall describe the UPS's protection from inverter failures, internal switching failures, and any UPS malfunction that could cause the site to lose power.
- 4.7B Should a DC Power System be proposed, the repeater sites should operate from a 24 or 48 Volt DC power source. The master site and all repeater sites shall have battery plants sized for 4 hours of full operation with all equipment energized and all repeater channels continuously keyed. The master site shall sustain full operation for a minimum 4-hour period. All repeater sites proposed shall also have battery plants sized for 4-hour operations. A cost reduction option shall be proposed to reduce the backup operating time to 2 hours.
- 4.7C The battery systems shall utilize sealed lead-calcium cells and redundant charger components rated for telecommunication service. An automatic low voltage disconnect device shall be provided to protect the battery plants from discharge-related damage.
- 4.7D Repeater stations shall be housed in either open racks or, preferably, forced-air ventilated equipment cabinets. Cabinets, if proposed, shall be free standing and incorporate removable, hinged front and rear doors.
- 4.7E A maximum of four (4) DC operated repeater stations shall be housed in any equipment rack or cabinet. Each cabinet shall include redundant, metered DC/DC power converters sufficient to sustain the continuous operation of all four-repeater stations.
- 4.7F Each repeater station shall incorporate a fused power distribution panel incorporating protection for power amplifier, exciter and receiver groupings.
- 4.7G The cabinet ventilation fan, if required, shall be DC powered and thermostatically controlled.
- 4.7H Each equipment cabinet shall be protected by a separate DC-power circuit breaker.
- 4.7I The primary battery chargers, low voltage disconnect and DC circuit breaker panel shall be installed in freestanding open relay rack units.
- 4.7J Likewise, the simulcast system controller, console/audio controller and dispatch/system manager console modem equipment shall be housed in free standing ventilated equipment cabinets similar to those used for repeater stations.
- 4.7K Auxiliary site loads essential to proper system operation, i.e., tower-top preamp and receiver multicoupler, shall be interconnected to an inverter-protected AC power source.
- 4.7L The Contractor shall furnish plans and specifications to all materials and labor necessary to complete the installation of AC and DC power systems at all backbone sites.

Fully Compliant Partially Compliant Non-Compliant

4.8 Uninterruptible Power Supply (UPS) Specifications

- 4.8A All repeater sites shall include either a DC Power System or an Uninterruptible Power Supply (UPS). The Proposer shall select between these two options based on the power requirements for their equipment, choosing the most reliable configuration. If a UPS is proposed, the Proposer shall describe the UPS's protection from inverter failures, internal switching failures, and any UPS malfunction that could cause the site to lose power.
- 4.8B Should a UPS be proposed, plans and specifications for UPS systems shall be furnished by the Contractor for all other sites and at any site which is not equipped with an existing UPS or DC power supply.
- 4.8C The master site and all repeater sites that are proposed to have a UPS shall have the UPS sized for 4 hours of full operation with all equipment energized and all repeater channels continuously keyed. The master site shall sustain full operation for a minimum 4-hour period.
- 4.8D UPS systems shall have 4-hour battery back-up time with an option to reduce the backup operating time to 2 hours.
- 4.8E The UPS shall incorporate single or three phase (as appropriate) input and output over current protection. A maintenance bypass switch shall be provided, and UPS units shall also be wired with bypass switches, which allow the unit to be taken fully out of service allowing commercial power to be fed to the load. The system shall be "on-line" ferroresonant transformer technology or as an alternate static Pulse Width Modulated (PWM) technology. The UPS shall be UL 1778 and 1449 listed. Acceptable vendors are Best Power Technology Inc., or an approved equivalent.

4.8.1 General Requirements

- 4.8.1A It shall be the responsibility of the Contractor to provide plans and specifications to install and test a complete and operable UPS system in each electronic equipment shelter to be supplied pursuant to this procurement. Equipment shall be new; factory tested and shall be installed in the shelter prior to delivery to the site.

UPS Documentation

- 4.8.1B The following documentation shall be supplied to the City for each UPS supplied:
- ◆ Specification and data sheets depicting dimensions, weight, location of conduit entry, grounding and wiring requirements and details for bolting assembly frames to floor
 - ◆ Schematic wiring diagrams showing input and output protective devices and field connections, battery connections, interconnect wiring, controls and instruments

- Manufacturer's certified standard test data
- Manufacturer's warranty documents
- Manufacturer's installation instructions
- Manufacturer's Operating and Maintenance Manuals

UPS Warranty

- 4.8.1C A no deductible warranty, which provides for on site service by a factory authorized service contractor shall be provided. This warranty shall provide coverage against all defects in materials and workmanship for a period of two (2) years from the final system acceptance date of the radio communications system. The batteries shall be warranted for ten (10) years - prorated basis from the date of shipment.

UPS Start Up Service

- 4.8.1D A factory authorized service representative shall provide initial start up service and shall conduct acceptance testing at each site at which the UPS is installed. Test records shall be furnished to the City.

UPS Ratings

- 4.8.1E UPS shall be continuous, "On-Line, No-Break" static type employing the latest state-of-the-art solid state components incorporating microprocessor based Pulse Width Modulated (PWM) technology or ferroresonant transformer design. The UPS system shall consist of free standing cabinets consisting of a rectified section, inverter section, batteries, solid state transfer switch, isolation transformer, manual synchronized make-before-break bypass switch and input and output over current protective devices. Also included are all status and alarm displays, remote interface communicator (typically RS-232 type), control devices, meters, components, cabling and connectors. Alarm monitoring shall be provided at the UPS site and shall be remoted to the Houston Emergency Center.
- 4.8.1F UPS and associated components shall be housed in heavy-duty reinforced steel freestanding finished cabinets requiring front or side access. Batteries shall be housed in the UPS or if necessary, in a matching cabinet.
- 4.8.1G UPS rating shall be 240 volt \pm 10% single phase input and 120/240 \pm 3% single phase, three wire output, output frequency range of 0.01 Hz (or better), battery back-up time of approximately 120 minutes @ full load for 0.8 (lag) P.F. computer type loads. Temp. 0-40 degrees Celsius, Rel. Humidity 0-95% non-condensing, noise level: 60 dBA approx. @ 3' and noise reduction greater than 60 dB (normal mode) and 120 dB (common mode). UPSs shall be sized to support their designated loads, + 25% growth.

Description and Operation

- 4.8.1H The capacity of the solid state rectifier section shall be sufficient to maintain the battery in a fully-charged condition and continuously supply the required load through the inverter while floating the battery.
- 4.8.1I The system offered shall not include any switching device or devices which will interrupt the continuity of power in any way.

- 4.8.1J The output voltage of the UPS shall be maintained within $\pm 3\%$ over the nominal output voltage under any load conditions within UPS rating and ambient temperature range specified.
- 4.8.1K The sine wave output shall have a maximum of 5% total harmonic distortion over the entire range of output voltage at any load at any power factor.
- 4.8.1L Automatic Frequency regulation shall maintain the output frequency to within ± 0.1 Hz for all combinations of temperature, input voltage variation and load variation. The output shall not follow the reference source beyond $\pm 0.3\%$ Hz of nominal frequency. When input returns to normal, the UPS shall automatically synchronize to the line frequency.
- 4.8.1M The components shall be selected to provide sufficient voltage capability and ample current-carrying capacity to furnish reasonable margin for handling over-currents and minor voltage variations. In no case shall components be operated at more than 80% of the device's maximum steady state rating.
- 4.8.1N The UPS shall be capable of withstanding without failure, short circuit currents and surges of magnitude and duration in accordance with ANSI/IEEE Standard C62.41, categories A and B.
- 4.8.1O The UPS shall be capable of carrying 100% of the rated UPS output current continuously and shall be capable of carrying 125% of rated output current for approximately 10 minutes.
- 4.8.1P The system transient response shall be $\pm 5\%$ from nominal peak voltage for 100% load step. Voltage recovery shall be within 4 mSec. to $\pm 3\%$ of nominal voltage.
- 4.8.1Q The battery system shall be of the lead acid maintenance-free sealed, non-gaseous type with a minimum ten (10) year life.
- 4.8.1R The rectifier shall maintain a DC output voltage regulation of $\pm 1\%$ with a maximum of 2% RMS ripple. Rectifier shall be of the solid-state full wave SC bridge design to limit AC wave-shape distortion on the power system.
- 4.8.1S As a minimum, over current protection (10 KAIC circuit breakers or 100 KAIC C.L. Fuses) shall be provided for:
- ◆ AC Input
 - ◆ Rectifier Input
 - ◆ Inverter Input
 - ◆ AC Output
 - ◆ Battery Input

UPS Accessories

- 4.8.1T The following items shall be mounted on the instrument panel of the UPS cabinet via microprocessor based LED or equal display (including lights/meters) for the following characteristics:

- ◆ Mode Select Switch (UPS Normal, UPS Bypass & Battery Modes)
- ◆ Input AC Voltage
- ◆ Battery DC Voltage
- ◆ Rectifier DC Voltage
- ◆ Output AC Voltage
- ◆ Output AC Amperage
- ◆ Output AC Frequency
- ◆ Synchronizing verification
- ◆ Low Battery DC Voltage Indication
- ◆ Static Switch Position Indication
- ◆ Manual By-Pass Mode Indication
- ◆ Float-Equalize switch/timer DC Circuit Indication
- ◆ % Rated Load Indication
- ◆ Battery back-up time available in Minutes.

4.8.1U The following conditions shall have audible and visual alarms in addition to dry contacts that shall be connected to the alarm system by the Contractor:

- Low & High Battery Voltage
- Automatic Bypass Operation
- Emergency Operation (UPS on Battery)
- Rectifier/Inverter Failure
- Common Trip Alarm (form "C")

4.8.1V All external power and control connections shall be terminated on terminal blocks and identified clearly on wiring diagrams.

4.8.1W The UPS cabinet and battery cabinet (if not in UPS cabinet) shall be provided with a ¼" x 1" copper ground bus with mechanical type lug connector for City's #6-#1/0 AWG copper ground cable. UPS manufacturer shall indicate on applicable drawing(s) requirements for neutral-ground bonding per UL Listing qualifying as "Separately Delivered System" per NEC Art. 250.

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Section

5

Digital Ring Microwave System

5.1 General

- 5.1A The City of Houston is requiring that the Proposers include the design and cost for a complete microwave system to support the proposed trunked radio system. As a potential cost-saving measure, the City is also planning to solicit separately proposals for the connectivity portion of this project. Thus, Proposers are required to provide a "Cost-Reduction Option" in their pricing which deletes the proposed microwave.
- 5.1B The requirements stated herein represent a functional specification for a new multi-band, OC-3 SONET digital microwave communications network to support the 700/800 MHz digital, trunked radio system for the City of Houston as specified elsewhere in this document.
- 5.1C This section defines the technical requirements for the major equipment items comprising the digital microwave network. Minor equipment and hardware including wiring, connectors, cabling, fuses, circuit breakers, brackets, fasteners, power supplies, converters or conditioners, and other items which are necessary to provide a complete and fully functioning system shall also be furnished and installed by the Proposer.
- 5.1D All equipment furnished by the Contractor shall be new, meet the requirements of this specification and the manufacturers' published specifications, comply with all Federal, state, and county laws, rules, regulations, and ordinances, be in operable condition at the time of delivery, be finished (painted or surface treated in accordance with manufacturers' standard practices), reflect high quality workmanship throughout, and be suitable for the intended purposes delineated herein.
- 5.1E The Contractor shall be responsible for the design and delivery of the microwave system, as well as installation, optimization, and performance verification testing of the complete network.

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5.2 System requirements and configuration

5.2.1 Topology

- 5.2.1A The topology of the microwave system shall be designed by the Contractor to efficiently achieve the connectivity required by the proposed mobile radio system.

- 5.2.1B Full connectivity of all traffic shall be provided at the radio system master site (NOC), the Houston Emergency Center and the backup master site.
- 5.2.1C Although some spur paths are expected in the design, ring protection shall be used to the maximum extent practical to provide the greatest reliability and protection against catastrophic equipment failure or loss of a complete site.
- 5.2.1D Fiber optic cable may be incorporated into the microwave network design and implementation to the extent that 1) it meets all other requirements for connectivity, quality and availability and 2) its use is endorsed by the City of Houston.
- 5.2.2 Frequencies, bandwidths, licenses and technical parameters
- 5.2.2A Contractor shall develop a system layout and frequency plan which will provide the most reliable propagation using available frequencies, while appropriately considering rain fading characteristics of the various frequency bands in the Houston area.
- 5.2.2B Applications for frequency coordination and FCC (Federal Communications Commission) licensing for the microwave radio paths shall be prepared and filed by the Contractor. The results of the required frequency engineering analysis and the applications for FCC authorization shall be transmitted to the City of Houston for review and execution prior to filing with the FCC. Proposer shall be responsible for the cost of microwave frequency coordination and any FCC filing fees that may be imposed.
- 5.2.2C The RF paths planned for the digital microwave network shall utilize FCC Part 101 frequencies assigned for full-period service in available 6, 11 or 18 GHz frequency bands.
- 5.2.2D To the greatest extent possible, consideration shall be given to minimizing differences in product lines and equipment types while maximizing availability and performance.
- 5.2.2E Where ring protection is achieved, non-redundant radios may be provided, so long as the availability requirement is met.
- 5.2.2F Wherever ring protection is not provided, only frequencies not subject to rain outage shall be used and radios shall be configured as monitored hot standby (MHSB) or MHSB with space diversity, if required.
- 5.2.2G The system shall be designed with sufficient capacity to accommodate the channel requirements of the radio system plus a minimum of 40 percent growth to each site. Contractor shall provide a detailed channel plan for the microwave system.
- 5.2.2H The Proposer shall describe future system capacity expansion capabilities and expansion limitations for the proposed equipment.
- 5.2.2I The system shall support data rates ranging from OC3 down to DS0 to efficiently use the available spectrum and bandwidth, while meeting the capacity requirements of the interfaces with base radios, network control equipment and any other components or network resources that may be identified.

5.2.2J Where rings are planned, each ring shall be designed for a minimum of 99.9999% availability.

5.2.3 Path Design

5.2.3A Path design data shall be provided for all proposed paths. This shall include path profiles, reliability calculations, radio and antenna details, and all other supporting data

5.2.3B Proposer shall include a tree growth factor of 20 ft. to be added to measured tree heights at critical points along all microwave paths. Path profile data sheets included with final path engineering documents shall clearly denote the tree growth factor used at each critical point.

5.2.3C All paths in the system, including rings and spurs, shall be designed for a minimum one-way path reliability of 99.9999% per year using the Vigants model in TIA TSB-10-F. The 10⁻⁶ BER receiver threshold shall be used as the outage point.

5.2.3D All paths in the system, including spurs and rings, shall have a required long-term, unfaded RBER (residual bit error rate) of <10⁻¹¹.

5.2.3E All paths in the 11 and 18 GHz band and any band where rain outage is a significant factor, shall be designed for a minimum rain availability of 99.995% per year, using the parameters and methods of ITU-R Rec. P.530-11.

5.2.3F Contractor shall be responsible for the complete design of all microwave paths. If criteria other than those defined in this paragraph are proposed, Proposer shall provide in the proposal all specific differences and why those are being suggested in place of those following. For calculating path clearances on non-diversity paths or top dishes on space diversity paths, the worst case of 0.3 F1 @ K=2/3rds and F1 @ K=4/3rds shall be used. For diversity paths (top to bottom dishes) clearance shall be as provided for in ITU-R Rec. P.530-11.

5.2.4 Physical Path and Site Surveys

5.2.4A Contractor shall be responsible to perform physical path surveys to locate obstructions on the paths and to ensure that proper path clearances are maintained in the design. Contractor shall guarantee the paths clear of any and all obstructions.

5.2.4B Contractor shall be responsible to provide all personnel, maps, proper instrumentation and any other equipment or material necessary to perform the physical path and site surveys.

5.2.4C In executing the path surveys, if a particular location along the path is already developed with existing structures not likely to be rebuilt or extended/expanded, the Contractor shall state the pre-existence of these objects. Also, Contractor shall search for existing construction plans, permits, etc. for proposed structures along the projected path. If new structure(s) are proposed, the Contractor shall take the new construction into account in the microwave path calculations.

5.2.4D Contractor shall provide results of the physical path surveys on every path. These submittals shall provide, as a minimum, the following information:

- ◆ Verified site geodetic coordinates in NAD83 formats
 - ◆ Verified ground elevations along paths
 - ◆ Obstruction heights along microwave paths
 - ◆ Path profile characteristics, path clearances at critical points along the path, potential reflection points and natural/manmade shielding along the paths are to be identified /noted and discussed in detail
- 5.2.4E Contractor shall provide results of physical site surveys of every site. These submittals shall provide, as a minimum, the following information and material:
- ◆ Verified site geodetic coordinates in NAD83 formats
 - ◆ Verified site elevations
 - ◆ General site characteristics: access, nearest utility power location, soil conditions, surrounding land features, and optimum positioning for new towers
 - ◆ Location map plotted on USGS 7.5 min map
 - ◆ Proposed plot plan

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5.3 General Equipment Requirements for All Sites

- 5.3A All materials, design, and construction procedures shall be in accordance with all applicable federal, state and local building codes.
- 5.3B Redundancy of radios and each multiplexer (above channel bank level) shall be provided, down to the DS1 level, such that no single failure will disrupt more than a single DS1, assuming normal ring availability and operation.
- 5.3C Equipment to be used in the NOC and backup NOC shall be provided in racks to the maximum extent practical, except for alarm and control computers and monitors, which may be better suited for desk-top placement.
- 5.3D Shielding and filtering shall be provided to prevent interference from, or to, other radio frequency equipment installed near or in the vicinity of the proposed equipment. The equipment shall meet or exceed spurious frequency emissions, conducted or radiated, as outlined in Part 15 of the FCC Rules and Regulations, Subpart J, Class B Computing Devices. Equipment shall be operationally compatible with the following types of equipment located adjacent to the microwave radio:
- ◆ VHF Base/Mobile Stations
 - ◆ UHF Base/Mobile Stations

- ◆ 700/800 MHz Base Stations
 - ◆ VHF/UHF Hand-held Radios
 - ◆ DC Power Systems
- 5.3E Installation of all electrical equipment, power distribution, lighting and outlet assemblies, alarm and grounding systems, including associated wireways, and wiring, shall comply with the most recent edition of the following:
- ◆ National Electrical Code (NEC),
 - ◆ National Fire Protection Association (NFPA),
 - ◆ Occupational Safety and Health Administration (OSHA).
- 5.3F All electrical equipment and devices shall be listed, approved, or certified by Underwriters Laboratories (UL), or other Nationally Recognized Testing Lab (NRTL).
- 5.3G All microwave system equipment, microwave path design and construction shall comply with the latest editions of the following applicable rules, regulations, standards, and specifications:

Federal Communications Commission (FCC)

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

Bellcore Technical References and Advisories and Compatibility Bulletins:

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

American National Standards Institute (ANSI) and EIA/TIA standards:

- ◆ T1.105 – Digital Hierarchy Optical Interface Rates and Formats Specifications
- ◆ T1.106 Digital Hierarchy Optical Interface Specifications (single mode)
- ◆ T1.102 – North American Digital Hierarchy – Electrical Interfaces
- ◆ T1.313 – Electrical Protection for Telecommunications Central Offices and Similar Type Facilities
- ◆ T1.333 – Grounding and Bonding of Telecommunications Equipment
- ◆ T1.334 – Electrical Protection of Communications Towers and Associated Structures
- ◆ ANSI-J-STD-607-A-2002 _ Commercial Building Grounding and Bonding Requirements For Telecommunications
- ◆ T1.403 – Extended Superframe Format Interface Specification
- ◆ C37.90.1 – Surge Withstand Capability Tests
- ◆ C37.90.2 – Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers
- ◆ TIA/EIA-222 (latest version) – Structural Standards for Steel Antenna Towers and Antenna Supporting Structures
- ◆ RS-252- (latest version)– Standard Microwave Transmissions Systems
- ◆ TSB-10-F – Interference Criteria for Microwave systems
- ◆ EIA-195 (latest version)– Electrical and Mechanical Characteristics for Terrestrial Microwave Relay System Antennas and Passive Reflectors
- ◆ EIA- 210 (latest version)– Terminating and Signaling Equipment for Microwave Communications Systems
- ◆ EIA-310 (latest version)– Racks, Panels, and Associated Equipment

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5.4 Microwave Site Equipment Requirements

5.4.1 Common

5.4.1A All indoor equipment intended for operational microwave sites shall be provided in 7 foot tall, self-supporting, EIA standard, 19" equipment racks.

5.4.1B Each rack shall have a separate fuse panel with alarm and a ground bar.

5.4.1C Redundant equipment shall have dual, independent power feeds from separate circuit breakers to ensure that no single point of failure will cause a disruption of service.

5.4.1D All indoor microwave site equipment shall operate within the full specification requirements over a temperature range of 0° to 55° C with up to 95% humidity (non-condensing).

5.4.2 Microwave Radio Specifications

5.4.2A The equipment shall be designed and manufactured for continuous duty operation in a fixed station application, be of all solid state design, and have an expected operational service life of at least 15 years with proper maintenance and service.

5.4.2B All radios shall be compliant with FCC Rules and Regulations, Part 101 and type-accepted for its intended use, specifically including spectral density requirements.

5.4.2C MHSB receivers shall be provided with an asymmetrical RF directional coupler having less than 1 dB loss to the preferred receiver and 7-10 dB to the non-preferred receiver.

5.4.2D Switching between redundant receivers in MHSB or SD configurations shall employ hitless switching, causing no errors in the data throughput.

5.4.2E Microwave radios configured as MHSB (monitored hot standby), shall have the capability to automatically switch far end transmitters via a control signal through the reverse path when the BER of both receivers exceeds 10⁻⁵.

5.4.2F Radios configured for space diversity shall include an adjustment to equalize delay (DADE) for different waveguide lengths for space diversity antennas.

5.4.2G Minimum additional functional requirements for each microwave radio shall include:

- ◆ Forward error correction
- ◆ Time domain and slope equalizer
- ◆ Automatic Transmitter Power Control (ATPC)

5.4.3 Service channel and Orderwire

5.4.3A The digital service channel shall employ radio overhead or SONET overhead to permit a minimum of one (1) voice circuit and two (2) independent RS-232C data transmission circuits between all sites without consuming payload capacity.

5.4.3B The service channel shall be interconnected between radios to prevent loss of channel connectivity in the event of loss of any single spur or ring radio.

5.4.3C Each site shall be equipped with a complete orderwire / voice maintenance channel unit with selective call and "all-call" features, and including a speaker, ringer, and DTMF handset.

5.4.3D A PBX station interface shall be provided at the Houston Emergency Center to allow any orderwire station on any (assuming multiple independent rings) orderwire system

to be interconnected with other PBX station users. Interface shall be capable of both inbound and outbound calls.

5.4.4 Radio Control and Monitoring Functions

- 5.4.4A All microwave radios shall have local, on-site provisioning, control, and monitoring capability via a keypad, craft interface terminal or simple computer terminal provided at each site. This capability shall:
- 5.4.4.1A allow configuration of software-programmable radio parameters, monitoring of radio status and faults, and observation of various traffic performance measurements,
 - 5.4.4.1B provide access to the same information from any other radio at any site in the system, and
 - 5.4.4.1C Operate independently of the centralized SNMP network management system (NMS), specified elsewhere in this RFP.
- 5.4.4B Proposer shall supply a list of alarms, programmable parameters, and manner of access to for each type of microwave radio.
- 5.4.4C At least 16 (sixteen) external alarms and at least 8 (eight) external control points (for environmental alarm and control) shall be provided for each site, in addition to those internal ones employed for radio and SONET multiplex alarm and control. Each external alarm or control interface shall use a dry contact interface.
- 5.4.4D Radio status and performance information shall also be made available via an SNMP network management system (NMS), specified elsewhere in this RFP.

5.4.5 Multiplexers and access

- 5.4.5A A DSX access panel shall be provided at every microwave site and shall serve as the demarcation point between the microwave network and the radio system. The DSX panel shall provide access to every DS1 circuit dropped at the site, whether subsequently connected to a DS1 interface to another microwave radio, to a radio system base station, to a channel bank or to a router. Jacks for line, equipment and monitor shall be provided for each circuit, allowing for isolating and testing in either direction.
- 5.4.5B Sufficient quantity and stability of precise timing sources shall be provided and employed to ensure synchronization of all nodes in the system. Contractor shall explain in detail and show in a timing diagram where clock sources will be employed and how system synchronization will be achieved.
- 5.4.5C The SONET multiplexers shall have an SNMP network management system (NMS), specified elsewhere in this RFP, independent of, but similar to, the radio NMS.
- 5.4.5D Loopback test capability shall be provided at each site for each circuit and for each traffic speed accessible at that site. Loopback shall be controllable locally and from the remote end of a circuit, as well as via the SONET multiplexer and its NMS master.

5.4.6 DC Power System

- 5.4.6A All microwave site equipment (radios, alarm and multiplexers and excepting the waveguide dehydrator) shall be powered by a positive-ground, 48-volt battery system furnished by Contractor. Each system shall include batteries, battery rack or mounting hardware, float-type battery charger, low voltage disconnect, and DC load center.
- 5.4.6B The entire DC power system shall be sized to accommodate the number of electrical circuits and the electrical load of the equipment specified in this project plus a future growth of 50% of load and circuits.
- 5.4.6C Each battery charger shall:
- 5.4.6C1 Be modular and sized to power the full load (including the future growth identified above), as well as recharge a fully discharged battery in less than 24 hours.
 - 5.4.6C2 Have sufficient filtering and regulation to power all or any portion of the load without the need for batteries.
 - 5.4.6C3 Be provided with dual AC input circuits and circuit breakers (such that there will be no single point of failure), DC circuit breaker, DC voltmeter, DC current meter, current limiting and high voltage shutdown circuitry and continuous float voltage adjustment.
 - 5.4.6C4 Have separate dry-contact alarm points for, as a minimum, low voltage, high voltage, charger failure and loss of AC input.
 - 5.4.6C5 Operate from 208 or 240 VAC, as appropriate to the site installation.
 - 5.4.6C6 Employ redundant rectifier modules, provided on a 1:N basis, such that no single failure shall overload the remaining system, even with future growth included.
- 5.4.6D Each battery system shall:
- 5.4.6D1 be modular and of the stationary, sealed, valve-regulated, maintenance-free type
 - 5.4.6D2 be designed for a minimum 20-year life expectancy
 - 5.4.6D3 Have sufficient capacity to provide a minimum of 8-hours operation of the microwave station equipment including the future growth identified above.
 - 5.4.6D4 Include secure mounting rack or facilities and include protection from ruptured battery cells.
 - 5.4.6D5 Not require venting facilities or a special battery room.
- 5.4.6E A wall-mounted DC load center with circuit breakers shall be provided with the DC power system to provide protected DC distribution to all -48 VDC-powered equipment, including future growth.
- 5.4.6F An automatic low-voltage disconnect shall be provided to protect the batteries from over discharging.

5.4.7 Network Management Systems (NMS)

- 5.4.7A Two separate but parallel NMS's shall be provided, one for the radio network and one for the SONET multiplexers. Each NMS shall have at least two points of access to its respective operating radio or multiplex network, such that no single point of failure or ring operation shall disrupt communication between the masters and their respective operating equipment network.
- 5.4.7B Masters for each NMS shall be provided identically at 3 locations – the Houston Emergency Center, the primary NOC and the backup NOC.
- 5.4.7C Each master shall:
- 5.4.7C1 be powered by 120 VAC/60 Hz from a UPS provided by Proposer to carry the planned load for at least 4 hours,
 - 5.4.7C2 include dedicated PC's or workstations, each with full capability to easily and effectively view all system graphics, monitor the status of any alarms, and operate any control points on the system,
 - 5.4.7C3 contain graphical user interfaces (GUI's), views including, as a minimum, an overall system map, a site detail of each site and an equipment rack or subsystem, suitable for viewing details of individual equipment shelf or module status.
 - 5.4.7C4 Provide time-date-site-event logging and storage of individual alarm, fault or status changes with sufficient storage capacity to record all events for a period of at least 40 days,
 - 5.4.7C5 Include any and all PC's, monitors, mice, storage devices, servers, modems, routers, switches, cables, connectors, software and any other items or accessories necessary to make each master fully operational.
 - 5.4.7C6 Include software and hardware as needed for configuration and provisioning management as well as performance monitoring of its respective network,
- 5.4.7D The master at the Houston Emergency Center shall include long-term storage hardware and software tools for all logged alarms (separately for the radio and multiplex systems) to be stored for a minimum of 10 years, while allowing efficient searching and retrieval of events for trend and after-action event analysis.
- 5.4.7E In the proposal, Proposer shall:
- 5.4.7E1 List all alarms for each microwave radio type,
 - 5.4.7E2 List all alarms for the SONET multiplexer,
 - 5.4.7E3 Separately explain how the information will be transported to the masters from the radio and from the multiplex equipment,
 - 5.4.7E4 Explain how the information will be displayed on the respective masters,

- 5.4.7E5 List what equipment will be provided at the master sites.
- 5.4.7F All available alarms from ancillary and environmental alarms shall be wired to NMS remotes and configured into the NMS master for appropriate display and functioning. These alarms shall include, but not be limited to:
- ◆ Loss of AC power,
 - ◆ Low battery voltage,
 - ◆ High battery voltage,
 - ◆ Loss of waveguide pressure,
 - ◆ Fuse alarm for each rack,
 - ◆ Door open,
 - ◆ Tower light controller failure, if applicable,
 - ◆ High temperature building,
 - ◆ Low temperature building,
 - ◆ Smoke detector alarm
- 5.4.8 Antenna System Requirements
- 5.4.8A Microwave antennas shall be selected by Contractor and be FCC-Part 101-Category "A" compliant, parabolic dishes.
- 5.4.8B All microwave antennas, regardless of size and frequency band, shall be provided with protective radomes, standard four-inch pipe mounts, dual side struts and ice shields
- 5.4.8C Antennas, side struts, ice shield mounts, transmission lines and grounds shall be attached to the tower in accordance with the manufacturer's instructions and relevant EIA/TIA standards.
- 5.4.8D Antenna systems shall use standard waveguide sizes and rectangular flanges of a consistent type to the maximum extent practical, so as to minimize sparing and tool costs.
- 5.4.8E All transmission lines shall be either pressurized jacketed copper elliptical waveguide or jacketed copper coaxial cable in continuous lengths without splices and shall be installed in accordance with manufacturers' specifications.
- 5.4.8F Where transmission lines consist of elliptical waveguide, it shall be of premium quality, use pre-tuned connectors, and include rigid and flexible waveguide sections that provide a measurable return loss equal to or greater than 23 dB, as measured at the antenna port of the radio.
- 5.4.8G Flex waveguide shall not be used outdoors.
- 5.4.8H An AC-powered, automatic dehydrator of the mechanical, non-desiccant type, and all accessory equipment, including line monitoring for each waveguide and an overpressure relief valve, shall be provided for every microwave site with a pressurized feedline.

- 5.4.8I The dehydrator shall provide the necessary capacity for all of the waveguides and feedhorns with an anticipated leak rate of 1%, and provide sufficient capacity to maintain a stable pressure during a 19°C (35° F) temperature drop in 60 minutes.
- 5.4.8J All dehydrators shall provide dry contact alarms for at least low pressure, high humidity and excess run time alarms.

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5.5 Testing and Inspection Requirements

5.5.1 General

- 5.5.1A It shall be understood that the ultimate acceptance for the microwave system is its functional suitability to meet the operational requirements of the mobile radio system, which it was designed to support. That being the case, despite any testing, reviews, or demonstrations of the microwave system, acceptance or approval of it may be withdrawn or superseded at any time if operational requirements of the radio system are found unfulfilled by the microwave system. Those requirements may necessitate additional equipment or modification of the microwave system at any time that the then-current system is found lacking. Contractor shall make any and all such changes, as may be required at no cost to the City.
- 5.5.1B Within 60 calendar days after final radio system design, for every piece of equipment provided, the Contractor shall provide three (3) paper copies and three (3) electronic copies the following items for review by the City:
- ◆ Manufacturer's Product Literature,
 - ◆ Manufacturer's Performance Data Sheets,
 - ◆ Manufacturer's Published Standard Warranty,
 - ◆ Samples of all relevant manufacturer's standard factory test and inspection forms,
 - ◆ Complete Set of System Configuration Drawings, including an index listing,
 - ◆ Final Design Equipment List, organized by site,
 - ◆ Final Design Equipment List, organized in a sortable, Excel spreadsheet format with equipment line items as rows and site designations as columns.
- 5.5.1C The microwave system acceptance process consists of several steps, itemized as follows:
- ◆ Review final equipment list for each site, including description, OEM name, model number, quantity, software revision number,

- ◆ Review relevant manufacturer's standard factory test data sheets,
- ◆ Determine specifications to test or demonstrate and where each should be performed,
- ◆ Develop factory acceptance test (FAT) procedure,
- ◆ Develop field test procedure,
- ◆ Perform FAT procedure until confirmation of compliance is obtained,
- ◆ Perform field test procedures until confirmation of compliance is obtained,

5.5.1D Assuming that manufacturer's quality assurance program satisfies the City's requirements, redundant verification of manufacturer's standard production test measurements will not be required. However, some sampling, as directed and observed by the City, may be required and shall be accommodated by Contractor.

5.5.2 Factory Acceptance Testing (FAT)

5.5.2A The microwave system factory acceptance testing shall:

- ◆ Be set up as a single, completely interconnected and configured system simulation including all electronic equipment, specifically including all radios, multiplexers, and NMS equipment,
- ◆ Include simulated system conditions for hop-to-hop fade margins and end-to-end BER measurements,
- ◆ Demonstrate actual system equipment operation with various staged fault conditions of the operating NMS, radios and multiplexers,

5.5.2B Acceptance testing of the microwave system shall include, but not be limited to, the below list of specific tests and inspections. Each test shall be performed, at least once, whether as part of the manufacturer's manufacturing and quality assurance program or as part of this contract's FAT. Regardless of when performed, complete documentation of each test and its results, signed by the Contractor, shall be shipped with each corresponding piece of equipment.

5.5.2C Each alarm-generating test shall be verified to produce a corresponding alarm on the NMS and the craft interface terminal.

5.5.2D The results of the tests and the associated punch list of outstanding items for re-testing, if any, shall be signed by both parties and forwarded to the Buyer for review and acceptance. Any outstanding items shall be resolved within seven (7) working days and these items shall be re-tested. If the outstanding items have an effect on other previously performed tests, then re-testing of those tests shall also be included.

5.5.2E Specific test shall include:

DC power supplies

- ◆ Measure all accessible power supply voltages and verify compliance with manufacturer's published specifications,

Radios

- ◆ Verify radio nameplate/label and provisioning with system documentation,
- ◆ Receiver Checks: frequency, sensitivity, AGC calibration, MHSB switching, alarm verification to NMS,
- ◆ Transmitter Checks: frequency, power, MHSB switching, alarm verification to NMS,

Transmission Tests

- ◆ Orderwire levels and function, DTMF dialing – selective and all-call
- ◆ Reverse Channel Switch (MHSB only)

Multiplexers

- ◆ Verify provisioning with system documentation,
- ◆ Verify synchronization configurations,
- ◆ Test error-free operation of every DS1 line, as defined in system channel plan.

5.5.3 Microwave Field Testing

5.5.3A Complete documentation of Field Test results shall be provided upon completion of testing.

5.5.3B The following tests, in addition to other standard manufacturer's test procedures, shall be performed:

Antenna system:

5.5.3C Each path shall be aligned and tested to conform with engineering design and path survey calculations,

5.5.3D Each antenna waveguide shall be swept and plotted in accordance with manufacturer's specifications. Measured return loss shall be a minimum of 23 dB across the entire frequency band of interest.

5.5.3E Antenna waveguide shall be pressurized in accordance with manufacturer's specifications and leak down tests will be performed to ensure leak rate does not exceed manufacturer's specifications,

5.5.3F Verify waveguide pressure alarm to NMS master,

5.5.3G Verify the correct antenna sway brace and ice shield configurations,

5.5.3H Verify proper grounding and waveguide support

Power Plant:

5.5.3I Measure and record individual cell and power plant total output voltages

5.5.3J Set float voltage on charger

5.5.3K Set and verify alarm thresholds on battery charger in accordance with manufacturer's specifications. Verify alarm indication on NMS

Radios:

5.5.3L **Transmitter:** Measure and record transmit power and frequency; verify operation of ATPC, if and where used.

5.5.3M **Receiver:** Measure and record RF receiver local oscillator frequency; verify MHSB, and/or space diversity error-less receiver switching and operation of reverse path protection, as applicable

Overall RF system:

5.5.3N The fade margin of each path shall be measured to both the 10⁻⁶ and 10⁻³ BER thresholds and relevant AGC voltages and RSL readings recorded. Results shall be tabulated, compared with calculated predictions, summarized, and signed by Contractor's test team and submitted to the City for approval.

5.5.3O BER test shall be performed for 24 hours on each microwave hop

NMS:

5.5.3P Verify each environmental alarm from each site, specifically including: open door, AC power failure, high temperature, low temperature, smoke detector, battery charger failure, low waveguide pressure, tower light alarm, and fuse panel alarm, as applicable.

5.5.3Q Verify reporting to all NMS master sites.

5.5.3R Verify proper display, acknowledging, logging and storage of all alarms by each master

Multiplex, timing and synchronization:

5.5.3S Verify DS1 operation using BER test set at DSX demarcation points on a loopback basis, as well as a point-to-point basis from each site to ensure absence of timing problems.

5.5.3T Verify that synchronization is maintained on each DS1, equipped or unequipped

5.5.3U Verify operation of timing network in normal and backup (failed clock module) modes in all ring configurations

5.5.3V Verify proper automatic, alternate-route ring switching in all rings, as applicable

Total microwave system availability test

5.5.3W After completion of installation and all other testing, a 7-day period shall begin during which all equipment must perform failure-free.

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Section

6

Dispatch Consoles

6.1 Overview of New Dispatch Console Facilities

- 6.1A The purpose of this Section is to outline the requirements for the new dispatch console systems needed for this project. Proposers shall review the City's existing communications consoles and equipment at the City's current dispatch centers to familiarize themselves with the current console system environment.
- 6.1B This section describes a state-of-the-art IP network architecture based console system with GUI based operator and Supervisory positions that are "user friendly", highly reliable, and incorporate radio control in a manner that shall provide for efficient and simple operation by the dispatchers and department personnel in any combination of functions available. This Section sets the minimum performance standards for the dispatch systems and operation. The proposed system shall provide all of the necessary functions to control and monitor the radio system and related subsystems.
- 6.1C All proposed dispatch console systems shall be a high-tier product specifically designed for use in a large-scale urbanized Public Safety / Mission Critical environment and shall be modularly expandable to support expected City growth. The systems shall be fully compatible with the associated Project 25 based trunked radio system infrastructure. The console systems proposed shall be configured to provide continuous 24 hour non-stop full-featured operation utilizing the latest proven console system technology.
- 6.1D The console system shall incorporate redundancy in critical areas that can negatively impact operations if equipment or communication links failures occur. Connectivity between the console systems and the radio system's primary and backup Master Network Controllers (MNCs) shall be fully redundant with diverse routing and automatic fault restoration so that loss of a link between the MNCs and the console systems will not impact dispatch operations. The Proposer is responsible for providing the required IP connectivity.
- 6.1E The console system shall be modularly expandable and provide for future radio system expansion needs in the most efficient and flexible manner possible.

6.1.1 Houston Emergency Center

Police and Fire Dispatch

- 6.1.1A The City of Houston's public safety answering point (PSAP) and Police and Fire dispatch centers are located within the Houston Emergency Center at 5320 North Sheppard St..

Figure 6.1.1A - Houston Emergency Center



- 6.1.1B The Houston Emergency Center is currently equipped with a large sophisticated redundant IPC (formerly Orbacom) conventional T-5 console system which has been upgraded over the past four years as needed. As part of this project, the IPC system will be replaced with a new IP based trunked dispatch console system that is fully compatible with the new proposed trunked radio infrastructure.
- 6.1.1C For maintenance support, each of the system's two Prime Sites that support the Master Network Controllers (MNCs) shall be equipped with one (1) full-featured IP based radio dispatch operation position. These consoles shall be based on the same console product proposed for the Police and Fire dispatch areas at the HEC. Console furniture is not required.
- 6.1.1D The proposed console system shall be IP based and must be configured with a truly redundant architecture to provide continuous non-stop operation. There are currently redundant mirror-image equipment rooms in place in different locations within the HEC for the console infrastructure electronics. Uninterruptible AC power is already provided at the facility in the equipment rooms and in the dispatch center. Additional UPS systems for the HEC consoles are not needed. Grounding facilities in the equipment rooms have recently been upgraded to meet Motorola's R-56 grounding standards.
- 6.1.1E The console equipment rooms and the actual dispatch console operator positions are located on separate floors within the facility. The City will conduct a site tour of the HEC dispatch center and associated equipment rooms to provide Proposers an opportunity to view the existing layout and facilities. The HEC facility is a secured access facility. Each Proposer wanting to tour the console facilities must sign up for the tour and provide the City with a list of attendees for the site tour at least one week prior to the tour date. The City reserves the right to deny site access to anyone. The City contact for the site tour is Mr. Doug Moore at (713) 247-1073. Each proposer will be limited to no more than five (5) personnel for the tour.
- 6.1.1F The HEC facility in its entirety is relatively new and the dispatch console furniture currently in place will remain in use with the new radio system. Transitioning from one radio and console system to another will require careful planning. Due to good planning during the original design of the HEC facility, there is currently empty rack

space available in the HEC equipment rooms, some of which is tentatively earmarked to support the new console infrastructure electronics. There are also other City initiatives that may utilize some of the rack space in the equipment room, therefore Proposers shall identify the amount of rack space needed to support the initial console operations as well as the future expansion defined in the following paragraphs. Proposals shall include scaled detailed rack space drawings of the equipment room identifying what equipment will be installed to support the proposed console system. Drawings shall be provided in AutoCAD or Microsoft Visio format. As discussed elsewhere in this RFP, electronic copies of drawings shall be provided in addition to printed versions.

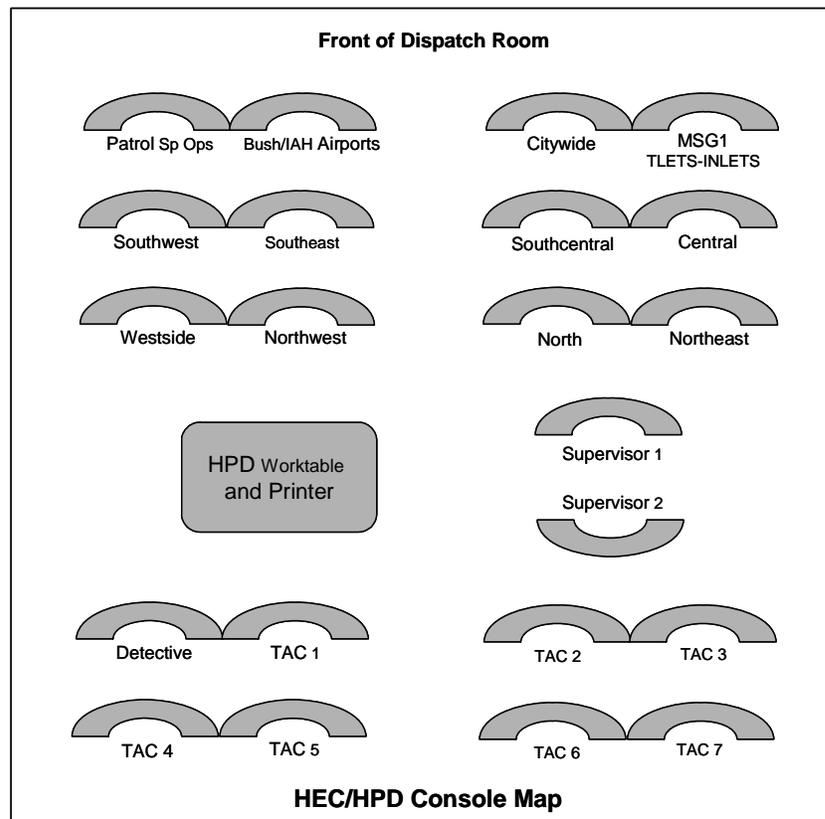
- 6.1.1G The existing console furniture utilizes special LCD display mounting techniques for dispatch screens. Proposers should pay special attention to the current mounting arrangement during the HEC site tour. The existing LCD displays have internal power supplies due to a shortage of space for external power supplies.
- 6.1.1H The console system routers, switches and control equipment will be located on a different floor of the HEC facility than the dispatch operator positions. Cabling runs between the equipment room and the current dispatch operator positions are lengthy and should be noted during the site tour. Video display image quality at the dispatch operator and Supervisory positions is of significant concern to the City. System designs that provide poor, fuzzy, or blurred display images at the operator, Supervisory, and training console positions shall not be acceptable.
- 6.1.1I The City of Houston plans to develop a backup Police/Fire dispatch facility at an undisclosed location in the near future. Consequently, a separate backup Police / Fire dispatch console system will be required. For the purposes of the backup facility, a redundant set of mirror-image Police and Fire dispatch operator positions shall be proposed for the backup facility, utilizing the same console product proposed for use at the HEC. The backup consoles shall provide the same functionality as the primary consoles but will operate independently of those at the HEC and shall be capable of full operation regardless of loss of the console infrastructure at the HEC. Because the location of the backup dispatch facility is not currently available, the Proposer is not currently responsible for providing the IP connectivity to the backup location.
- 6.1.1J Console furniture shall not be proposed for the backup location. The backup consoles shall be capable of full-featured independent operation from the console facilities to be located at the HEC. Proposed pricing for the backup console system shall be provided as a "delete option", priced as a separate line item from the HEC console system so that the City team can assess the cost of the network based backup console system.

Police Dispatch Consoles

- 6.1.1K The HPD area within the dispatch center is equipped with twenty-two (22) dispatch workstations, of which twenty (20) are currently equipped with radio dispatch console equipment. For the purposes of your proposal, twenty (20) new radio dispatch positions shall be proposed. The remaining fifteen (15) furniture positions currently support overload work situations, as well as provide redundant work stations in the event that one or more of the operator positions suffer a non-radio equipment problem.

- 6.1.1L The Police dispatch console system at the HEC shall be expandable to accommodate an additional fifteen (15) radio dispatch operator positions without a major console upgrade.
- 6.1.1M The existing HPD dispatch console positions include the following:
- ◆ Northeast
 - ◆ North Shepherd (or North)
 - ◆ Northwest
 - ◆ Westside
 - ◆ Central
 - ◆ South Central
 - ◆ Southeast
 - ◆ Southwest
 - ◆ Detective
 - ◆ Bush and Hobby
 - ◆ Special Operations
 - ◆ Police Supervisor 1
 - ◆ Police Supervisor 2
 - ◆ Citywide
 - ◆ MSG1 (TLETS and NLETS)
- 6.1.1N All positions shall be capable of being programmed for full-featured operation on any of the trunked talkgroups incorporated into the City's system, with proper management approval.
- 6.1.1O HPD currently operates two remote dispatch positions on the 19th floor of the Police Administration building located downtown at 1200 Travis St. These positions are old and as part of this procurement, will be replaced with two (2) new full-featured dispatch operator positions configured like the HEC HPD dispatch operator positions. The selected vendor will be responsible for providing the IP connectivity for these remote operator positions.
- 6.1.1P Figure 6.1.1B that follows represents what the 20 new console positions layout should consist of for HPD dispatch.

Figure 6.1.1B



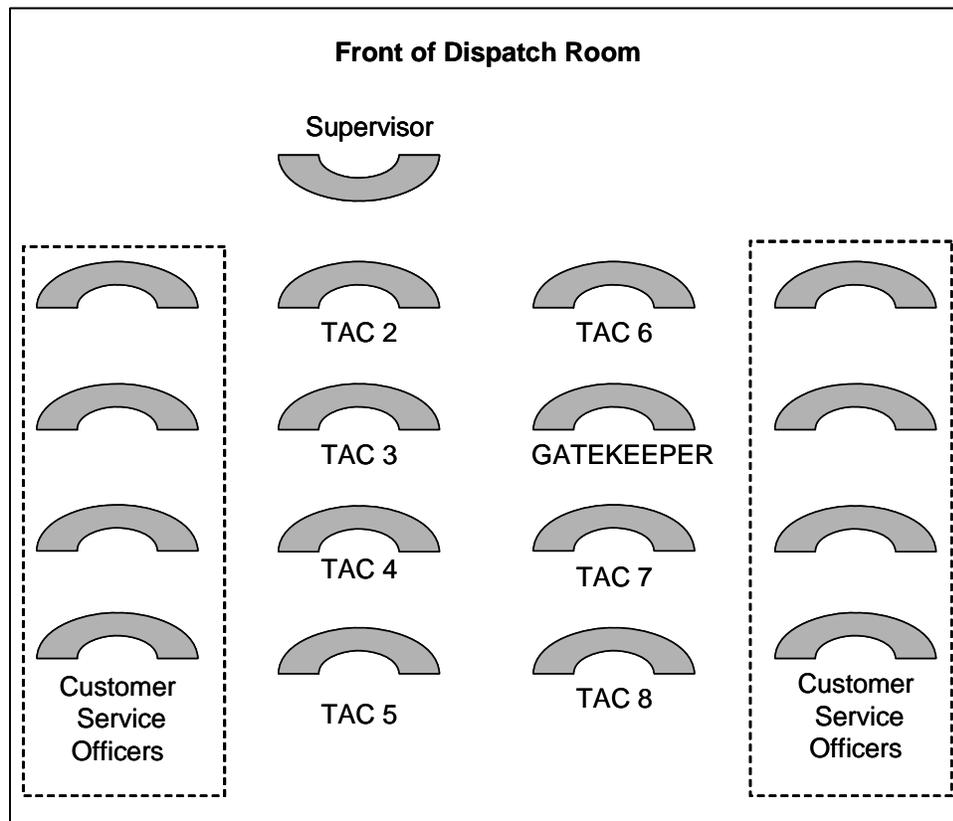
Fire Dispatch Consoles

6.1.1Q The Fire Department currently operates nine (9) radio dispatch positions at the Houston Emergency Center (HEC) which are configured identically with the exception of the Supervisor's console. This symmetry provides redundancy in case an operator position fails, allowing any position to be used to support any Fire/EMS dispatching need. The nine positions are designated as follows:

- ◆ **Position 1** - Citywide Fire Dispatch channel
- ◆ **Position 2** - Citywide Primary Tactical channel
- ◆ **Position 3** - Citywide Primary Tactical channel
- ◆ **Position 4** – Citywide Primary Tactical channel
- ◆ **Position 5** – Citywide Secondary Tactical channel
- ◆ **Position 6** – Citywide Administrative/Tactical channel
- ◆ **Position 7** – Citywide Secondary Tactical channel
- ◆ **Position 8** – City Secondary Tactical channel
- ◆ **Position 9** – Supervisor

6.1.1R As part of this project, the Fire Department will be expanding the number of dispatch operator positions from 9 to 22. Twenty-two (22) dispatch operator positions shall be provided initially, with a future growth expandability of eleven (11) additional operator positions in the Fire Dispatch area at the HEC.

Figure 6.1.1C - Fire Dispatch Positions



- 6.1.1S In the new Fire dispatch console system, all positions shall be capable of being programmed for full-featured operation on any of the trunked system talkgroups incorporated into the City's system, with proper management approval. The Fire dispatch console system at HEC shall be expandable to accommodate an additional eleven (11) radio dispatch operator positions without a major console upgrade.
- 6.1.1T The Fire Department currently operates two remote dispatch positions at the Fire Administration building located downtown at 1205 Dart Street. These positions are old and as part of this procurement, will be replaced with two (2) new full-featured dispatch operator positions configured like the HEC HFD dispatch operator positions. The selected Contractor will be responsible for providing the IP connectivity for these remote operator positions.
- 6.1.1U The Fire Department is developing a new Telemetry Room on the first floor at the HEC. Nine (9) full-featured radio dispatch operator positions shall be proposed for installation in the new Telemetry Room. Future expansion capability for this room shall allow for the addition of five (5) additional radio dispatch operator positions. These dispatch operator positions shall be based on the same product family as the Fire consoles in the Fire Dispatch area at the HEC. The Proposer shall be responsible for providing the IP connectivity to these consoles. No console furniture is required for these consoles. No additional UPS power is required for these consoles.

Training Consoles at HEC

- 6.1.1V The City operates a Police/Fire dispatcher training facility at the HEC which is currently equipped with CAD/RMS work stations. The City wants to add a radio dispatch operator position at each training position. A total of twelve (12) training positions shall be initially proposed with potential expansion of an additional six (6) positions at a later date. Training consoles shall be based on the same product family as the HEC HPD and HFD dispatch consoles. The Proposer shall be responsible for providing the IP connectivity for these consoles.

Public Works & Engineering – Public Utilities Division Dispatch

- 6.1.1W The City's Public Utilities Division dispatch center is located at 7101 Renwick and is equipped with a relatively new Motorola CentraCom Gold Elite console system which is linked to the City's PW&E SmartNet trunked radio system by RF control stations. In July 2006 the Utilities Maintenance Branch of the Public Utilities Division completely renovated their dispatch center at the Renwick Drive facility. The dispatch center is now equipped with twelve (12) Motorola Centracom Gold dispatch consoles and a new logging recorder. The console system's Central Electronics Bank (CEB) is located on-site. This is the primary dispatch location for all of the Utilities Maintenance sections which includes the following sections:

- ◆ Repair
- ◆ Landscaping
- ◆ Concrete
- ◆ Heavy Construction
- ◆ Valves
- ◆ Stoppage.

- 6.1.1X The dispatch center operates 24/7 with a staff of 12 people during the day and a 2 people at night. The radio dispatch positions are all identically configured with the same channel control windows so that any position can be used by any dispatcher when necessary. For the purposes of proposal development, and to provide improved functionality and control, the Public Utilities console system shall be replaced with a new IP based, network interfaced console system from the same product family as the Police and Fire console system at HEC. There is an existing UPS system at this location. A new UPS is not needed.
- 6.1.1Y The City may ultimately reuse the current Public Utilities console system with trunked control stations for the system interface. That final decision will be made after an evaluation of the system proposals and associated costs has been completed.
- 6.1.1Z The City's Waste Water Division currently operates two radio dispatch positions at their facility on Groveway Street. These positions shall be replaced with two (2) full-featured IP based dispatch operator positions based on the same product family as the HEC console positions. Console furniture is not needed at this location. The Proposer will be responsible for providing the IP connectivity to this location.

6.2 Radio Dispatch Console Requirements

6.2A This section sets the minimum performance standards for dispatch systems consisting of numerous dispatch consoles and associated hardware, software, equipment enclosures and control electronics. The equipment shall provide all of the necessary functions to control and monitor two-way conventional base stations, repeaters, the trunked simulcast radio system and related subsystems. The console system shall be capable of facilitating reasonable future radio system expansion needs in the most efficient and flexible manner possible.

6.2B Note: The term "channel" is used in this Section to refer to talkgroups within the trunked radio system or conventional channels.

6.2.1 System Architecture

6.2.1A The system architecture shall consist of two main components: a redundant, IP based electronics control package and dispatch operator consoles which share the electronics package. The console electronics shall use a distributed IP based multi-processor concept and shall employ a physical architecture that consists of electronic assemblies housing servers, routers, LAN/WAN gear, conventional channel interfaces, logging and instant recall recorder connectivity, dispatch operator positions, radio equipment (as appropriate) and auxiliary function interface modules. All circuitry contained in the radio control, signaling and audio amplification sections of the console shall be solid state and shall be microprocessor controlled. Both the Police and Fire dispatch centers shall be supported by on-site control stations to facilitate backup recording and backup control station usage.

6.2.1B Each console operator position shall be PC based and have its own dedicated microprocessor controller board, as shall every radio and control interface in the system. All system audio shall be digitally encoded using time division multiplexing (TDM) and digital signal processing (DSP) techniques. The system shall continuously run digital and audio diagnostics to verify and assure proper performance and shall be capable of automatically taking corrective action to restore proper operation should a failure be detected.

6.2.1C Software used to determine the various functions to be performed by the console shall be field programmable. Firmware or software used to determine the various functions to be performed by the console system shall be field programmable by the use of electrically alterable non-volatile technology (EE Proms). Adding/deleting channels, and changing channel names, shall be programmable without replacing UV erasing circuits.

6.2.1D All line interface and console supporting electronics shall be installed into standard 19" EIA racks. All circuit cards shall have routine adjustment controls, such as line input and output levels, conveniently accessible for adjustments.

6.2.2 Quality

6.2.2A All equipment shall conform to industry standards to be of the highest quality and reliability. All materials shall be new (not previously sold or refurbished) and shall be

the best of their respective kinds, free of corrosion, dust, scratches, indentations or other such defects. The design and construction of the communications consoles and related equipment shall be performed in a neat and craftsman like manner and shall be consistent with professional engineering and installation practices.

6.2.3 Standards

6.2.3A All equipment shall meet or exceed the latest applicable standards of the FCC, EIA, NEC, IEEE, APCO Project 16B and APCO Project 25. In addition, the equipment shall conform to the requirements of the local telephone company with respect to the audio levels and control voltages that may be applied on telephone company lines. Proposers shall certify that the equipment being offered meets or exceeds all of the specified requirements.

6.2.4 State-Of-The-Art Design

6.2.4A The equipment proposed shall reflect the state-of-the-art in console system design. The offering shall only include items, which will be in full production in conformance with the City's project schedule. The City anticipates operating the console systems provided for this procurement for at least 10 years without a major console system upgrade or replacement.

6.2.5 Console System Life Cycle

6.2.5A The proposal shall include a detailed explanation of the proposed console system's product life cycle including console infrastructure components and operator positions. The proposal shall clearly identify where the system proposed for the City of Houston falls within the system's life cycle and clearly identify the expected lifetime of the proposed console system for the City of Houston. Products that are approaching the end of their life cycle shall not be proposed since they will face declining vendor support prematurely.

6.2.6 Agency Partitioning

6.2.6A The console system shall allow multiple agencies to share a common system while maintaining full control over and functional operation of their respective resources.

6.2.7 Centralized System Configuration

6.2.7A The console system shall allow all console configuration to be done at a single location with system changes automatically distributed across the system.

6.2.8 Centralized Fault Management

6.2.8A The console system shall provide for robust system fault management from a centralized location at the HEC. Secondary remote fault management from an alternate location such as a centralized system maintenance facility shall also be provided. Remote fault maintenance shall be protected from unauthorized access without proper credentials and security clearances.

6.2.9 Trunking Compatibility

6.2.9A The console system shall be compatible with the trunked radio system specified, meeting all applicable standards of APCO Project 16B and APCO Project 25 in effect at the time of proposal submission. The console system shall directly interface with the proposed trunked radio infrastructure at the network level and shall provide redundant, monitored network connectivity between the radio infrastructure and the console system.

6.2.10 Conventional Analog Channel Support

6.2.10A The console system shall support conventional analog channels to facilitate radio interoperability with a variety of outside agencies. A conventional station gateway shall be incorporated into the system that will interface with conventional base stations / repeaters and translate their audio into and out of an IP format. The gateway shall provide support for a 4 wire E&M interface for analog audio sources. The system shall be initially configured to support a minimum of ninety-five (95) analog sources, as follows:

- ◆ 37 Conventional Interfaces for back RF Control Stations
- ◆ 8 Conventional Interfaces for 700 MHz Interoperability Repeaters
- ◆ 50 Conventional Interfaces for upcoming Interoperability and Mutual Aid

6.2.11 Harris County Regional Radio System Interoperability

6.2.11A The console system shall provide robust radio interoperability with Harris County agency personnel and other agency personnel that utilize the Harris County SmartZone radio systems. Direct interoperability through compatible equipment or through a Project 25 ISSI interface is preferred. If interconnectivity via a Project 25 ISSI interface is proposed, the proposal shall provide a detailed description of what will be needed on both the City and County sides of the fence to successfully implement the interface.

6.2.11B If a network level interface is not possible, interoperability shall be provided at the RF level through the use of control stations. Harris County has established specific system-wide talkgroups for radio interoperability including:

- ◆ Regional SmartZone – Mutual Aid Talk Groups 01 - 06
- ◆ Regional SmartZone – Interoperability Talk Groups 01 – 06

The City of Houston currently has another project which will provide interoperability control stations, base stations, and repeaters to be located at the HEC. Thus, Proposers are not required to include these Regional Radio System control stations in this project.

6.2.11C The HEC tower and external radio equipment shelter are not part of this project. They are being developed as a separate project, but should be in place to support the new trunked radio system implementation. Connectivity between the HEC tower & the HEC equipment rooms will be via optical fiber links provided by the City.

6.2.12 Remote Console Capability

6.2.12A The City will, from time to time, have a need to establish one or more remote console operator positions within the HEC or at other City or non-City facilities at locations to be determined. As part of the initial system procurement, the City's Emergency Operations Center (EOC) at the HEC shall be equipped with two (2) IP based radio operator consoles, one for the EOC Manager's position and the other for the EOC Assistant Manager's position. Space at these locations is at a premium, therefore operator positions that have a smaller footprint are preferred. These operator positions shall be from the same product family as the HPD and HFD consoles at the HEC.

6.2.12B Field Emergency Operations Center (FEOC) – The City operates a FEOC as shown in the following Figure. One (1) IP based radio operator position shall be proposed for the FEOC. The City of Houston will provide the required connectivity to this console.

Figure 6.2.12A - City's Field Emergency Operations Center



6.2.12C The proposed remote positions shall provide for full-featured remote console operation via an IP based communication link. For the purposes of the proposal, remote operator positions shall consist of a PC based unit with mouse, 19" LCD touch screen, keyboard, external speakers, and necessary LAN / WAN interface.

6.2.12D Remote operator positions shall provide the same functional and security capabilities as the positions located within the HEC dispatch centers.

6.2.13 Patching Capability

6.2.13A The system shall provide for the flexible patching of talkgroups and conventional channels without the need for "double vocoding" which can degrade audio quality.

Each operator position shall be capable of supporting up to five (5) patches on a temporary or permanent basis. A patching window will identify all patched in operation at any moment. In addition, all channel modules will provide a displayed indication when a talkgroup or channel is involved in a patch.

6.2.14 On-Site Visits

6.2.14A In order to ensure an understanding of the system requirements, a qualified technical representative of the console manufacturer shall participate in the site tour of the various dispatch locations prior to the proposal submission. This is to help ensure that all required functions will be present and properly configured in the system.

6.2.15 Proposal Response

6.2.15A In order to demonstrate a thorough knowledge of the total console system and an understanding of the City's overall requirements, Proposers shall submit a detailed console response within the system proposal. The console submittal shall, at a minimum, include a plan view of each type (PD, FD, EOC, FEOC, training) of console (to scale), a detailed drawing of each control panel with all controls identified, an itemized listing of the exact equipment being offered for each console, a complete description of each feature of the system, a description of each major system component and a complete list of options available for the system.

6.2.15B The console submittal shall include a table showing the dimensions of all proposed console equipment. Proposers shall certify that the equipment list included with the proposal response is complete and suitable for the equipment being offered and is compliant with the intent of the specifications. As stated previously, the City's existing console furniture will be reused in this project.

6.2.15C The console submittal shall provide a written overview of the proposed console system configuration with block diagrams depicting the network architecture. The overview shall also include a failure mode analysis of the console system that addresses potential failures that might occur and how the system responds to each failure to maintain operational status.

6.2.16 Console Manufacturing Support and Documentation

6.2.16A The console system shall undergo extensive factory testing prior to shipment. This testing shall encompass all parts of the console equipment at the board level. Computer assisted testing shall be used to assure proper operation of all circuit board components and functions furnished with the console.

6.3 Operator Console Positions

6.3A The console system shall be designed to enhance the dispatchers' capabilities in performing resource management tasks and to minimize the effort and concentration required for efficient use and control of the trunked radio system. This shall in part, be accomplished through the use of high quality touch screen LCD monitors for selecting dedicated channel and talkgroup control windows representing all base stations, repeaters, talkgroups, alert paging and auxiliary functions at each console.

- 6.3B To minimize operator confusion and the chance of errors being made, all channels, talkgroups and individual ID's shall be referred to and displayed by alphanumeric names in English. Numeric only references for talkgroup or channel names shall not be acceptable. Manually cross-referencing a channel name to a number shall not be acceptable for any dispatch operation.
- 6.3C It is desired that all control functions displayed be user configurable and organized on the viewing screen in the most efficient and flexible manner possible. The use of printed, paste-on and/or snap-on, mechanically engraved labels are specifically excluded under this specification.
- 6.3D Each function within each channel/talkgroup control representation, and all other functions controlled through the console shall be color-coded with user definable color choices. These functions shall include but not be limited to audio activity indicators, transmit push-to-talks, volume controls, etc. Touch screen and keyboard/mouse operations shall be used to select and use all dispatch functions.
- 6.3E The supervisory positions shall have Supervisory Control, the capability of overriding the other radio dispatch positions.

6.3.1 Functionality

Console System Reliability

- 6.3.1A Due to the critical nature of the Public Safety and Local Government services provided by the City, a high degree of console system reliability is required. The console system, to the greatest extent possible, shall:
- ◆ Provide continuous and automatic self testing and diagnosis
 - ◆ Be automatically self-correcting
 - ◆ Alert the operator and dispatch supervisors in the event of component or sub-system failure
 - ◆ Allow continued system operation in the event of failure of a console sub-system, through isolation of the defective sub-system and use of redundant components.
- 6.3.1B The City's 24-hour dispatch centers are mission critical and cannot be disabled. A high degree of modularity is required to reduce the number of sub-systems affected by a single component failure. The ability to repair, reprogram or replace sub-systems without impacting dispatch operations shall be provided, as continued console operation is necessary during repair.
- 6.3.1C Proposers shall recommend the spare modules and parts needed to promptly restore the console to full service following potential sub-system failures. **The recommended spare modules and parts shall be listed as individual items including model or part number, description and cost.** These costs shall be included in the overall system recommended spare parts listing to be provided in the Pricing Section of the proposal.

- 6.3.1D The console system shall be interfaced with the system / network terminal and supply statistics and diagnostics identifying console sub-system failures and for the purposes of making service related inquiries.

Diagnostics

- 6.3.1E The console system shall be equipped with a number of self-diagnostic subsystems that shall continuously monitor and verify the correct operation of each distributed microprocessor, each audio path in the console electronics and between the electronics and each dispatch positions as well as the Master Network Controllers. Diagnostic capability shall be distributed among independent and redundant subsystems and shall not rely on one central diagnostic circuit.
- 6.3.1F Each digital message routed through the system shall include error correction such as a Cyclical Redundancy Check or its functional equivalent to assure data integrity. The console electronics shall periodically run audio diagnostics through each and every transmit and receive audio path in the system. The audio paths shall include the automatic audio level setting circuitry.
- 6.3.1G Should a fault be detected, the Supervisory consoles at the HEC shall be notified via the System's Network Managers terminals, fault minimizing routines shall be automatically activated and diagnostic information shall be logged on an associated server and system printer. Diagnostic messages shall be presented in an easy to read text format which shall enable non-technical supervisory personnel to intelligently evaluate the situation and minimize disruption to normal operations. Diagnostic systems that require the dispatch supervisor to cross reference an error code to a fault message shall not be acceptable.

Power Supply

- 6.3.1H The console system servers, switches, controllers, and routers shall be supported by redundant power supplies. It is a critical requirement that a power supply failure shall not affect operations. External power to the console servers, routers, switches and equipment and the dispatch operator positions shall be supplied at a nominal 120 VAC at 60 Hz, single phase. The HEC facility is equipped with an uninterruptible AC power system to support the console system equipment room and the dispatch operator positions.

Grounding

- 6.3.1I The HEC console equipment rooms have been recently upgraded to comply with Motorola's R-56 Standards and Guidelines for Communication Sites. All proposed equipment must be properly grounded during installation. The City will inspect all equipment installations provided by the vendor.

End to End Encryption

- 6.3.1J The console system shall provide a high level of security by providing end-to-end DES and AES encryption of selected talkgroups that are configured for encrypted operation.

Link Failure –Operator Level

- 6.3.1K The console system shall notify the operator and associated Supervisory position(s) of a link failure between the operator position and the console system.

Link Failure – Infrastructure Level

- 6.3.1L The console system shall notify all operator and Supervisory positions of a link failure between the console infrastructure and the Master Network Controllers.

Fallback operation

- 6.3.1M In the event that primary and backup network links between the console system and the radio infrastructure are lost, the console system shall revert to a fallback mode of operation utilizing RF control stations to communicate with field personnel. The City understands that in this mode of operation, some of the trunked system's capabilities will not be available. The proposal must clearly address and describe what normal operational capabilities will not be available.
- 6.3.1N The fallback control stations shall be assigned to a dedicated channel select folder (screen) at the operator positions. When link connectivity is lost, a link failure message shall prominently appear on the LCD display to notify the operator that the console system is no longer in contact with the radio infrastructure. The operator can then select the fallback operation folder (screen) and the desired talkgroup to communicate with field personnel via the console and fallback control stations.
- 6.3.1O A bank of thirty-seven (37) control stations shall be proposed to support the fallback mode of operation at HEC. Control stations shall be rack mounted and installed in the new equipment shelter to be located at the base of the City's new radio tower at the HEC. Control stations shall utilize control station combiners and a receiver multicoupler to reduce the number of antennas and transmission lines to be installed on the tower. Control stations shall be equipped with a rechargeable auxiliary power system utilizing long life sealed gel-cell batteries and charger. Battery capacity shall be based on a four hour run time at a 25-25-50 duty cycle. Recharging of the batteries shall not exceed 24 hours.

Logging Recorder and Logging Recorder Interface

- 6.3.1P The City of Houston intends to utilize their existing logging recorder to log all talkgroup audio traffic from the trunked radio system. Thus, a logging recorder interface shall be provided which provides a detrunken audio output for all talkgroups operating on the trunked system. In addition, the City of Houston wants to locate a secondary Computerized Logging Recorder, which will log the talkgroup audio for all system talkgroups, in the HEC Master Site Equipment Room. The Proposer shall provide a cost for this secondary Logging Recorder. The recorder shall have the capacity to log all talkgroup audio for a period of two weeks. There shall be two User Terminals.

Dispatch Operator Positions

- 6.3.1Q Each of the radio dispatch consoles shall provide all controls that apply to the various channel/talkgroups and auxiliary functions for the console. Operator positions shall be PC based, utilizing modern PC equipment in current production at the time the system

is staged to help provide a long equipment life. The operator position application shall be Windows based. The proposal shall identify the proposed operating system and provide a description of the PC equipment proposed for the project. Each console operator and Supervisory position shall include at a minimum the following:

- 6.3.1Q1 **User login accounts** – Each operator position and Supervisory position shall require a valid user login and security password to access the console system and its capabilities. The system shall provide multiple levels of access security for different levels of system usage.
- 6.3.1Q2 **Talkgroup/Channel Select** - Each talkgroup or channel shall be capable of independent selection by the dispatcher. The channel window shall provide a visual window indication when the corresponding channel is selected and when that talkgroup is transmitting.
- 6.3.1Q3 **Select Speaker** – Shall provide audio from the selected channels/talkgroups, with an independent volume control. A volume level display shall be provided for each channel as well as a select speaker audio level adjustment that ranges from silent to full volume.
- 6.3.1Q4 **Unselect Speaker** – Shall provide audio from unselected channels/ talkgroups, with an independent volume control for the unselect speaker. Up to four (4) unselect speakers shall be optionally available per operator position. The standard configuration shall include one unselect speaker.
- 6.3.1Q5 **Transmit Function** - A color-coded transmit function to control the push-to-talk (PTT) function for the selected transmitter(s) and/or talkgroup(s). The PTT function shall be capable of being enabled by a PTT button on the headset, a PTT indication on the LCD display, and by the dual foot switch at the position.
- 6.3.1Q6 **CTCSS Monitor or Disable Function** - Shall disable the receiver CTCSS decoder of the selected base station(s) for monitoring purposes.
- 6.3.1Q7 **Console Clock** - Shall display time in a twelve or twenty four-hour format (user selectable) and day of the year (HH:MM:SS day) at each operator position; The console clock shall derive its reference time signal from a GPS or WWV Master Time Source to be provided as part of the console system the system. The HEC facility already has a master time source in operation. The console system shall be capable of interfacing with the existing time source in the event that the City elects to utilize the existing source only.
- 6.3.1Q8 **VU Meter or Display** - Shall present a visual indication of transmit audio levels.
- 6.3.1Q9 Keypad or screen representation of a keypad for numeric data entry.
- 6.3.1Q10 **Microphone** - panel mounted gooseneck microphone, cardioid pattern type. The microphone shall be resistant to interference, such as transmitting hum from lights, cathode ray tube terminals, or other devices used in the proximity of the console.
- 6.3.1Q11 **Intercom** - Intercom between all operator positions shall be provided. A visual display shall be provided to identify both the calling and called parties by console

name. Multiple simultaneous intercom conversations between individual consoles shall be possible.

- 6.3.1Q12 **Talkgroup/Channel/Telephone Cross Patch** - this function shall allow cross patching talkgroups/channels and telephone to permit intercommunications. As participants are added or deleted, there shall be no variation in audio levels or quality. All patch audio shall be digitally processed. The patch shall utilize a single trunked channel when patching more than one talkgroup. The console systems shall contain a minimum of four (4) independent telephone patches for three phone lines.
- 6.3.1Q13 **Talkgroup Call** – The console system shall support trunked talkgroup calls on any talkgroups programmed into the system, with appropriate management approvals.
- 6.3.1Q14 **Trunked Announcement Group Calls** – The console system shall support trunked announcement group calls on any announcement groups programmed into the system, with appropriate management approvals.
- 6.3.1Q15 **Trunked Emergency Calls** - The console system shall support trunked emergency calls from any user radio programmed into the system, with appropriate management approvals.
- 6.3.1Q16 **Private Call** - Selected users and dispatchers shall have the ability to selectively communicate “privately” with another individual on the system regardless of what talkgroup either unit is in. The call shall allow the two users to utilize a single channel resource to communicate without the participation of other units in their respective talkgroups.
- 6.3.1Q17 **Selective Alert** - Selected users and all dispatchers shall have the ability to selectively send and receive alert to and from an individual user on the system regardless of what talkgroup either unit is on. The call shall allow an individual to alert another user with a distinctive tone and their individual ID (ID on display radios only). The alert shall be accomplished over the signaling (control) channel and shall not affect any voice channels on the system.
- 6.3.1Q18 **All Mute** – All console positions shall provide a one button “All Mute” function that will alternately temporarily mute or unmute all incoming radio traffic audio to that position. An adjustable time-out-timer shall automatically cancel the all mute function after a pre-determined time has elapsed.
- 6.3.1Q19 **ID Display Queuing** - Queuing of at least ten plain English ID's (ID scroll list) on the channel window for standard calls and emergency calls.
- 6.3.1Q20 **All Receiver Mute Function** - A function that will immediately mute the received audio from all unselected channels shall be provided. This condition shall be indicated visually, and be automatically canceled by a user adjustable time-out timer.
- 6.3.1Q21 **Simultaneous Select** - Controls shall be provided that allow the operator to manually select any combination of console controlled base stations for simultaneous transmissions. Three selectable combinations shall be allowed at the discretion of the dispatcher. The combined transmission shall utilize a single trunked channel when involving more than one talkgroup.

- 6.3.1Q22 **Instant Transmit Function** – Each operator position (including Supervisors) shall provide an instant transmit function which will allow the dispatcher to quickly key up a talkgroup by depressing the instant transmit “button”.
- 6.3.1Q23 **Emergency/Reset** – All consoles shall be capable of declaring and receiving emergency alerts from user radios and other operator positions operating on the trunked radio system regardless of the status of the channel control window. Emergency messages shall be indicated by a flashing red ID, an emergency ID character and an audible alert. Dispatcher acknowledgment of the message shall silence the audible alert and stop the flashing display. The console system shall be capable of queuing multiple emergency messages in the display stack and the emergency ID character shall continue to flash until all messages have been viewed by the dispatcher. The most recent emergency declaration shall be displayed and the dispatcher shall be able to scroll through the queue to view queued emergencies.
- 6.3.1Q24 The Emergency feature shall be programmable to allow the alert message to be delivered and displayed in predefined ways, including display on the current talkgroup in use by the person declaring the emergency, and display on a separate pre-defined talkgroup. The declaring alias shall be displayed on user radios of the same talkgroup and at the appropriate dispatch operator positions.
- 6.3.1Q25 **Alert Tones** - The console system shall provide a minimum of three distinct over-the-air tones to be used for alerting purposes. Each alert tone shall be immediately broadcast on the selected talkgroup, group call or all call, when activated. Tones shall be presented in the headset as sidetone audio only, at a reduced volume level level to confirm that the tone was generated and sent. The following selections shall be available as a minimum:
- Alert 1:** Steady Alert Tone - shall generate a nominal 1000 Hz steady tone
 - Alert 2:** Warbling Tone - shall generate a warbling tone
 - Alert 3:** Pulsed Alert Tone - shall initiate an automatic sequence, consisting of a nominal 1000 Hz tone, for a period of two (2) seconds
- 6.3.1Q27 **Paging Encoders** - Each Police and Fire console operator position and Supervisory positions shall include a multi-format paging / signaling encoder that is accessible through the data entry keypad and a one button per station encoder panel. The encoder shall be capable of encoding industry standard two-tone sequential and DTMF signaling formats.
- 6.3.1Q29 **Preprogrammed Single Button Function Paging** - Each console shall be capable of supporting 250 pre-programmed single-button paging functions.
- 6.3.1Q30 **Indication** - A color-coded status call indicator shall be provided for each talkgroup or channel in a channel control window on the LCD display.
- 6.3.1Q31 **Talkgroup/Channel Busy Indicator** - Consoles shall have channel busy indicators to visually indicate that the channel is in use by another console.
- 6.3.1Q32 **Individual Volume Adjust** - Shall be provided for each talkgroup or channel on the console. Associated color-coded status indicators shall continuously show whether

the channel is in the full or adjustable volume mode. The volume control shall be automatically bypassed when a channel is placed in select status.

- 6.3.1Q33 **Talkgroup/Channel Cross Patch** - Shall allow the dispatcher to patch any two or more channels together. Trunked talkgroups shall be combined and utilize a single trunked channel for the patched call. Inbound audio from any member of the patch shall be present in the select speaker if any member of the patch is selected. If the dispatcher transmits on any talkgroup or channel included in a patch, then audio shall be heard by all members of the patch.
- 6.3.1Q34 **Channel Name** - Designated channel control modules shall include a minimum of twelve character alphanumeric display symbols to identify the channel.
- 6.3.1Q35 **Talkgroup/Channel Cross Mute** – Consoles shall include a cross mute feature, which precludes voice communication from a dispatcher's microphone being repeated over loud speakers at other consoles in the dispatch center.
- 6.3.1Q36 **Supervisory Control** - The supervisors' consoles shall provide takeover control to prevent other dispatch consoles from keying repeaters or base stations for each channel supported by parallel consoles. Supervisory consoles shall be capable of overriding transmissions from other consoles and field units.
- 6.3.1Q37 **Repeat Disable** - The Supervisors' positions shall be equipped with the ability to disable received audio from being repeated, as needed.
- 6.3.1Q38 **LCD Display** - State-of-the-art color 19-inch touch screen LCD displays shall be used. The operator shall have the ability and necessary interface/keyboard to change the screen displays. Proposers shall identify the particular display proposed for the City by make and model in the console description to be provided in the proposal response.
- 6.3.1Q39 **Headset and Jack** - Proposers shall describe available wired and wireless dispatcher headsets available for use with the proposed operator positions. The headset jacks shall support both radio and telephone audio operation in the new console system.

The console shall provide independent level settings for audio input from the headset microphone and the gooseneck microphones, such that dispatchers may freely switch operation between microphones without affecting dispatch audio quality.

Dual headset jacks shall be provided at each console operator position. The jacks shall provide TX and RX audio and PTT as well as telephone support. Separate headset volume controls for radio and telephone audio output shall be provided. One telephone style handset shall be provided in each dispatch center for training purposes.

- 6.3.1Q40 **Footswitch** - Each of the console operator positions shall be equipped with a dual footswitch. The unit shall have a dual pedal footswitch for PTT of the selected channel(s). The footswitch shall be heavy duty, designed for Public Safety use, and shall be designed so as not to skid on a smooth flooring surface

6.3.1Q41 Status Messaging - Each of the console operator positions and Supervisory positions shall be equipped with the ability to receive and display status messaging from user radios. A minimum of 125 different pre-defined messages shall be supported. Typically, text messages will be used to indicate status reports and updates from field units.

The ID of the sender shall be displayed in a dedicated status messaging window on the GUI. The window shall display the message sent, along with the ID and a time stamp. The window shall scroll messages & place the most recent message at the top of the list.

Upon receipt of a message, an audible alert shall notify the operator that a new message has arrived and needs to be viewed. Text messages shall include a message requesting to speak with the console operator. The operator shall be able to respond with a group call for a group alias and with an individual call for an individual alias. Text messages shall be archived by the system so that they can be easily reviewed at any time for management or emergency purposes.

6.3.1Q42 Instant Recall Recorder (IRR) - Each of the console operator positions and Supervisory positions shall be equipped with an instant recall recorder capable of allowing the operator to quickly retrieve and playback recent radio traffic and recent telephone calls at the operator position. The recorder shall be capable of recording and replay of the latest incoming radio traffic from any radio channel or 700 / 800 MHz talk group selected on the radio dispatch console for transmission and the latest radio transmissions received on the selected talkgroup or channel at that position.

The IRR must be capable of storing at least 30 minutes (state maximum available) of message material in solid state dynamic RAM or on a hard drive to allow instant access to recorded information. Simultaneous record and playback shall be possible, with incoming calls taking priority. Recording shall begin whenever an audio signal or off-hook telephone condition is presented to the recorder input. The system shall enable an operator to save a message for future referral or re-recording.

The system shall be capable of playing a message back at reduced speed, without a change in voice pitch. The range in speed variation shall be at least 2:1, but a greater range is desirable.

The control panel shall contain the minimum following controls:

- ◆ Fast Forward
- ◆ Fast Rewind
- ◆ Pause
- ◆ Restore
- ◆ Save
- ◆ Clear
- ◆ Volume Control

The IRR control window shall have an alphanumeric display indicating such information as message length, message ID, radio user ID, number, date, time.

6.3.1Q43 **Call History Window** – Each console position shall provide a call history window that allows the operator to review the last 20 calls received at that position.

6.4 Console Electronics

6.4.1 Description

6.4.1A The console electronics such as console servers, routers, external hard drives, conventional interface units, and LAN / WAN gear shall be installed in equipment racks within the HEC equipment rooms and equipment rooms at other console locations at other City facilities. Space for front and rear servicing shall be provided. Proposers shall provide scaled layout drawings, for the proposed electronics equipment and associated hardware. Such drawings shall be provided in Microsoft Visio, or AutoCAD format in print and electronic format on CD or DVD media. All electronic files provided to the City shall be thoroughly screened for viruses and spyware prior to submission.

6.4.1B The console electronics shall contain the various microprocessor base station and receiver interfaces, console interfaces, auxiliary function interfaces and other interfaces needed for system operation. The interface controller circuit board cards shall be mounted in card cages. All controller cards shall be of plug-in design and shall be able to be inserted and/or removed from the card cage with power applied and the system on-line.

6.4.2 System Interfaces

6.4.2A Each transmit and receive interface card shall incorporate all circuitry required to operate remotely controlled base stations and the trunked repeaters. As a minimum, each interface shall consist of a plug-in circuit card that may contain related circuitry, line driver amplifiers, two wire and four wire receive amplifiers, digital automatic level adjustment circuitry and fault diagnostic circuitry. The module shall be capable of remotely controlling base stations using industry standard tone remote control and DC remote control. The vendor shall provide all equipment necessary to insure proper keying of the trunked radio system, and interoperability radios.

6.4.3 Console Auxiliary I/O Functions

6.4.3A Each operator position shall be able to support up to thirty-two (32) unique input / output modules. Each module shall include a “soft button” and descriptive test line to identify the function and the status, respectively. Text colors shall be user definable. Auxiliary I/O shall support :

- ◆ Input
- ◆ Momentary output
- ◆ Toggled output
- ◆ Alarm input

6.4.3B Inputs / outputs shall be optically isolated or control relay switches that activate relays, open doors, and perform special tasks by depressing the “soft button” associated with it.

6.4.4 Grounding

6.4.4A For personnel safety and equipment protection, all console equipment shall be properly grounded. At the HEC facility, a below floor grounding ring will be accessible for grounding connection of the equipment. Exothermic welding shall be used to connect equipment grounds to this ring.

6.4.5 Power Line Surge Protection

6.4.5A Secondary AC line transient and surge protection shall be provided by the vendor for the console infrastructure electronics equipment and for each operator and supervisory position in the system. The HEC facility is equipped with a large UPS system for the radio and CAD equipment rooms and the existing dispatch consoles.

6.4.6 Telephone Circuit Protection

6.4.6A Transient and surge protection shall be provided for each telephone circuit in the system. The surge protectors shall be sealed, three-element, gas filled spark gaps, having a nominal discharge current rating of spikes of 12,000 amperes or more.

6.5 Master Time Source

6.5A The HEC currently employs a master time system to synchronize equipment within the center. The Proposer shall provide a recommendation on how the new dispatch consoles and trunked radio system equipment may best be configured to synchronize with the existing HEC system.

6.6 Other Requirements

6.6.1 Cabling

6.6.1A The following subsections highlight the cabling requirements for the console and related equipment. Please utilize the information obtained during the site visits to determine the specific requirements.

Dispatch Centers

6.6.1B All cabling within the dispatch center will be routed under the flooring in cable troughs. All cabling shall be plenum rated.

6.6.1C All cabling between the console system, other system components, and the microwave channel banks/control lines shall be connected at a demarcation point consisting of an integrated or pre-wired modular panel (such as ADC Telecommunications, AMP, and Ortronics).

6.6.1D The cabling between modular panels shall utilize flat 8 wire RJ45 cable and connectors. The modular interface panel for a specific piece of equipment shall be mounted on the same equipment rack as the equipment it serves.

- 6.6.1E Circuit identification shall be provided on the modular panels and the cabling.
- 6.6.1F The use of any conventional type 66 punch blocks is not acceptable. Extensive use of or long runs of TELCO 25 cabling is not preferred.
- 6.6.1G All cabling shall be terminated with appropriate connectors for ease of field installation and shall be terminated to the nearest 1 foot length. All cabling used for system interconnect shall be tested during factory staging of the system.
- 6.6.1H A description and detailed wiring diagram of each modular panel utilized shall be provided as part of the "as-built" drawings.

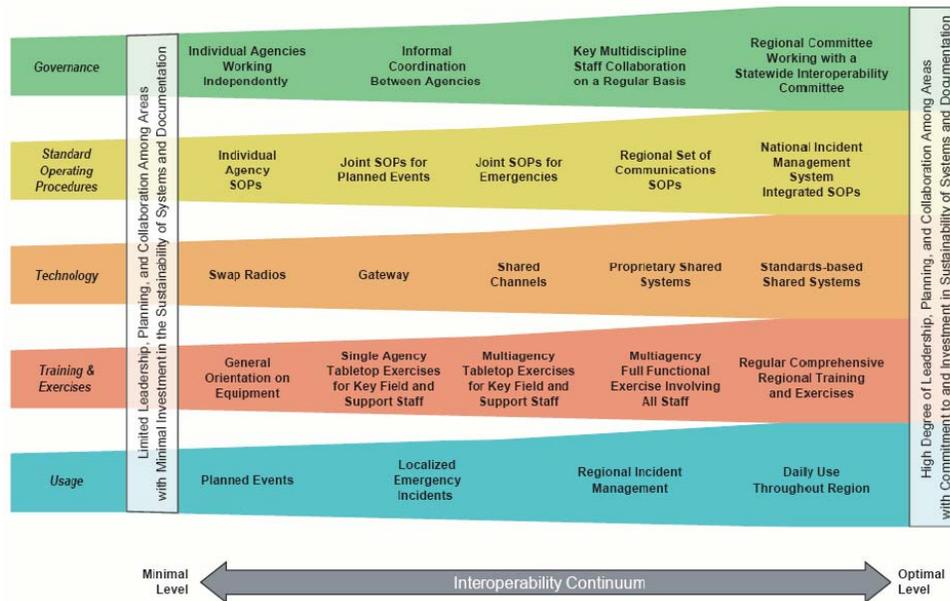
6.7 Fire Station Alerting System

- 6.7A The City of Houston currently operates a complex Fire Alerting System, which incorporates multiple levels of communication transport which serve as backup. The primary Emergency Alerting System (EAS) utilizes the HPD 800 MHz RD-LAP wireless data system for communication transport and will remain in operation for the foreseeable future. The Department also utilizes two backup alerting systems, one in the UHF frequency band, the other in the VHF band. The City wishes to keep this system intact, operating the way it does today, to the extent possible. The existing IPC (formally Orbacom) dispatch consoles do play a role in this Fire Alerting System. The IPC consoles provide the 2nd level of communication transport by interfacing to a 3rd party MDC1200 encoding device. There is an MDC1200 decoding device at each fire station. From the IPC consoles, the dispatcher can then selectively signal any City of Houston fire station, activating a single relay at the selected fire station(s).
- 6.7B The proposed dispatch console system must replicate this selective signalling to each fire station, providing a single relay closure at each fire station(s). The signalling must be activated from the dispatch consoles. The Proposer must devise the methodology for accomplishing this functionality. The 700/800 MHz trunked radio system may not be used as the communication link or in any way be involved in the process

6.8 Radio Interoperability Support

- 6.8A As this new system will be a shared citywide resource, direct unit-to-unit interoperability within the City of Houston agencies will be inherent in the system through the development of a well designed fleet map or talkgroup structure. Controlled interoperability with other non-City agencies must also be supported by the new radio system.
- 6.8B As outlined in Section 2 of this RFP, the City intends to develop a system that is standards based, in conformance with the Project 25 Suite of standards and provides Level 5 radio interoperability as defined by the Safecom Interoperability Continuum shown below.

Figure 6.9A - Safecom Interoperability Continuum



6.8C While this will accommodate a majority of day to day interactions with surrounding agencies, there will still be a number of external agencies that operate on various non-compatible radio systems that cannot communicate directly with the City’s new system without the assistance of a “patch”. The City currently has another project which will provide interoperability control stations, base stations, and repeaters to be located at the HEC to accommodate interoperability with these external agencies. Thus, for the interoperability portion of this project, Proposers are required to provide only the eight (8) 700 MHz interoperability conventional repeater systems to be located at the HEC. Additionally, the Proposer shall provide conventional station interfaces into the proposed Dispatch Consoles which allows the City to add up to fifty (50) conventional tone, DC, or local controlled devices at a later date to accommodate these external agencies.

Fully Compliant Partially Compliant Non-Compliant

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**Section
7**

Radio Equipment Specifications

7.1 Technical Specifications – Fixed Equipment

7.1.1 General Trunking Controller Specifications

7.1.1A Section 2.4.1 of this RFP describes the reliability and feature requirements of the trunking Master Network Controllers (MNC) and any trunking sub-system controllers that might be slaved off of the MNC. The specifications in this section apply to all levels of trunking controllers, including the MNC and any sub-system controllers employed in the wide-area system.

- ◆ **Environmental** – All trunking controllers shall be designed to operate under the following conditions:
 - **Temperature:** -30° to +60° C
 - **Humidity:** 95% non-condensing
 - **Radio Frequency Fields:** Equipment shall be properly shielded to allow proper operation in equipment rooms or buildings occupied by base station transmitters, with associated strong RF fields.
- ◆ **Duty Cycle** - Equipment proposed by Proposers shall be rated for continuous duty.
- ◆ **Radio Channel/Site Expansion Capabilities** – The expansion capabilities of all trunking controllers used in the system design shall be clearly explained, taking into account the capacity consumed by the system design. Limitations relating to the total number of sites (both simulcast and non-simulcast) and total number of channels in system shall be described.
- ◆ **Data/Control Interfaces** - The Proposer shall provide all necessary interfaces with base repeaters, peripheral computer hardware or the microwave system. Interfaces shall include cabling and modems, all of which shall be identified by the Proposer in the functional diagrams of the proposed system.
- ◆ **Alarms and Diagnostics** - The trunking controllers and their associated subsystems shall provide alarms for key operational parameters, and shall provide for remote inquiry, display, disablement and diagnostic functions.
- ◆ Other operational features of the trunked controller shall be:
 - Processing inbound and outbound requests for channels and channel assignment.
 - Continuous Channel Assignment Updating

- Recent User Priority
- Adjustments of System Time-Out Parameters
- System Diagnostics

7.1.2 Radio Repeaters, 700/800 MHz

- 7.1.2A Radio repeaters are to be 700/800 MHz, continuous duty, transmitter/mobile relay, receiver combinations. All transmitters shall be solid state. The repeaters shall be in either 19" racks or floor mounted 19" closed rack type cabinet with a door that shall be security protected with a lock. A key shall be required to operate the door latch. All locks shall be keyed the same with five (5) keys provided.
- 7.1.2B It is preferred that the stations operate directly from a DC power source without individual power supplies, inverters, or converters for each station. The methodology for powering the stations shall be described in the proposal along with its relation to reliability.
- 7.1.2C **Metering** shall be provided for the repeater units to monitor all points in the transmitter and receiver circuitry needed to maintain, align and adjust these units. The methodology for metering shall be described in the proposal.
- 7.1.2D All equipment, at time of delivery, shall be **FCC type accepted** for the proposed application, and proposals shall provide the type acceptance numbers in their proposals, if available.
- 7.1.2E It is essential that all equipment including receivers, transmitters, terminated circulators, filters, watt meters and any other RF carrying assemblies be supplied with type "N", "HN", "LC", Series "C", BNC, or EIA flange constant impedance **connectors**. Any other type of connector is not acceptable. No adapter shall be utilized with equipment or assemblies to convert from one type of connector to the specified types. If any connectors other than those listed are used and supplied, it shall be considered serious non-compliance with the Specification and may result in the rejection of a proposal or, after award, a default in the contract.
- 7.1.2F The stations' receiver and transmitter antenna systems shall utilize separate antennas in accordance with the Proposer's recommendations. In any event, the receiver and transmitter must be capable of simultaneous operation with the **antenna configuration** supplied. Also, the units shall be protected from other co-site in-band and out-of-band transmitters and shall permit full duplex continuous operation without degradation at each site in the system, with all co-site transmitting equipment activated.
- 7.1.2G Although continuous or digitally coded squelch is not specified, the trunked system supplied must transmit a suitable code to **quiet** the associated **receivers** so that no noise burst (commonly known as squelch tail) will be detected.
- 7.1.2H **Transmitter final current and voltage metering shall** be mounted inside of the repeater cabinet.

7.1.2I The Contractor shall provide complete diagrams for each site showing site plan, equipment layout, the cable placement, connectors used, grounding location, and lengths of all cable used.

7.1.3 Antenna Systems

Transmission Lines

7.1.3A All fixed station RF transmission lines used in conjunction with the system shall be Andrew foam cable or equivalent for any cable runs exceeding 15' for receive or transmit purposes. Proposers shall utilize industry practices to select the appropriate size transmission line for each installation. Lines shall be selected to minimize line loss as needed to meet coverage requirements.

- ◆ For short runs, i.e., less than 15', Andrew LDF4-50 or equivalent cables are authorized.
- ◆ All connectors used shall be type "N", "HN" Series "C", "LC", BNC, or EIA flange, and must be fully compatible with directly associated equipment or jumpers in the system. Care should be taken to ensure that the power rating of all connectors is not exceeded by the system's Effective Radiated Power (ERP). Connectors must be of non-ferrous construction. No splices or adapters shall be used under any circumstance. However, it is permissible to utilize different connectors on opposite ends of a cable to avoid the use of adapters. When transforming from one diameter cable to another, it is acceptable to use flange reducers, so long as the cable V.S.W.R. specification is not changed.
- ◆ Care must be exercised in the installation of all connectors. A loss in excess of 0.25 dB per connector is not acceptable. In addition, any connectors/connections used outdoors must be protected from corrosion and be fully weatherproof. The use of vinyl tape is not acceptable for any purpose whatsoever; its use shall constitute a default of contract.

Antennas

7.1.3B The mobile relay base station antennas shall be of the type necessary to provide the required coverage as specified herein.

- ◆ All exposed antenna hardware, i.e., mounting brackets, must be fabricated from 17-7 PH stainless steel.
- ◆ The Contractor shall determine the correct transmission line lengths for each site and provide opening in the wall for the entrance of the line. All cables must be secured with stainless steel clamps and hardware and put in troughs; these shall be supplied as part of this procurement. The use of coaxial adapters and/or splices is prohibited. No underground conduit installations are permitted.
- ◆ To ensure that antennas and lines meet specifications after installation, all mobile relay base station antennas and transmission lines shall be sweep tested with a Time Domain Reflectometer (TDR). A test sweep shall also be made using a frequency domain reflectometer at the operating frequencies with the antenna

attached. A chart recording of TDR measurements shall be made and retained in the Site Log. No V.S.W.R. in excess of 1.2:1 is permitted at any fixed station.

Transmitter Combiner

- 7.1.3C The Contractor may employ any type of suitable transmitter combiner that meets or exceeds the following parameters:

General	Expandable transmitter combiner shall be provided which will provide inputs for a maximum of ten (10) transmitters when fully expanded. The selection of the combiners will depend upon the final assignment of frequencies.
Power Rating	The combiner shall provide sufficient operating margin to allow the input of ten (10) transmitters of the output power selected by the Proposer for the trunked system.
Isolation	Transmitter isolation required as a result of an E.M.C. Study performed by the Proposer shall be an integral part of the combiner. Isolators shall be equipped with R.F. terminating loads rated for the full output power of the transmitter.
Bandwidth	The combiner shall provide for use of any frequencies within the public safety trunked frequency pool.
Frequency Separation	To be determined by final assignment of frequencies.
VSWR	1.25:1 or less
Mechanical	Shall be mounted in a self-supporting steel relay rack.
Insertion Loss	4.0 dB maximum, per channel.
Transmitter Noise	-75 dB, min. @ 500 kHz.
IMD and Harmonic Products	-80 dB minimum
Full Performance	-30° to +60° C

- 7.1.3C The proposal shall state the manufacturer and model number of the combiners at all sites and provide complete specifications and feature documentation.

Receiver Multicoupler/Pre-Amplifier

- 7.1.3D The Contractor may employ any type of multicoupler or amplifier, which meets or exceeds the following parameters:

TOWER MOUNTED AMPLIFIER: (OPTIONAL)	
General	Use of a tower mounted low noise amplifier with a receiver multicoupler is optional at each fixed site.
Gain	Minimum 10 dB

Noise Figure	1.0 dB or better
Third Order Intercept Point	+37 dBm or better
Mechanical	Shall be housed in a gasket sealed weather resistant housing designed for mounting to the tower structure with galvanized steel U-bolts. Consideration shall be given to the galvanic effect of this box in interacting with the steel tower structure.
Power Supply	D.C. power shall be passed to the amplifier via the center conductor of the coaxial transmission line. The AC Power Supply shall be 120 Volts, 60 Hertz.
Amplifier Bypass	The system shall be capable of a bypass around the amplifier system such that the main line, jumper assemblies, and antenna may be tested.
Amplifier Failure Protection	The system shall be equipped with protection from a primary amplifier failure. The proposal shall state the protection methodology employed. Any performance degradation as a result of the failure shall be explained.
Test Port and Test Line	The system shall be equipped with a test port and test line to allow the frequency performance of the tower-mounted amplifier system to be tested from the equipment shelter.
Lightning & Surge Protection (Rated @ 50,000 amps, 30 strokes)	Protection of the AC and D.C. power supplies and R.F. input of the amplifier shall be provided by a combination of gas tubes, Zener diodes and M.O.V.'s, and careful grounding of the enclosure.
Metering	Metering of the D.C. power supply shall be provided in the equipment shelter at the base of the tower.
RECEIVER MULTICOUPLER:	
General	Shall be expandable and provide output ports for each proposed receiver at the site.
Lightning Protection (Rated @ 50,000 amps, 30 strokes)	The R.F. input to the device shall be protected with a gas tube type lightning arrester, which will pass the D.C. required to power the tower mounted amplifier.
Mechanical	Shall be mounted in a relay rack with other equipment at the site, or shall be provided with a steel self supporting relay rack. D.C. metering of the tower mounted amplifier power supply shall be mounted in this panel.
Preselector	A receiver preselector shall be provided to attenuate out of band signals by at least 40 dB.
Gain	Gain through the multicoupler system shall be field adjustable.
Noise Figure	2 dB or lower

1 dB Compression Point	18 dBm minimum
3rd Order Intercept Point	30 dBm minimum
Receiver-to- Receiver Isolation	25 dB minimum
Full Performance	-30° C to +60° C

Fully Compliant Partially Compliant Non-Compliant

7.2 Technical Specifications – User Equipment

7.2.1 Overview

- 7.2.1A The City shall be purchasing radio user equipment that will require different features depending on the user departments and their operational needs. By “radio user equipment”, the solicitation refers to mobile radios, portable radios, and control station radios. These radios will fall into several classes, from those with the most features and flexibility such as alpha-numeric displays, speaker/microphone/antenna assemblies, etc. to more standard models.
- 7.2.1B All mobile and portable radios, and control station radios shall be capable of performing all functions and features of the system.
- 7.2.1C To enhance interoperability, the City is interested in acquiring a Project 25 product that is a multiband subscriber capable of operating in multiple frequency bands, that is, the 700/800 MHz band and the UHF and VHF bands in the same radio. The Proposer shall provide any available information on such a product.
- 7.2.1D This section provides general requirements for the user equipment. Details on the specific user equipment and quantities required by each department may be found in Section 14 - *Proposed Pricing*.
- 7.2.1E If P25 Phase II technology is not proposed for initial installation, Proposers shall provide a detailed explanation of the system offering including the P25 Phase II impact on all user radio equipment, specifically whether or not the radios proposed are currently P25 Phase II capable, or are upgradeable from Phase I to Phase II. If they are upgradeable to Phase II, describe the process required to upgrade them to Phase II operation, whether it is a simple software update, requires modification to the radios or required replacement of the radios. If the radios require modification, describe the modifications and whether or not the City will receive the same radios back that it sent in for those modifications.
- 7.2.1F This will be an extremely complex system infrastructure throughout which the radio units will operate, consisting potentially of multiple layers, sites, and subsystems with overlapping coverage. Superior performance of the system will depend on the radio units’ abilities to properly and predictably roam throughout the system. The Proposers

shall provide a detailed discussion of the methodology with which the radio units roam, including:

- ◆ Methodology by which the radio units choose on which site/subsystem to register
- ◆ How the radio units avoid remaining on a low signal site when in range of a higher-signal site.
- ◆ The radio units' algorithm for accessing a site upon power-up and upon requiring a site change.
- ◆ Any features in the radio units' roaming algorithm, which might provide for more efficient system operation (automatically favoring a higher-capacity site, etc.). Please provide details on how these features operate.
- ◆ If the proposed system architecture relies upon radio unit registration, then describe how the system protects from conditions that might entail numerous radios registering simultaneously, thus potentially overloading the system.
- ◆ If a radio unit or talkgroup has been denied access to a site or subsystem via the system manager, please explain the methodology by which the radio units are kept off of this site or subsystem.
- ◆ Please describe the radio units' flexibility for operating in City-preferred conditions upon infrastructure failures. For example, changing to an available wide-area subsystem when a "site trunking" condition occurs, or conversely, remaining in the "site trunking" condition.
- ◆ Please describe the process by which the radio unit will be pulled into a group call as late joiners.
- ◆ Please describe manual and automatic selection to group calls.
- ◆ Please describe dynamic regrouping process in response to special incidents.

7.2.1G The Proposer shall describe the process by which system frequencies are programmed into the radio units. Specifically, if sites and/or channels are added to the system at a later date, what must be performed to the radio units to accommodate these additional sites/channels.

7.2.2 Mobile Radio, 700/800 MHz

7.2.2A Mobile radios supplied under this procurement shall be frequency synthesized and furnished to operate on all channels in the 700/800 MHz land mobile bands. Specific channel assignment will be made by the trunking control system. In the event the mobile radio unit begins operating on a site or subsystem which is in a failed mode, a unique tone will be heard on the unit's speaker and indicated on the displaying if applicable. Proposers shall describe the capabilities of the proposed mobile radios to provide an indication to the user that the trunked system is operating in a mode that is not normal. It is preferred that users have the ability to silence the failure indication tone.

- 7.2.2B The frequency programming shall be accomplished through the use of EE-PROMs. Detailed operational and technical instructions on programming shall also be supplied. The unit shall be 100% solid-state. The RF output power into 50 Ohms shall be 15 Watts minimum.
- 7.2.2C Mobile stations shall have an engraved or stamped multi-digit unique serial number applied to each unit. These shall be of such type, and located in such a position that their removal or alteration is as difficult to do and as obvious to spot as economically feasible. It is not the intent of the City in requiring this identification to raise the cost of the units by any significant percentage. Proposers must be aware of this intent when proposing a suitable method of identification.
- 7.2.2D Additionally, the Contractor must provide the City with a paper copy and an electronic copy (inventory) of a complete listing of all unique serial numbers by department used for identification, and must also maintain a copy in its records to facilitate system support and future purchases.
- 7.2.2E The mobile station exterior housing shall be made of plated or painted steel or aluminum of sufficient gauge to provide for adequate protection and theft deterrence. Plastic, nylon or other suitable synthetic material may be used for the radio enclosure/housing if its usage is adequately justified and it can meet the required performance specifications.
- 7.2.2F The interconnecting cable, including + and - DC power, shall be of such construction that frequent exposure to hydraulic fluids and petroleum based oils will cause minimal damage such as cracking or softening of the cable jacket.
- 7.2.2G A transmitter time-out-timer must be provided to limit key-down time.
- 7.2.2H All mobile units except dash-mounted radios shall be supplied with control unit, speaker, microphone and all accessories required for installation. Proposers shall include the price of one (1) control unit for each trunk-mounted radio, unless otherwise noted in the pricing section.
- 7.2.2I All mobile units supplied must be fully compatible with the fixed station equipment provided under this procurement.
- 7.2.2J The contractor shall be required to demonstrate that the microprocessor-based equipment is totally functional in the vehicular environment, which the City intends it to be used. This test shall include, but not be limited to, RF immunity, DC input voltage fluctuations, noise introduced in the DC line and typical usage impact. Any degradation of functional parameters of the equipment supplied due to normal or emergency operation of the vehicle in which it is installed shall be corrected by the Contractor.
- 7.2.2K Open air mobile units and all external headsets, microphones and speakers must be weatherproofed and suitable for outdoor mounting. All installation cabling, brackets, etc. must be part of this procurement.
- 7.2.2L Control head mounting locations shall be subject to the approval of the particular department being supplied. Mobile antennas and cabling to trunk or dash mounted

- units must be supplied as part of this procurement, replacing any existing cabling and antennas.
- 7.2.2M Fire, EMS, and special purpose vehicles with intercoms shall be equipped with a water resistant speaker and noise-canceling microphone. In addition, when required, pump control units with headsets and water resistant speakers shall be supplied. Mobiles for the City of Houston Fire Departments must be connected to the headset intercom system (EZ-Comm) currently in place on fire apparatus.
- 7.2.2N External heat radiators shall be used to keep the RF power transistors within conservative operating temperature, without allowing airborne contaminants to enter the interior portion of the radio. The housing shall be devoid of any louvers or other openings thereby protecting the radio set from dirt, dust, and moisture and splashing water.
- 7.2.2O The mobile radio shall be capable of operation from a nominal 12-volt dc primary power source, with positive action reverse polarity protection to avoid damage if the radio were to be incorrectly installed. In that event, the only damage allowed shall be blown fuses if the radio were turned "ON". The radio set shall operate from a negative ground primary source.
- 7.2.2P All power should be derived directly from the vehicle battery, without using active components such as transistors in an oscillator circuit, step-up transformers, or rectifiers. Primary power input shall be adequately fused to assure fast and positive action.
- 7.2.2Q Some mobile radios will require priority-scanning capability. These units shall be capable of scanning a minimum of ten (10) fleets/sub fleets. The operator shall be readily able to select the fleets/sub fleets to be scanned, to designate and change the priority channel, and to enable or disable the scanning mode.
- 7.2.2R Additional equipment specifications are listed below.
- 7.2.2S Automatic Unit Identification - Shall transmit a digital unit identification on push to talk.
- 7.2.2T System Compatibility - Mobile radios shall be equipped and compatible with software related features of the trunking system:
- ◆ Dynamic talkgroup reconfiguration
 - ◆ System access priority
 - ◆ Trunking controller failure operating mode
 - ◆ Signaling error correction (To correct erroneous talkgroup assignments, software shall provide for the mobile to revert to the signaling channel in the event that a unit is assigned to an incorrect talkgroup)
 - ◆ Wide area operation capability
 - ◆ Selective inhibit and uninhibit

- ◆ Visual and audible notification whenever any reduced backbone functionality occurs or operation is localized to autonomous subsystems
- ◆ Multikey Encryption (Selected Public Safety radios)
- ◆ Over-The-Air-Rekeying (OTAR) (Selected Public Safety radios)
- ◆ Software driven tuning and alignment capabilities
- ◆ Batch cloning capability
- ◆ Over-The-Air-Programming (OTAP)

7.2.2U **Emergency Alarm Switch** - As outlined in the pricing section, mobile radio control heads shall be equipped with an emergency switch which will encode a unit identification and emergency status message when depressed. This indication shall be placed onto the system immediately, and shall be decoded and displayed at the user's dispatch center.

7.2.2V **Status Tones** - Audible indication shall be provided for the following operational conditions:

- ◆ System busy
- ◆ Callback when channel is available
- ◆ Trunking controller failure
- ◆ Time out timer operation
- ◆ Access to system denied
- ◆ Out of range of trunked system

7.2.2W **Control Head**

- ◆ Mounting - Shall provide for mounting on vertical or horizontal plane mounting surface
- ◆ Displays - Shall be clearly labeled and shall be backlit for nighttime visibility
- ◆ Microphone - Palm type, with push to talk switch
- ◆ Selector Switches - Rotary selectors and volume controls are required on Public Safety radios, instead of rocker buttons
- ◆ Multiple control heads - Some vehicles require a front and rear control heads
- ◆ An "on-off" switch shall control primary power to the radio set.
- ◆ A volume control shall regulate the audio level of the speaker.
- ◆ Indicator lamps (either incandescent, LED, or LCD devices) shall be provided which indicate "radio set on" and "transmitter carrier on" functions.
- ◆ A talkgroup selector switch or switches, if applicable.

7.2.2X **Service Facilities** - A central metering jack shall be provided for connecting test apparatus to the radio for measuring transmitter and receiver circuitry alignment.

7.2.2Y **Selective Signaling and Alert Decoder**

- ◆ Shall allow for selective signaling of mobile units
- ◆ Shall provide a visual or audible indication on the control head of a call waiting

7.2.2Z **Talk-around and Conventional Operation** - Shall provide for direct, simplex, mobile-to-mobile communication on the base station transmit frequency or other frequency, and conventional mobile relay operation

7.2.2AA **Transmission Lines and Antennas** - Three types of mobile antennas are to be proposed by Offerors. Antenna types to be proposed are:

COLLINEAR ROOF OR TRUNK MOUNT ANTENNA	
Mounting:	¾" Hole Roof Top Mount (NMO type)
Gain:	+3 dB with respect to Quarter Wave
Cable:	Antenna Specialists Proflex or equivalent, minimum 17' in length
Connector:	To Match Mobile Radio

ON GLASS DISGUISE ANTENNA	
Mounting:	Glass mount with impedance Coupling Device
Gain:	+3 dB with respect to Quarter Wave
Cable:	RG58U or better, minimum 15' in length
Connector:	To Match Mobile Radio, detachable at antenna coupling box

LOW SILHOUETTE TRANSIT ANTENNA	
Mounting:	Stainless steel bolts/screws over rubber mounting pad
Gain:	Unity
Cable:	Antenna Specialists Proflex or equivalent, minimum 20' in length
Connector:	To Match Mobile Radio

7.2.2BB Transit antennas will be used on fire apparatus and buses to reduce maintenance and antenna damage.

7.2.2CC All mobile connections must be weatherproof to minimize corrosion.

7.2.2DD The City envisions that at least three tiers of mobile radio products will be considered. The features for these three tiers are differentiated in Section 14 - *Proposed Pricing*.

7.2.3 Portable Radio, 700/800 MHz

- 7.2.3A The portable radio shall meet MIL 810 C, D, and E standards for shock, vibration, salt, fog, dust and rain, and shall consist of weather resistant, FM transmitter, receiver battery power supply and operating controls, all housed in a durable, attractive, weather resistant enclosure. The case of the unit shall fit comfortably in, and permit, one hand operation. Power output of the transmitter shall be a minimum of 2.5 Watts minimum.
- 7.2.3B Portable radios supplied under this procurement shall be frequency synthesized and furnished to operate on all channels in the 700/800 MHz land mobile bands. Specific channel assignment will be made by the trunking control system. In the event the portable radio unit begins operating on a site or subsystem which is in a failed mode, a unique tone will be heard on the unit's speaker and indicated on the display if applicable. Proposers shall describe the capabilities of the proposed portable radios to provide an indication to the user that the trunked system is operating in a mode that is not normal. It is preferred that users have the ability to silence the failure indication tone.
- 7.2.3C The frequency programming shall be accomplished through the use of EE-PROMS. Radios shall be delivered with all necessary channels already programmed. Detailed operational and technical instructions on programming shall also be supplied.
- 7.2.3D The radio set shall be small, lightweight and rugged. Its weight, including battery, shall not exceed 1134 gm. (40 oz). Solid-state circuitry shall be used throughout. The radio set shall be capable of withstanding severe operating conditions. The portable housing shall be constructed of high impact resistant material. It shall be sealed and gasketed to protect internally mounted circuitry against dust, foreign particles, moisture and splashing water. Opening the battery compartment shall not break the seal to the radio circuitry. "Ruggedized" portable radios are preferred. If available, ruggedized portable radios shall be offered and thoroughly described.
- 7.2.3E The radio shall be single battery operated to insure uniform battery depletion. For the purposes of the proposal, Proposers shall use a rechargeable nickel-cadmium battery, which shall be quickly and easily removed. Battery life, based on a 10% transmit, 10% receive, 80% stand-by duty cycle, measured in accordance with EIA RS-316 at 250 milliwatts of audio output, shall be at least twelve (12) hours. Batteries must be capable of full recharge in one (1) hour or less. Batteries provided must be capable of withstanding a 3' drop test to concrete without damaging battery performance or visibly cracking the battery housing.
- 7.2.3F The City of Houston is interested in considering different types of batteries. The Proposer shall include in their proposal a section describing the pros and cons of their available battery types, including their operational parameters. The City intends on making final decisions on battery types after evaluating this response. The City is also interested in compatible battery cases that would allow the use of standard commercially available AA Alkaline batteries with your portable radio equipment.
- 7.2.3G The volume and mode selection controls on the portable radios shall be mounted on the top of the unit for easy access. A rotary control knob shall be provided to select talkgroups as desired, simultaneously selecting the correct transmitter and receiver

- digital code. Other controls shall include a volume control/on-off switch. A sealed transmitter "push-to-talk" (PTT) switch shall be provided on the side of the unit, and an emergency switch shall be provided for user defined quantities of radios. The switch shall not rotate through more than 355 degrees.
- 7.2.3H A variable automatic transmit timer shall turn off the transmitter after a predetermined length of transmission and audibly alert the operator that his transmitter is off with a tone. The audio output level of the tone shall be independent of the volume control.
- 7.2.3I All portables shall be available with a variety of devices such as belt clips, leather cases, etc. Public safety speaker/microphone assemblies shall be available and thoroughly described in the proposal. Further, it must be possible for an operator to remove the public safety speaker/microphone assembly from a portable radio without the use of tools, and then operate the radio in normal fashion. Speaker/microphones shall not have antennas on the microphone. All speaker/microphones shall use coiled cords to connect the speaker microphone to the radio, and shall be available in at least three (3) different lengths. Speaker microphones shall be noise canceling. Speaker microphones for the Fire Department shall be water resistant.
- 7.2.3J The City of Houston is interested identifying compatibility issues with existing electronic equipment in use by City departments today. Proposers shall include in their proposal a section specifically describing compatibility issues with the Scott E-Z Radio Comm and the Grace Industries Electronic Accountability System in use by the Houston Fire Department today.
- 7.2.3K Additional equipment specifications are listed below.
- 7.2.3L **Unit Identification** - Shall transmit a digital unit identification when the PTT switch is depressed
- 7.2.3M **System Compatibility** - Radios shall be equipped and compatible with the following trunked system software or firmware related functions:
- ◆ Dynamic talkgroup reconfiguration
 - ◆ System access priority
 - ◆ Trunking controller failure operating mode
 - ◆ Signaling error correction (To correct erroneous talkgroup assignments, software shall provide for the mobile to revert to the signaling channel in the event that a unit is assigned to an incorrect talkgroup)
 - ◆ Wide area operation capability
 - ◆ Selective inhibit and uninhibit
 - ◆ Visual and audible notification whenever any reduced backbone functionality occurs or operation is localized to autonomous subsystems
 - ◆ Multikey Encryption (Selected Public Safety radios)

- ◆ Over-The-Air-Rekeying (OTAR) (Selected Public Safety radios)
 - ◆ Software driven tuning and alignment capabilities
 - ◆ Batch cloning capability
 - ◆ Over-The-Air-Programming (OTAP)
- 7.2.3N **Emergency Alarm Switch** - An emergency button/switch shall be provided for those units requiring it in the pricing section, which, when activated, permits immediate access to a channel and alerts the dispatcher of an emergency transmission. When the emergency button is activated, the transmitter operates in its highest priority mode, and the PTT switch can be used to key the transmitter in that mode. No receive audio shall be present unless the PTT switch is first activated.
- 7.2.3O Proposers shall describe in their proposal how they intend to comply with this emergency call requirement for hand-held radio sets.
- 7.2.3P **Status Tones** - Shall provide audible indication of the following conditions:
- ◆ System busy
 - ◆ Call back when channel available
 - ◆ Trunking controller failure
 - ◆ Time out timer activation
 - ◆ Access to system denied
 - ◆ Out of trunked radio system range
 - ◆ Master Network Controller failure
 - ◆ Other reduced capability indicator
- 7.2.3Q **Selector Switches** - Rotary selectors and volume controls are strongly preferred instead of rocker buttons. Rotary selectors are required on Public Safety models.

Battery Chargers

- 7.2.3R Battery charging units operating from 110V AC, 60 Hz primary power shall be provided. Multi-unit chargers shall be capable of fully charging batteries in two (2) hours or less. All chargers shall automatically switch to trickle charge when the battery is 70% (or more) charged. Miniature meters (scaleless) or lighted indicators shall be provided which will indicate when a battery is charging and also when it is fully charged.
- 7.2.3S Three types of battery chargers shall be provided:
- ◆ Desktop charger capable of holding a single radio unit or battery.
 - ◆ Multi-unit charger suitable for wall mounting or desktop placement.
 - ◆ Multi-unit battery charger/conditioner capable of diagnosing/ restoring battery performance.

- 7.2.3T Each charger provided shall be capable of recharging batteries with the nickel-cadmium or nickel metal hydride battery either connected to, or removed from, the radio set. The charger shall be equipped with manual and automatic full discharge option to first fully discharge the battery to a minimum of 1 volt per cell and then recharge the battery, or else the bidder shall certify that this feature is not needed, because the batteries being supplied are not susceptible to developing "battery memories".
- 7.2.3U The City envisions that at least three tiers of portable radio products will be considered. The features for these three tiers are differentiated in Section 14 - *Proposed Pricing*.
- 7.2.4 Control Stations
- 7.2.4A Radio operation in the trunked radio system from various fixed locations within the system is required. Control stations, including antennas and transmission lines, shall be provided as listed in the pricing section.
- 7.2.4B All radio equipment shall be FCC type accepted under Part 90 of the FCC Rules and Regulations. Control stations shall be available with an optional auxiliary power system capable of sustaining operation for a period of four hours. Rechargeable batteries shall be provided, sealed batteries shall be used. Recharge time shall not exceed 12 hours; chargers shall be included.
- 7.2.4C Additional equipment specifications are listed below.
- 7.2.4D **Automatic Unit Identification** - Shall transmit a digital unit identification on push to talk.
- 7.2.4E **System Compatibility** - Mobile radios shall be equipped and compatible with software related features of the trunking system:
- ◆ Dynamic talkgroup reconfiguration
 - ◆ System access priority
 - ◆ Trunking controller failure operating mode
 - ◆ Signaling error correction (To correct erroneous talkgroup assignments, software shall provide for the mobile to revert to the signaling channel in the event that a unit is assigned to an incorrect talkgroup)
 - ◆ Wide area operation capability
 - ◆ Selective inhibit and uninhibit
 - ◆ Visual and audible notification whenever any reduced backbone functionality occurs or operation is localized to autonomous subsystems
 - ◆ Multikey Encryption (Selected Public Safety radios)
 - ◆ Over-The-Air-Rekeying (OTAR) (Selected Public Safety radios)

- ◆ Software driven tuning and alignment capabilities
- ◆ Batch cloning capability
- ◆ Over-The-Air-Programming (OTAP)

7.2.4F **Emergency Alarm Switch** - As outlined in the pricing section, control stations shall be equipped with an emergency switch which will encode a unit identification and emergency status message when depressed. This indication shall be placed onto the system immediately, and shall be decoded and displayed at the user's dispatch center.

7.2.4G **Status Tones** - Audible indication shall be provided for the following operational conditions:

- ◆ System busy
- ◆ Callback when channel is available
- ◆ Trunking controller failure
- ◆ Time out timer operation
- ◆ Access to system denied
- ◆ Out of range of trunked system

Control Head

- ◆ Displays - Shall be clearly labeled and shall be backlit for nighttime visibility
- ◆ Microphone – Desk or palm type, with push to talk switch
- ◆ Selector Switches - Rotary selectors and volume controls are required on Public Safety radios, instead of rocker buttons
- ◆ An "on-off" switch shall control primary power to the radio set.
- ◆ A volume control shall regulate the audio level of the speaker.
- ◆ Indicator lamps (either incandescent, LED, or LCD devices) shall be provided which indicate "radio set on" and "transmitter carrier on" functions.
- ◆ A talkgroup selector switch or switches, if applicable.

7.2.4H **Service Facilities** - A central metering jack shall be provided for connecting test apparatus to the radio for measuring transmitter and receiver circuitry alignment.

7.2.4I **Selective Signaling and Alert Decoder**

- ◆ Shall allow for selective signaling of radio units
- ◆ Shall provide a visual or audible indication on the control head of a call waiting

7.2.4J **Talk-around and Conventional Operation** - Shall provide for direct, simplex, radio-to-radio communication on the base station transmit frequency or other frequency, and conventional mobile relay operation

7.2.4K Additional equipment specifications are found in the following tables.

Figure 7.2.4A

Base Station, Mobile, Portable, Control Station Specifications
(Public Safety Tiers)

SPECIFICATIONS	REPEATER	MOBILE	PORTABLE	CONTROL
Power Requirements	120 Vac, 60 Hz & 12 or 24 VDC	11-16 Vdc, negative ground	Ni-MH preferred or Nickel-Cadmium, (re-chargeable)	120 Vac, 60 Hz & 12 or 24 VDC
Temperature	-30° to +60° C (Full Performance)	-30° to +60° C (Full Performance)	-30° to +60° C (Full Performance)	-30° to +60° C (Full Performance)
Humidity	95% @ 50° C	95% @ 50° C	95% @ 50° C	95% to 50° C
Duty Cycle	Continuous	20% Tx 100% Rx	10% Tx 10% Rx 80% Stby (8 hour minimum battery life)	20% Tx 100% Rx
Shock & Vibration		MIL 810 C/D/E	MIL 810 C/D/E	MIL 810 C/D/E
Tx RF Output Power	≥60 watts	15 watts	2.5 watts	10 watts
Tx RF Output Impedance	50 Ω	50 Ω	--	50 Ω
Tx Frequency Stability	Note 1 -30°/+60° C	±0.00015% -30°/+60° C	±0.00015% -30°/+60° C	±0.00015% -30°/+60° C
FCC Emission Designator	16F3, 16F9	16F3	16F3	16F3
Tx Local Audio Sensitivity	-15 dBm @ 3.3 kHz deviation			-15 dBm @ 3.3 kHz deviation
Tx Audio Response	+1, -3 dB, 6 dB pre-emphasis	+1, -3 dB, 6 dB pre-emphasis	+1, -3 dB, 6 dB pre-emphasis	+1, -3 dB, 6 dB pre-emphasis
Tx Audio Distortion	≤2% @ 1 kHz @ 5 kHz deviation	≤3% @ 1 kHz	<5% @ 1 kHz	≤3% @ 1kHz
Tx Spurious & Harmonic	≥-65 dB	≥-75 dB	≥-75 dB	≥-75 dB
Tx FM Noise	≥-50 dB @ 3.3 kHz deviation & 1.0 kHz modulation	≥-40 dB @ 3.3 kHz deviation & 1.0 kHz modulation	≥-40 dB @ 3.3 kHz deviation & 1.0 kHz modulation	≥-40 dB @ 3.3 kHz deviation & 1.0 kHz modulation
Rx Frequency Stability	±0.0001% -30°/+60° C	±0.00015% -30°/+60° C	±0.00015% -30°/+60° C	±0.00015% -30°/+60° C
Rx Sensitivity (EIA SINAD)	0.35μV/12dB SINAD	0.35μV/12dB SINAD	0.35μV/12dB SINAD	0.35μV/12dB SINAD
Rx Selectivity (12.5kHz Channel)	≥-60 dB	≥-63 dB	≥-63 dB	≥-63 dB
Rx Intermod Rejection	≥-80 dB	≥-70 dB	≥-70 dB	≥-70 dB

SPECIFICATIONS	REPEATER	MOBILE	PORTABLE	CONTROL
Rx Spurious & Image Rejection	≥-90 dB	≥-75 dB	≥-75 dB	≥-75 dB
Rx Audio Response	+1, -3 dB, 6dB/octave de-emph	+1, -3 dB, 6dB/octave de-emph	Note 2	+1, -3 dB, 6dB/octave de-emph
Rx Audio Output	Min. 1 watt, ≤5% distortion @ max. rated output	5 or 10 watts, ≤3% distortion @ max. rated output	0.5 watts, ≤5% distortion @ max. rated output	1.5 watts, min ≤3% distortion @ max. rated output

Figure 7.2.4B
Mobile, Portable, Control Station Specifications
(Non-Public Safety Tier)

SPECIFICATIONS	MOBILE	PORTABLE	CONTROL
Power Requirements	11-16 Vdc, negative ground	Ni-MH preferred or Nickel-Cadmium, (re-chargeable)	120 Vac, 60 Hz & 12 or 24 VDC
Temperature	-30° to +60° C (Full Performance)	-30° to +60° C (Full Performance)	-30° to +60° C (Full Performance)
Humidity	95% @ 50° C	95% @ 50° C	95% to 50° C
Duty Cycle	20% Tx 100% Rx	10% Tx 10% Rx 80% Stby (8 hour minimum battery life)	20% Tx 100% Rx
Shock & Vibration	MIL 810 C/D	MIL 810 C/D	MIL 810 C/D
Tx RF Output Power	15 watts	2.5 watts	10 watts
Tx RF Output Impedance	50 Ω	--	50 Ω
Tx Frequency Stability	±0.00015% -30°/+60° C	±0.00015% -30°/+60° C	±0.00015% -30°/+60° C
FCC Emission Designator	16F3	16F3	16F3
Tx Audio Response	+1, -3 dB, 6 dB pre-emphasis	+1, -3 dB, 6 dB pre-emphasis	+1, -3 dB, 6 dB pre-emphasis
Tx Audio Distortion	≤3% @ 1 kHz	<5% @ 1 kHz	≤3% @ 1kHz
Tx Spurious & Harmonic	≥-70 dB	≥-70 dB	≥-70 dB
Tx FM Noise (12.5kHz channels)	≥-31 dB @ 3.3 kHz deviation & 1.0 kHz modulation	≥-31 dB @ 3.3 kHz deviation & 1.0 kHz modulation	≥-31 dB @ 3.3 kHz deviation & 1.0 kHz modulation
Rx Frequency Stability	±0.00015% -30°/+60° C	±0.00015% -30°/+60° C	±0.00015% -30°/+60° C
Rx Sensitivity (EIA SINAD)	0.35μV/12dB SINAD	0.35μV/12dB SINAD	0.35μV/12dB SINAD
Rx Selectivity (12.5kHz Channel)	≥-60 dB	≥-60 dB	≥-60 dB

SPECIFICATIONS	MOBILE	PORTABLE	CONTROL
Rx Spurious & Image Rejection	≥-70 dB	≥-70 dB	≥-70 dB
Rx Audio Response	+1, -3 dB, 6dB/octave de-emph	Note 2	+1, -3 dB, 6dB/octave de-emph
Rx Audio Output	5 or 10 watts, ≤3% distortion @ max. rated output	0.5 watts, ≤5% distortion @ max. rated output	1.5 watts, min ≤3% distortion @ max. rated output

Notes:

- 1) Proposers shall specify the stability of the oscillators used for simulcast operation. For any non-simulcast sites proposed, Proposers shall specify the base station transmitter stability.
- 2) Overall audio response of the microphone and all elements of the transmitter shall be between +4 and -6 dB of a dB/octave reference from 800 to 2500 Hz and between +4 and -10 dB from 300-3000 Hz when measured at constant sound pressure level of +104 dB (0.0002 dynes per square centimeter reference). Electrical audio response shall be between +1 and -3 dB of the standard EIA 6 dB/octave pre-emphasis characteristic between 300 and 3000 Hz with the exception of a permissible 6 dB/octave roll-off from 2500-3000 Hz.

Fully Compliant Partially Compliant Non-Compliant

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Section

8

Implementation & Payment

8.1 Implementation

- 8.1A The new system shall be installed in two phases. Phase I shall include the complete installation and optimization of the 700 / 800 MHz radio infrastructure which is comprised of multiple repeater sites consisting of base repeater radios, microwave system, power and grounding systems, towers, shelters, trunked system controllers and audio switches and associated equipment. Phase I will also include the installation of Police, Fire, and PW&E radio dispatch center equipment and the associated console electronics equipment for the system.
- 8.1B Phase II will consist of the installation of the City agencies onto the radio infrastructure. Final system acceptance will not be considered until all City agencies have been successfully installed on the new network, Phases I and II.
- 8.1C The implementation of any system of this size and complexity is a significant undertaking. Careful planning of all aspects of the project including the physical installation of equipment, new system testing, training, and cutover of the City agencies onto the new system are required to ensure a successful project. The successful Proposer will provide detailed plans of processes for tracking and controlling the project. The proposal will include a high level project plan for the overall project schedule, work breakdown structure, project communications, quality assurance, change control procedures and a transition and cutover plan for each affected City agency. Special consideration must be given to the day-to-day operations of the City agencies, which must not be disturbed or interrupted.
- 8.1D The project plan will be a dynamic document in that it will be continually updated and evaluated as the project progresses. A detailed project plan and schedule will be required of the Contractor after the system design review.

8.1.1 Project Schedule

- 8.1.1A Due to the age of the City's current radio systems, the City wants to develop and implement the new system as soon as possible. The Proposer needs to provide a tentative project schedule including the below listed tasks.
- ◆ Contract signing / Notice to Proceed
 - ◆ Completion of system design review
 - ◆ Training of the technicians responsible for system maintenance
 - ◆ System staging completed
 - ◆ Completion of infrastructure installations at end locations

- ◆ Infrastructure acceptance testing successfully completed
 - ◆ Coverage testing successfully completed
 - ◆ Test documentation submitted to the City
 - ◆ Initial Subscriber Fleet of non-public safety user training and subscriber installation completed
 - ◆ 60-day operational test successfully completed
 - ◆ System infrastructure accepted, Warranty begins
 - ◆ Completion of transitioning the remaining City agencies to the system
 - ◆ Project completion
- 8.1.1B A detailed project schedule shall be provided as part of each proposal. The project schedule shall be referenced to the contract execution date. The project schedule shall clearly identify tasks to be performed by both the City and the Contractor.
- 8.1.1C The project timeline shall include important milestones and logical breakpoints during which the City and Proposer shall assess the progress to date, and prepare for the remaining project tasks.
- 8.1.1D The first milestone of the Proposer's timeline shall be contract execution. All other events will be referenced in number of days from contract execution. The second major milestone in the proposed schedule shall be completion of system staging. At staging, all of the infrastructure equipment required to make a fully operational communications system shall be assembled into the proposed configuration and tested as a system, including, but not limited to:
- ◆ Repeater sites
 - ◆ Network and site controllers
 - ◆ LAN/WAN/Audio Distribution Equipment
 - ◆ Alarm and control units
 - ◆ All Dispatch Consoles
 - ◆ Representative subscribers
 - ◆ System Management systems
 - ◆ System Alarm Panels
 - ◆ Combiners and multicouplers
 - ◆ Jumper cables cut to size for their end location

- ◆ Transmitter site
 - ◆ Microwave system – The Proposer shall decide whether the microwave system is staged with the trunked radio system equipment or separate at the microwave vendor facility.
- 8.1.1E At the successful completion of system staging, the fixed network will not be shipped until approval to ship has been granted by the City.
- 8.1.1F Upon receipt of City approval, the fixed network equipment shall be delivered to the City by a method designed to safely transport sophisticated electronic equipment. Upon arrival at the destination, all equipment will be received and inventoried by the Contractor. Any interim storage required for the equipment is the responsibility of the Proposer. Title for the equipment shall not pass to the City until the equipment has been fully installed and paid for.
- 8.1.1G When the system has been fully installed, programmed, is operational, and fully tested by the Proposer according to agreed upon test scripts, the City shall then be notified in writing that the system is ready for acceptance testing. The proposed timeline shall include an appropriate amount of time for City officials to witness all such tests.
- 8.1.1H The Coverage Acceptance Tests shall not begin until the system has been fully optimized and the infrastructure tests have been successfully completed and passed. Documentation of both the infrastructure and coverage test results shall be presented for the City's review following successful completion of the coverage tests. The proposed timeline shall allow at least three (3) weeks for the City to review and approve the test documentation after all testing has been completed.
- 8.1.1I Non-Public Safety user training and subscriber installation should be scheduled to begin within one (1) month after successful completion of the Coverage Acceptance Test. This will provide ample time for the City to review all test documentation, and time for the Contractor to resolve any deficiencies. This will also allow the Contractor time to prepare for the cutover to the new system, which will include training all users and issuing radio equipment.
- 8.1.1J A 60 consecutive day operational system test without a major failure will be required as part of system acceptance. For the purposes of your proposal, it shall be assumed that the following agencies will be transitioned to the new system prior to the 60-day operational test. These agencies will be non-critical users and will provide a measure of system loading and usage during the 60 day operational test. Tentatively, such agencies may include:
- ◆ City to select agencies as appropriate, typically non-public safety agencies
 - ◆ Agency 2 to be determined
 - ◆ Agency 3 to be determined
 - ◆ Agency 4 to be determined
- 8.1.1K The 60-day operational test, or Burn-In period, shall be scheduled to start upon written notification to the City that the system is ready for the burn-in test and the initial user training and initial subscriber transitions have been successfully completed.

- 8.1.1L If the system performs as specified for 60 consecutive days, and the remainder of the acceptance tests and punch listed items have been resolved, then the system infrastructure will be considered accepted. Any major failure that occurs, at the discretion of the City's project manager, may reset the 60 day operational test period clock. The project manager's decision to reset the clock should be based, in part, upon the source and severity of the failure as well as the operational impact suffered by the users.
- 8.1.1M The system will be observed during this period to ensure that it performs as specified. Any failure to perform as specified in the contract will be remedied before the infrastructure is accepted.
- 8.1.1N The cutover and transition of the remaining City agencies will follow the same process as the initial agencies, but will not begin until the 60-day operational test has been successfully completed.
- 8.1.1O Upon successful completion of the Burn-In period and completion of agency transitions, the Contractor shall begin demobilization and removal of existing infrastructure equipment. Infrastructure equipment shall include base stations, consoles, associated control cables, antennas, and transmission lines. Towers shall be cleaned of any existing mounting hardware, grounding straps, etc., that are no longer needed and shall be appropriately finished.
- 8.1.1P Old infrastructure equipment will be conspicuously labeled with the following information:
- ◆ Site Name and description
 - ◆ Make, Model & Serial No.
 - ◆ Associated Accessories or Options
 - ◆ Frequency Information
- Particular attention must be given to the City asset tags which must be recorded and inventoried.
- 8.1.1Q Infrastructure equipment will be carefully inventoried as it is removed, and shall be stored in a City designated location within the City of Houston area.
- 8.1.1R The first phase of the project shall be considered complete when all aspects of the Contract and Statement of Work have been fulfilled, the system has been completed, the Acceptance Test Plan has been successfully completed, the 60-day Burn-In period has been successfully passed, all old infrastructure equipment has been removed, the Dispatch Centers utilized by the subscribers have been completed, all software is of the latest version, and all required documentation has been completed and approved, and significant punch listed items have been corrected.
- 8.1.1S The second phase of the project shall consist of the installation of additional agencies.

8.1.2 Work Breakdown Structure

- 8.1.2A The Work Breakdown Structure shall provide the detailed task listing of the physical work to be accomplished by the Contractor and the City. The initial work breakdown structure diagram can be a high-level block diagram or a numbered list of the tasks to

be accomplished by the City and the Contractor. The detailed work breakdown structure will be due three (3) weeks after the system design review. The work breakdown structure outlines the work needed to develop and implement the system. The tasks must be detailed enough so that all items are included and tracked, but it shall not be so detailed as to be cumbersome. Generally tasks are broken down into what work can be accomplished in 4 to 8 hours by a person or a team. The Work Breakdown Structure can be a part of the Project Schedule, but it must include the following:

- ◆ Task description
- ◆ Responsibility for completion of work task
- ◆ Date scheduled for completion
- ◆ Date of completion

8.1.3 Project Communications Plan

8.1.3A The Contractor will provide a detailed communication plan that outlines all forms of contact and information sharing needed by the project team to ensure a successful project. The Contractor will provide the name, contact information and resume of the Project Manager. The Project Manager will be the single point of contact for the project. The City is requiring a full-time on-site Contractor provided Project Manager with a local telephone number for contact. The Contractor shall provide a communication plan that includes contact information for the members of the project team and escalation procedures to be followed if there is an issue which may put the project or a portion of the project at risk. The communication plan must also show all levels of project reporting throughout the project lifecycle. The City requires a regularly scheduled weekly project meeting starting immediately after the contract signing. Items to be included in the communication plan:

- ◆ Project Team contact information
- ◆ Escalation procedure
- ◆ Scheduled meetings
 - Meeting cycles
 - Meeting agendas
 - Meeting report sample
 - Required attendees by title (engineer, user, executive, etc)
- ◆ Project status reports
 - Status report cycle
 - Content to be provided in the status report
 - Status report sample
 - Status report recipients
- ◆ Secure web site for document sharing

8.1.4 Quality Assurance Plan

8.1.4A The Quality Assurance Plan is a physical guideline of the steps taken to demonstrate that system implementation is proceeding in a manner that is consistent with the City expectations and industry standards. The quality plan should include a narrative

and/or photos of the acceptable final product of each phase of the installation. Physical inspection points need to be indicated and should include the following as a minimum guideline:

- ◆ The system design review
- ◆ System design documentation
- ◆ Equipment staging
- ◆ Equipment inspection and inventory
- ◆ Steps of inspection throughout the implementation process
 - The site is ready for construction
 - When pouring concrete
 - During placement of shelters
 - Before installing electronic equipment
 - After installation of electronic equipment
 - Before installation of antennas
 - After installation of antennas
- ◆ As-built documentation
- ◆ Final acceptance

8.1.4B The City and the Contractor must have the appropriate representatives inspect and approve the quality of work before moving to the next step. Inspection points must be a part of the Project Schedule.

8.1.5 Change Control Process

8.1.5A As with all projects of this size and complexity there will be changes to the original scope of work. An important part of managing a project is to prevent, track and document changes. The proposal will include the procedures to minimize or stop “scope creep”, identify potential problems that can change the schedule or project cost, and track and record changes that are agreed upon by the City and the Contractor. The proposal will include a sample change control document.

8.1.6 Transition and Cutover Plan

8.1.6A The proposal will include a high-level plan to transition agencies from the existing systems to the new system and the steps required to complete the cutover. During transition an agency must not have communications on the existing system disrupted. The final cutover will be planned in such a manner as to have minimal disruptions to the agency operations. The Proposer must consider the use of loaner radios, gateways, RF patches, timing, training and/or any other method to minimize disruptions to operations.

8.1.6B A detailed transition and cutover plan will be required from the Contractor sixty (60) days after the system review. The cutover plan must also include an exit plan to transition back to the old system if there is a problem during the cutover phase. There must be a well defined decision point for the agency representative to determine if the agency and the system are ready for cutover.

8.1.6C The Transition and cutover process is critical to the success of implementing a new system. The City will work closely with the Contractor to develop a successful plan.

The Contractor will be expected to understand the operations of the agencies to be cutover to develop a plan that will minimize disruptions.

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8.2 Time Constraints

8.2A Coverage testing will only take place between the months of May and September, when full foliage conditions exist.

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8.3 Payment Schedule

8.3A Payments will be made as key milestones are reached, in accordance with the following schedule:

PAYMENT SCHEDULE

MILESTONE	PAYMENT PERCENTAGE
Contract Signed & Executed	5%
Design Review Completed	5%
Completion of System Factory Staging	15%
Infrastructure Delivered & Fully Operational	15%
Infrastructure Acceptance Testing Completed	15%
Infrastructure Test Document Submitted & Approved	10%
Installation of Initial Subscriber Fleet Completed	5%
60-Day Burn-In Successfully Completed	5%
Infrastructure Accepted; Warranty Begins	20%
Complete Transition of Additional City Agencies	5%

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8.4 Extension of Project Schedule

8.4A Installation and satisfactory operation of the system must be completed within the period specified herein, or the time guaranteed by the Proposer in the project schedule submitted with the proposal, whichever is shorter. Extension of time for completion is unlikely especially if such extension would cause loss of funds appropriated to pay for this project.

8.4B Project extensions will be granted if delays are experienced as the result of:

- ◆ Actions taken by the City, or its agents
- ◆ Changes ordered by the City
- ◆ Difficulties experienced in obtaining FCC, FAA or zoning approval of proposed facilities, assuming approval requests were filed in a timely manner, and diligently pursued.
- ◆ Road repairs, mishaps, strikes, Acts of War, Acts of God, riots, lockouts or inclement weather which would delay equipment or limit access to any site at which work will be required

8.4C Due to the critical time constraints, should the Contractor fail to complete the project within the specified completion schedule, the sum of \$5,000.00 per calendar day will be deducted from the monies due the Contractor for purchase of the equipment/services. This sum shall not be considered as a penalty, but rather as reasonable liquidated damages, since it would be impracticable or extremely difficult to fix the actual damages. An extension of time may be allowed for delays beyond the control of the Contractor at the discretion of the City of Houston.

8.4D The Contractor shall submit requests for time extension(s) to the City, in writing. The request shall describe the type of delay, the cause and its apparent impact on contract delivery/completion schedules. The Contractor shall make such requests on the Friday of each week that potentially excusable delays occur.

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Section

9

Installation & Documentation

9.1 General

- 9.1A All installation work performed shall be in accordance with laws and regulations of the U.S. Department of Labor and the State of Texas.
- 9.1B The Contractor shall provide all the necessary personnel, tools, equipment and transportation for the successful installation of all equipment provided.
- 9.1C At a minimum, the Contractor shall provide at least one Project Manager, on site, full time (Site Manager).
- 9.1D The Site Manager shall oversee all aspects of system implementation, including site preparation, equipment programming, staging, installation, etc. Other individuals may assist the Site Manager in various functions such as reporting, accounting, testing, optimization, etc., but this individual shall have primary responsibility for the performance of the system.
- 9.1E The On-Site Manager shall focus solely upon the Radio Communication project from contract signing to acceptance of the system.
- 9.1F It shall be the responsibility of the Contractor to provide design, equipment, software and services to successfully install the new 700/800 MHz radio system as described in the specification. Optimization, troubleshooting, and adjustment of each subsystem shall be the Contractor's responsibility. Installation shall include the removal of existing mobile radio equipment and ancillary subsystems that will be replaced under this procurement. All equipment removed from service shall be kept together with any associated parts, cables, accessories, etc. Care shall be taken to prevent damage to any equipment parts, cables or accessories. The Contractor shall inventory these items as they are collected, and shall be returned to a storage facility designated by the City.
- 9.1G User equipment shall be individually boxed and sealed in suitable cardboard boxes, and labeled with the following information:
- ◆ User Department Name
 - ◆ Equipment Make, Model No. and Serial No.
 - ◆ Associated Accessories and Options
- 9.1H To the extent possible, the existing radio communications systems shall remain fully operational during installation of the new system and until the City provides final acceptance. Because existing systems support current operations, interruptions in service due to Contractor or Contractor activities cannot be tolerated. If interruptions in service are deemed by the Contractor to be unavoidable, written notification, detailing the nature and duration of such interruptions shall be provided to the City for review and approval no less than 30 days before the interruption is to occur. In the event that the Contractor or associated subcontractor causes a major outage resulting in loss of a

repeater site, or console system, the Contractor shall be assessed \$5,000 for each occurrence, and for each day that the outage continues.

- 9.1I Equipment shall be installed in a neat and workmanlike manner, in accordance with high standard professional practice, by competent technicians or mechanics. 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.
- 9.1J Subcontractors performing installation of any equipment or subsystems shall be identified in the Proposer's proposal. All installation subcontractors' experience and qualifications to perform the tasks associated with this procurement shall be outlined in the proposal.
- 9.1K 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 intent of the specifications.
- 9.1L 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.
- 9.1M Mobile installations performed in vehicles that are equipped with air-bag protection devices shall be installed in a manner that will not in any way impede the ability of the air bag to protect the occupants during a collision.

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9.2 Communication Sites

- 9.2A The Contractor shall be responsible for the installation of all of the necessary components associated with the communications system described in these specifications. The Contractor shall furnish all tools, test equipment, supplies and services necessary to provide a fully operational and satisfactory communications system for the City.
- 9.2.1 Repeaters
- 9.2.1A The installation of the radio frequency equipment will be provided by the Contractor at the designated location(s) within the equipment shelters at the base station sites. The Contractor shall supply and install all required equipment, accessories, punch-blocks, terminal strips and/or cables needed to interface to new and/or existing facilities.
- 9.2.1B It is preferred that all audio and control cable/wiring to and from the radio equipment be shielded. It is preferred that cable/wiring interfaced to the Public Switched Telephone Network be shielded up to the demarcation point.
- 9.2.1C All external equipment inter-cabling, whether NETWORK, RF, AC, AUDIO or CONTROL cables and/or wiring, shall be labeled with pre-printed adhesive wire labels. Markers shall be placed at each end, adjacent to the connector, plug or terminus. For

cables and/or wiring, within the shelter, markers shall be placed at 3' intervals along the length of the cable and/or wiring. This data shall be recorded in the installation documentation.

- 9.2.1D All equipment cables or cable bundles within the shelter, to the greatest extent feasible, will be neatly tied by means of plastic tie wraps and secured by clamps to flat surfaces.
- 9.2.1E All cable/wiring bundles exiting the equipment must do so through the top of the cabinets or racks. Rubber grommets or other suitable protection shall be used at cabinet knockouts to protect the cable/wiring. Splicing of NETWORK, AC, AUDIO or CONTROL cable/wiring will not be permitted.
- 9.2.2 Antennas & Transmission Lines
- 9.2.2A For each cable provided, 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.
- 9.2.2B The ends of rigid transmission line shall not connect directly to the antenna, to any RF equipment interference protection or multiplexing devices.
- 9.2.2C Transmission line runs inside equipment shelters or buildings shall be supported, every 3', with cable trays or stainless steel cable hangers. Multiple cable runs shall not be bundled together, but rather, shall be strung and supported adjacent to each other.
- 9.2.2D All coaxial jumper cables shall be ½" diameter (such as Andrew Superflex model FSJ4-50B), or approved equal.
- 9.2.2E Jumper cables shall be used to interconnect all interference protection or multiplexing devices with the coaxial antenna transmission line and radio frequency equipment.
- 9.2.2F 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. Jumper cable interconnections shall be weather proofed by installation of 3M cold shrink weather proofing kits, Andrews Type 241XXX or equivalent. The use of vinyl tape is not acceptable for this purpose.
- 9.2.2G All jumper cables shall be cut to length and shall use type 'N male' connectors except as dictated by the connector supplied with the antenna.
- 9.2.2H To meet cable bending specifications for strain relief purposes, equipment cabinet intra-cabling will be permitted by the use of ¼" diameter, such as Andrew Superflex, or RG-142 double shielded coaxial cable. These cables shall be limited to:
- ◆ 10 feet in length
 - ◆ Interconnection between the equipment RF port(s) and the cabinet feed-throughs or the first interference protection or multiplexing devices.
- 9.2.2I All coaxial cables exiting the equipment cabinets shall do so through cabinet feed-throughs. The feed-throughs shall be Celwave model PD-395, or approved equal.

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9.3 Communication Consoles

9.3.1 General

- 9.3.1A The installation of the new consoles and associated equipment shall be provided by the Contractor at all designated locations specified in Section 6, *Dispatch Consoles*.
- 9.3.1B The Contractor shall supply and install all required termination blocks, terminal strips and/or cables needed to interface the new console electronics to existing facilities such as radio equipment, telephone equipment, logging recorder equipment and/or auxiliary function and/or control circuits.
- 9.3.1C All new console intercabling, including those that are to terminate at existing punch blocks, shall be labeled with pre-printed adhesive wire markers. The markers shall be placed at each cable end, adjacent to the connector or plug. All cables and/or cable bundles will be hidden from view and will be neatly secured by means of plastic tie wraps.
- 9.3.1D All intercabling to the operator positions shall be provided with sufficient slack to permit movement of at least 5' in any direction.

9.3.2 Physical Interface Requirements

- 9.3.2A The Successful Contractor shall be responsible for the links between the console operator positions and the radio network.
- 9.3.2B The physical interface is expected to include, at a minimum, the following:
- ◆ Wire and/or network connections to the appropriate console termination points.
 - ◆ Wire and/or network connections to the appropriate audio distribution networks, and network components.
 - ◆ Proper termination of all used and unused I/O ports on audio distribution networks.

9.3.3 Functional Interface Requirements

- 9.3.3A The Successful Contractor shall be responsible for the functional interface(s) between the radio system and the communications consoles.
- 9.3.3B The functional interface is expected to include, at a minimum, the following:
- ◆ Adjustments of input signal level(s) to consoles
 - ◆ Adjustments of output signal level(s) to consoles
 - ◆ Adjustments of output signal level(s) from any required base station interfaces

- ◆ Adjustments of input signal level(s) to audio distribution networks from corresponding base station interfaces
- ◆ Verification of necessary base station control format(s)

9.3.3C Adjustments of the level and duration of the output signal(s) from the corresponding base station interface

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9.4 Mobile Radio

- 9.4A It is a requirement that the Contractor be capable of performing all mobile radio installations at a location provided by the Contractor, which has an indoor secured facility, or at a location(s) provided by the City. Pricing shall include all appropriate costs. The facility provided by the Contractor shall be located within the City, if feasible, and shall be subject to City approval. Mounting requirements will be supplied to the Successful Contractor.
- 9.4B Mobile unit installations are to become operational in the first phase, and shall not begin until the system infrastructure including the console electronics are installed, operational, and tested. Training for the console operators and mobile radio operation training for each department shall also be performed before the trunked mobile radio units are installed.
- 9.4C The Successful Contractor shall remove the existing radio unit (unless instructed not to) when installing the new trunked mobile radio. When removed, the existing radio, its control head, antenna, and wiring harness shall be placed in an individual storage box with a label indicating the City department it was removed from, make and model of radio, frequency band and date removed.
- 9.4D At a mutually agreed time of installation, the Successful Contractor will be given information as to the physical vehicle placement of the mobile units for each department and radio user. This work may include relocation of existing equipment. If the department has not provided the proper information by the scheduled time of the installation or does not provide the vehicle at the proper time, the department shall be responsible for any additional expenses. Proposers are to provide, as part of the RFP response, the cost for such rescheduling of the mobile installation.
- 9.4E All coaxial cable connectors shall be soldered to its cable or to its interface circuitry. Crimp-style connectors for this application are acceptable. Low loss Teflon antenna cable is preferred.
- 9.4F All wiring shall be appropriately dressed and connectorized in accordance with good engineering practices. Each main power lead shall be attached to its own in-line fuse rated for the maximum current drain of the associated circuit and connected as close as practical to the battery using approved methods and hardware. Obtaining power by connecting to existing radio equipment or any other device is unacceptable.

- 9.4G All cabling that is exposed shall be dressed with a flexible tubing and secured to the vehicle by attachment to any stationary support element using solid copper wire or fasteners. Plastic tie wraps should be used within at least 2' of the end connection points in areas not directly exposed to the weather.
- 9.4H The cable length shall allow minor repositioning of the equipment to allow for changing operating conditions. A representative from each department shall inspect the first installation of equipment. A department representative will inspect each vehicular installation. Each vehicular installation shall successfully complete an operational performance test and shall be approved via signature of the City department inspector.
- 9.4I The mobile assembly shall be positioned on a mounting assembly such that the mounting plates, base plates, brackets, etc., designed for mobile communication applications. The finished assembly shall be secured and remain in a fixed and motionless position under all operating conditions.

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9.5 As-Built Installation Documentation

- 9.5A Thorough "as built" documentation shall be provided by the Contractor and delivered to the City's Project Manager. Three (3) copies of the documentation shall be provided in 3-ring binders and three (3) copies on CD media in the original software format, including AutoCAD, Excel, and Word for drawings, spreadsheets, and text. At a minimum, the following "as built" documentation shall be included in each set:
- 9.5B A general system manual that describes the overall system layouts, architecture, and its operating and failure modes.
- ◆ System block diagrams.
 - ◆ Site layouts and floor plans of each equipment site, and dispatch facility, to scale.
 - ◆ Rack face drawings, to scale.
 - ◆ Drawings showing cable tray location details, to scale.
 - ◆ Microwave system map identifying each site, antenna make, model and orientation, and frequency of operation.
 - ◆ Radio propagation coverage maps.
 - ◆ Coverage Acceptance Test documentation.
 - ◆ All external equipment inter-cabling, whether NETWORK, 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. For cables and/or wiring, within the shelter, markers shall be placed at 3' intervals along the length of the cable and/or wiring.

- ◆ Interconnection drawings that show all connections between sub-assemblies, such as terminal boards, panel assemblies or other equipment, and which external connections are made, shall be provided.
- ◆ Numbering and labeling of all cabling associated with remote control units.
- ◆ Numbering and labeling of all connections to termination blocks associated with the control consoles.
- ◆ Numbering and labeling of all interconnecting cabling between repeaters, the central control, any remote site controllers or processors, alarm circuits, and leased telephone company circuits, and the microwave system.
- ◆ A log of level settings for all control circuits.
- ◆ A record of telephone circuits by circuit number and telephone number for service on these circuits.
- ◆ A microwave channelization plan.
- ◆ Documentation and labeling of transmission line routing and antenna mounting at all fixed sites, with detailed drawings showing all mounting hardware and accessories.
- ◆ Complete set of maintenance and operations manuals shall be provided for the system as whole and for each category of equipment purchased in association with this project
- ◆ Manuals for OEM hardware for each component of the system.
- ◆ Any unique wiring configurations or circuit modifications that are not part of the standard equipment documentation provided shall be included in the ring binder. All information as described in the previous paragraph shall be included, in addition to the theory and method of operation.
- ◆ A complete inventory of all provided equipment and software including model numbers, serial numbers, version numbers in printed form and in the latest version of Microsoft Access.
- ◆ Final fleetmap configuration, with all group I.D.'s and aliases.
- ◆ A complete roster of unit I.D.'s and aliases.
- ◆ Documentation of final programming configuration for all software programmable equipment.
- ◆ A soft copy and printed copy of all equipment programming templates used in the system.
- ◆ Copies of the Hardware Acceptance Test Plan, with all recorded measurements.

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Section

10

Acceptance Testing

- 10A Proper operation of the new trunked radio system is essential, both initially and in the long term. To help assure that the system is ready for agency use, the City and the selected Contractor will jointly undertake a structured System Acceptance Testing Program (ATP) process to verify proper installation, optimization, and performance of the system and its components. Radio coverage performance is an important part of the ATP process. Detailed information about the coverage testing process has been included in Section 3 – Radio Coverage Requirements, of this RFP.
- 10B As part of the Acceptance Testing Plan, the City is requiring both factory acceptance testing and post-delivery on-site field testing in Houston to verify operational compliance.

10.1 Factory Tests

- 10.1A Due to the size and complexity of the City's system, the City is requiring that the system be "staged" at a facility where system issues & problems that may arise during system development can be identified and corrected prior to shipment of the system infrastructure to the City of Houston.
- 10.1B The Contractor shall provide for a staging area to facilitate system assembly and testing. The staging area shall be in a secured facility specifically designed for the staging of large-scale Public Safety radio communication systems and equipment in a climate and RF controlled environment. Outdoor installation bays will not be an acceptable location for system staging.
- 10.1C Representatives from the City of Houston will attend and participate in the staging event. The Contractor will assemble and stage the system. Once the system is ready for City of Houston inspection and testing, the Contractor will notify the City's project manager in writing that the system is ready for review. The City and Contractor will arrange a mutually agreeable time for the testing event. All reasonable effort should be made to avoid the scheduling of staging during or around holidays, particularly Thanksgiving and Christmas. Under no circumstances does the City want to be rushed into and through system staging in the last few days of the year for the sole purpose of allowing the Contractor to "book the sale of the equipment" prior to year end. City representatives will cover their own travel expenses for the staging event.
- 10.1D The system staging testing process shall simulate as closely as possible the final configuration of the system. The system layout within the staging area shall, to the extent possible, be laid out geographically as it will be in the field. For example, northwest sites in the City shall be in the northwest corner of the staging area. This will permit the City's representatives to become familiar with the system layout and facilitate testing the appropriate system features while on-site.
- 10.1E Once the City team has arrived at the staging facility, the first on-site activity of staging will be for the Contractor to provide a presentation describing the staging event and schedule. The presentation will identify what equipment has been staged, and how the

system viewing and testing process will be conducted while City representatives are at the facility.

- 10.1F The following items and system components shall be part of the staging area test:
- ◆ Physical review of the system in the staging area to familiarize the City team with the equipment on-hand
 - ◆ Overview of the theory of system operation, particularly the redundant operational capabilities designed to keep the system operational when system failures occur.
 - ◆ Primary and backup Master Network Controllers
 - ◆ All trunking controllers
 - ◆ All repeater sites
 - ◆ All simulcast equipment
 - ◆ All voting comparators
 - ◆ All dispatch consoles
 - ◆ Proper operation of simulcast equipment and simulcast redundancy issues
 - ◆ Microwave equipment, including radios
 - ◆ Trunked system management system
 - ◆ Trunked system alarm and monitoring system
 - ◆ Representative user radio equipment
- 10.1G At the conclusion of factory testing, three (3) certified paper copies and three (3) electronic copies of the factory tests reports shall be submitted to the City for approval before the equipment is released for shipment to Houston. The City reserves the right to approve or disapprove shipment of the system infrastructure after system staging based on staging test results.
- 10.1H Upon approval from the City to begin shipping the system infrastructure, the Contractor shall provide appropriate shipping transportation via a method specifically designed for the safe transportation and delivery of such equipment.
- 10.1I The Contractor shall provide a reasonably detailed plan for system staging in the proposal, outlining the various systems tests that will be undertaken at the staging event.

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10.2 Field Acceptance Testing and Proof of Performance

- 10.2A Following final installation and optimization of all subsystem components at the end location, installation, performance and operational tests shall be performed by the Contractor and witnessed by the City to verify proper operation of all subsystems, features, and capabilities of the system. Physical inspections of all sites will be conducted to observe the quality and correctness of equipment and facility installations. Following physical inspections, the Contractor and City will perform and successfully complete acceptance testing prior to final system acceptance. Successful passage of the acceptance test plan will be a condition of final acceptance and final payment.
- 10.2B The Contractor shall provide all test equipment required for the ATP, and all such test equipment must be in current calibration with appropriate calibration records.
- 10.2C The Contractor shall provide a completed, thorough Coverage Acceptance Test Plan (CATP) with their proposal. The Contractor shall provide an outline of the proposed Functional Acceptance Test Plan (FATP). Test scripts are not required for the proposal, but will be required prior to contract execution.
- 10.2D The CATP and FATP shall include the procedures to be followed, the equipment to be used, and the pass/fail criteria to be utilized to verify system performance. Upon notification of selection for contract negotiation, a final acceptance test plan shall be submitted for review and approval prior to execution of a Contract.

Functional Acceptance Tests

- 10.2E The Functional Acceptance Tests will at a minimum include the following test procedures:
- ◆ Verification that all equipment has been delivered and properly installed in an appropriate manner in accordance with this RFP and the system Contract.
 - ◆ Demonstration that all equipment meets specification.
 - ◆ Verification that all functions and features are performed according to specification and Contract.
 - ◆ Verification that system redundancy capabilities function properly
 - ◆ Successful completion of dispatch console operation
 - ◆ Successful completion of system coverage testing
 - ◆ Successful completion of a 60-day burn-in test

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10.3 System Reliability Features

10.3A The Proposer shall use Figure 2.3.1 to devise a plan for testing the system's redundancy and fallback modes of operation. The Proposer is encouraged to be thorough with this plan. Examples of tests to be performed are:

- ◆ Commercial power failure at primary and backup Master sites, proper operation of auxiliary power systems
- ◆ Commercial power failure at repeater sites, proper operation of the auxiliary power systems, and the system as a whole
- ◆ Automatic switching to backup equipment
- ◆ Response time for transition to backup system
- ◆ Trunked signaling channel failure, and proper response
- ◆ Repeater failures and appropriate alarm reporting functions
- ◆ Trunked site failure, and proper alarm reporting & system response
- ◆ Primary and backup Master Network Controller failure and proper system response
- ◆ LAN/WAN equipment failures
- ◆ Frequency Standard failure
- ◆ Remote site controller failure
- ◆ Field radio behavior under system failure modes
- ◆ Loss of connectivity

10.3B Proposers should not limit their plan to this list, but rather use RFP Figure 2.3.1 to devise their own comprehensive plan.

10.3.1 Trunked System Features

- ◆ Automatic unit identification
- ◆ System access time: encrypted and non-encrypted calls
- ◆ Emergency alarm function, with and without all voice channels busy
- ◆ Talkgroup selection & operation (mobile, portable and control)
- ◆ Regrouping from control terminal
- ◆ Call queuing capability
- ◆ Emergency access to voice channel, all channels busy
- ◆ Operation of equipment alarm functions
- ◆ Operation of talk-group database
- ◆ Over-The-Air-Rekeying (OTAR)
- ◆ Over-The-Air-Programming (OTAP)

- ◆ Interface as appropriate to other radio systems for interoperability purposes
- ◆ Encryption operations

10.3.2 Microwave Subsystem Features

- ◆ Proper physical installation and labeling
- ◆ Fade margin verification (all paths)
- ◆ Signal-to-noise or BER performance of loaded system
- ◆ Operation of ring protection
- ◆ Frequency of transmitters
- ◆ Time domain reflectometry of transmission lines
- ◆ RF output power
- ◆ Alarm functions (internal & external)
- ◆ Operation of channel modules
- ◆ Operation of filters
- ◆ Operation of service channel
- ◆ Verification of proper orientation of antennas
- ◆ Completed system licensing
- ◆ T-1 routing

Refer to Section 5 – Digital Microwave System for additional detail.

10.3.3 Base Repeater Site Functions

- ◆ Transmit frequency and deviation
- ◆ Output and reflected power
- ◆ Receiver sensitivity
- ◆ Receiver multicoupler gain
- ◆ Receiver preamplifier gain
- ◆ Time domain reflectometry of transmission lines
- ◆ Frequency domain reflectometry of transmission lines
- ◆ Transmitter combiner loss
- ◆ System and site alarm functions
- ◆ System optimization
- ◆ Proper setting of audio levels and phase delays
- ◆ Receiver audio output levels
- ◆ Voting system function and level adjustment
- ◆ Proper operation of frequency standard
- ◆ Proper operation of redundant frequency standard

10.3.4 Communications Console Functions

- ◆ Proper installation and operation of the console system
- ◆ Proper operation of all talkgroup and conventional channel CRT controls and functions
- ◆ Proper operation of all signaling and encoding functions.
- ◆ Proper display of Unit ID and alias database functionality

- ◆ Adjustment of all audio line levels for best audio quality
- ◆ Proper operation of volume and mute controls.
- ◆ Proper operation of headset interfaces and volume controls.
- ◆ Proper operation of cross patch functions.
- ◆ Proper operation of instant call recorder/playback unit.
- ◆ Proper operation of relay controlled external devices.
- ◆ Proper operation of clocks, meters or other displays contained in console.
- ◆ Operation of self-diagnostic and testing features contained in the console electronics through simulation of failures.
- ◆ Proper operation of operator positions, displays, keyboard, mouse, and touch screens.
- ◆ Proper operation of automatic number identification and emergency identification functions.
- ◆ Proper operation of console operator position displays units
- ◆ Proper operation of AUX I/Os

10.3.5 Mobile and Portable Radio Functions

- ◆ Proper programming (personality) and fleet mapping in the radio
- ◆ Proper operation of talk-group selector switches
- ◆ Proper operation of automatic unit identification and emergency switch
- ◆ Transmit frequencies
- ◆ Transmitter output and reflected power
- ◆ Receiver sensitivity
- ◆ All proposed radio functions
- ◆ Proper operation of battery life display on the radio
- ◆ Proper operation of battery and charger
- ◆ Operation of accessory functions
- ◆ Proper operation of conventional base station selector (if used).
- ◆ Proper Receive Signal Strength Indication
- ◆ Proper site identification display

The Contractor will document mobile and portable testing. 5% of each subscriber type will be randomly selected and evaluated in conjunction with the testing.

10.3.6 Control Station – Remote Control Subsystem Functions

- ◆ Measurement of forward and reflected power
- ◆ Transmit frequency and deviation
- ◆ Receiver sensitivity

- ◆ Time domain reflectometry of transmission line
- ◆ Proper fleet and talkgroup operation
- ◆ Operation of remote control functions (if used)
- ◆ Proper installation, orientation, and grounding of directional antenna
- ◆ Proper operation of backup power systems where applicable
- ◆ Call alert or equivalent
- ◆ Talk-group scan
- ◆ Emergency alert
- ◆ Encrypted operation
- ◆ ID display
- ◆ Proper battery and charger performance

10.3.7 Wide-Area Operation

- ◆ Verification of automatic wide-area operation throughout the defined coverage area
- ◆ Site/system switching parameters
- ◆ Site/system switching operation
- ◆ Verification of site/subsystem preference operation within radio unit

10.3.8 System Management System

- ◆ System configuration
- ◆ Subscriber access management
- ◆ Manager partitioning
- ◆ Diagnostic management
- ◆ Dynamic radio commands
- ◆ Selective inhibit/uninhibit
- ◆ Activity reporting
- ◆ User database maintenance
- ◆ Activity monitor
- ◆ Automatic backup controller database updating
- ◆ Alarm system

10.3.9 Master Audio Switch/Network Controller

- ◆ Alarm Monitoring and Diagnostic Functionality
- ◆ Disablement of Failed Voice Channels
 - Low forward power
 - High reflected power
 - Unidentified carrier on unassigned voice channel
 - Signaling interface failure between base and controller
 - Audio circuit failure between controller and base
 - Voter receiver failed
 - Voter receiver disabled
- ◆ System Usage Reports

- System configuration
- Configuration information for all components in the system
- Functional configuration of controllers, channels and sites
- ◆ Subscriber Management
 - Manager database (list of system managers)
 - Logged on managers
 - Regrouped radios
 - Inhibited radios
 - Storm plans
 - Commands (tasks)-in-Progress (regroups, inhibits)
 - Subscriber configuration and attributes (by individual, talkgroup and multigroup)
- ◆ Channel Usage
 - Identification of calling units by talkgroup and unit identification number
 - Time of channel access
 - Duration of transmission
 - Classification of call
 - Channel assigned
 - Site or Sub-system involved in a call
- ◆ Fault Management
 - Current alarms
 - Alarm history (daily, weekly, monthly)
 - Alarm history (by component)
 - Technician notes
- ◆ Channel Access Priority Levels
- ◆ Dynamic Talkgroup Reconfiguration
- ◆ Selective Disablement of Field Units
- ◆ Control of Time Out Parameters
 - Channel Hang Time (message trunking)
 - Interfering Carrier Time (length of time channel remains enabled with an interfering carrier)
 - Remote Link Failure Time (length of time site remains enabled without a remote site data link)
 - Channel Fade Time (length of time channels remains assigned without a carrier or low speed data present)

- Emergency Call Time (length of channel hang time when an emergency call is initiated)
- ◆ Channel Partitioning

10.3.10 Equipment Delivery and Installation

- ◆ Inventory
- ◆ Appearance
- ◆ Cabling neatness
- ◆ Labeling
- ◆ Completeness, accuracy, and readability of documentation and drawings
- ◆ Removal of old equipment

10.3.11 Coverage Verification Tests

The coverage testing procedures detailed in Section 3 will be followed.

10.3.12 Site Grounding and Bonding Verification

10.2.12A Due to the critical need for a high quality grounding system, special attention will be paid to the proposed grounding system designs, installation, and performance. The ATP will include thorough inspections of the grounding and bonding systems installed as part of this project. Proper materials and installation practices shall be utilized in accordance with the requirements provided in Section 4 – *Communication Sites*.

10.3.12A All site grounding facilities that are to be installed below ground and buried shall be inspected and approved by a City representative after installation, but prior to burial. Grounding facilities that are installed and buried without City inspection shall not be approved.

10.3.12B As part of the proposed Acceptance Testing Plan, the Contractor shall provide a grounding and bonding test plan in accordance with grounding requirements provided in Section 4.

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10.4 ATP Documentation & Records

10.4A Within 30 days of successful completion of the Acceptance Testing Plan, the Contractor shall provide the City of Houston with a complete set of test documentation, including the testing procedures utilized, testing dates, testing locations, project participants, weather conditions, a description of testing irregularities or problems encountered, and testing results. Any punch listed items that have not been resolved within the 30 day window shall be listed along with the proposed resolution and timeframe for completion.

- 10.4B The documentation shall include a complete inventory database of all equipment sold to the City for this project. The data base shall be in a Microsoft Access format and shall be segmented into equipment types and location. For infrastructure equipment, the information must include an item description, the make, model, model number, serial number, and latest software load and version. Equipment passwords for access to password protected equipment shall also be provided to the City's Director of Wireless Communications.
- 10.4C For user radio equipment, radios shall be identified by City department and include a description, make, model, model number, serial number, latest software load and version and flash code.
- 10.4D Three (3) complete printed sets of ATP documentation shall be provided in 3-ring binders along with three (3) complete sets in electronic format (Adobe PDF) on DVD media.
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Section

11

Training

11.1 Training

- 11.1A The success of a new radio communication system is closely tied to an effective training program. If field users and dispatch personnel do not understand how to use the new equipment properly it often equates to the perception that the “new system does not work properly”. Consequently, the city is requiring that the Contractor provide a comprehensive training program as outlined in this section.
- 11.1B The Contractor prior to cutover and final acceptance of the system shall provide a comprehensive “Train-the-Trainer” training program for the identified audiences and the required knowledge areas as defined in this section. Such training shall include, at a minimum, sessions to familiarize dispatch center personnel with the operation of the trunked, microwave and alarm systems and with the control center equipment. Field personnel will be trained in the operation of mobile and portable equipment. The proposal must specify the amount of classroom training to be provided for all levels of training. A syllabus of the training program must be provided in your proposal. The City reserves the right to videotape classes and use it later for training at their discretion.
- 11.1C Written materials, computer files, and any audiovisual aids produced by the Contractor to provide training shall be furnished to the City for continuing education purposes.
- 11.1D Contractors are to submit a resume for each proposed trainer, a list of training classes, and prior client references who have been trained by the Contractor's training personnel. The City shall interview the Contractor's training team, and shall mutually agree on the training package and the qualifications of the training personnel prior to the development and execution of the training program.
- 11.1E The first training class in each category will be given to supervisory personnel of the agencies involved. Any deficiencies in the training program will be corrected before the rest of the affected personnel are trained. Training for the supervisory personnel will begin after completion of the fixed end hardware tests.

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11.2 Training Audience

Level 1 – Executive

- 11.2A Executives can be any user or non user of the system who require an overview of the two-way radio communication system, operations, fleetmaps, interoperability plans and a general understanding of the system.

11.2B Examples of personnel that fall into this category level include:

- ◆ City Management
- ◆ Emergency Management Planners
- ◆ Supervisory Personnel
- ◆ Project Managers

Level 2 – Operator

11.2C The operator is the person that actually uses a portable (handheld) unit, mobile (vehicle mount) unit or fixed control (base station) unit. The operator may be a daily user or a user only during emergencies and exercises.

11.2D Examples of personnel that fall into this category level include:

- ◆ Police Department Personnel
- ◆ Fire Department Personnel
- ◆ Public Works Personnel
- ◆ Houston Airport Personnel
- ◆ Emergency Managers

Level 3 – Dispatcher/Console Operator

11.2E The Dispatch/Console Operator directs communications during daily operations and emergency situations. The Dispatch/Console Operator needs a detailed understanding of operating the console system and agency operations.

11.2F Examples of personnel that fall into this category level include:

- ◆ Dispatcher/Console Operators
- ◆ Dispatch Supervisors

Level 4 – 1st Echelon Technician

11.2G The 1st Echelon Technician is the person that interfaces with the user concerning the operations, use and problems with handheld, mobile or base station radios. This person is integral in getting an operational unit into the hands of the user and determining if a problem is an operational error, with a radio unit or a system malfunction that may need escalation to higher maintenance.

11.2H Examples of personnel that fall into this category level include:

- ◆ Radio unit programmers
- ◆ Radio unit installers
- ◆ Help desk personnel
- ◆ Bench technician

Level 5 – System Technician

11.2I The System Technician is responsible for preventive maintenance, troubleshooting and repair of the system infrastructure. The System Technician develops and updates the system fleetmaps, investigates system issues and supports the System Manager.

11.2J Examples of personnel that fall into this category level include:

- ◆ City two-way radio RF infrastructure technician
- ◆ Microwave technician
- ◆ Dispatch console technician
- ◆ Fleetmap and subscriber programming manager
- ◆ Power system technician

Level 6 – System Manager

11.2K System Managers are technical managers that are responsible for managing user access, compiling and preparing reports, and maintaining system configuration databases and monitoring and reporting the overall health of the system. The System Manager is responsible for the successful day-to-day and emergency operations of the wide-area trunked system.

11.2L Examples of personnel that fall into this category level include:

- ◆ System Managers
- ◆ Lead System Manager

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11.3 Course Descriptions

System Overview

11.3A The Contractor will develop a high-level overview of the new communications system. This course is to be designed for users and non users, but it will be provided to all users as a standalone course or an introduction to other courses such as operator training. It will be in the Train-the-Trainer format allowing the City to provide an accurate system knowledge base for users, non users and/or project sponsors.

11.3B The System Overview courses will include, at a minimum, the following topics:

- ◆ An overview of the new system
- ◆ A comparison of old and new systems
- ◆ Project 25 update
- ◆ Proper radio procedures

Operator Training

11.3C The Contractor shall provide a comprehensive training program for field users based upon the Train-the-Trainer approach. The City shall identify an appropriate number of

designated trainers who shall be trained by the selected Contractor. Participants will have been successfully trained if they can then successfully train their own personnel.

11.3D Training of trainers shall begin after the fixed end hardware tests are complete, while dispatchers are also being trained. Users will be trained after all instructors and dispatchers have been trained.

11.3E User courses will include, at a minimum, the following topics:

- ◆ The System Overview Course
- ◆ Area of operation; coverage provided
- ◆ Operation of all subscriber features
- ◆ Operation and control of mobile and portable radios
- ◆ Operation and control of control stations
- ◆ Hands-on familiarization of all equipment functions
- ◆ Proper use of all associated accessories
- ◆ Proper radio procedures
- ◆ System failure and backup modes
- ◆ Basic troubleshooting techniques
- ◆ Proper handling and care of radio equipment, batteries and accessories

Dispatch/Console Operator Training

11.3F Dispatch console training shall also use the Train-the-Trainer approach. The Contractor shall conduct a minimum of four (4) comprehensive classroom operator training sessions in two (2) separate training cycles. Session 1 will be for all of the dispatch personnel Trainers before the new console system is placed in service. This will be conducted in a classroom environment, using training aids and the dispatch radio consoles. Training aids such as videos, system diagrams, training manuals showing functionality, and a qualified instructor shall be available for these classes. There shall be handouts available for all attendees, and Dispatcher Operator Training manuals for future reference and follow up training.

11.3G An additional training class, Cycle 2, shall also be conducted using operational console equipment. This will be conducted in the new or current dispatch centers utilizing the dispatch consoles. Each trainee shall be certified by the instructor to have a complete understanding of the new console operations and to be experienced and fully qualified to operate the new consoles, and to instruct others in their use.

11.3H Each student shall attend both Cycle 1 and 2. The classes shall be scheduled in cooperation with the City to minimize the impact on shift personnel.

11.3I A 3rd Cycle may be deemed necessary and requested by the City or the Contractor if so deemed necessary. This session will be coordinated with the successful Provider at no cost to the City.

1st Echelon Technician

- 11.3J The City has in-house radio system technicians and support personnel that have daily contact with the system users. The Contractor shall provide training to the 1st echelon of personnel to minimize problems getting operational units to the users and accurate problem identification to initiate an efficient course of action for repairs. Training at this level is critical to the effective implementation and operation of a system of this magnitude.
- 11.3K This level of training encompasses a broad range of personnel and their technical abilities. Help desk personnel need to have a technical understanding of different radio unit problems.
- 11.3L 1st Echelon training courses will include, at a minimum, the following topics:
- ◆ System Overview
 - ◆ Operator training
 - ◆ Programming of portable, mobile and control stations
 - ◆ Testing radio units for proper operations using a service monitor test set
 - ◆ Adjusting radio units to within specifications using radio software and a service monitor test set
 - ◆ Basic troubleshooting techniques
 - ◆ Disassembly / reassembly of radio units
 - ◆ Identifying radio units to be repaired in-house or at the factory
 - ◆ Monitor network system management software
 - ◆ Basic system infrastructure diagnostic techniques

System Technician Training

- 11.3M The City currently has an in-house staff of radio technicians, and they will need to attend technician training courses to become familiar with system maintenance, programming, problem diagnosis and correction. The City's technical staff should also receive hands-on instruction on the actual system, as it is being installed and optimized. Costs for the technician training should be quoted separately.
- 11.3N The proposed training program shall include the recommended level of technician training to enable the City's technicians to properly maintain the system. The proposed cost for technician training and system maintenance training courses shall be separately itemized to allow the City to reach decisions regarding ongoing maintenance of the installed system.
- 11.3O The technician training courses shall cover, at a minimum, the following topics:
- ◆ System Overview
 - ◆ Block diagram and circuit description
 - ◆ Comparison of the old and new systems

- ◆ Operational theory of all system components
- ◆ Principles of analog and digital transmission
- ◆ Proper operation of system capabilities
- ◆ System failure modes
- ◆ System diagnostic alarms
- ◆ Installation and turn-on procedures
- ◆ Operation of all required test equipment
- ◆ Alignment and optimization testing procedures
- ◆ Detailed troubleshooting procedures
- ◆ Unit/module replacement procedures
- ◆ Detailed repair procedures
- ◆ Detailed maintenance procedures
- ◆ Proper record-keeping
- ◆ Detailed review of system documentation structure, numbering system, and documentation control process
- ◆ Operating, safety, and traffic continuity procedures
- ◆ Detailed preventative maintenance procedures

11.3P Each of the items above shall be conducted with substantial hands-on involvement using equipment provided by the Contractor or third party suppliers as part of this system.

System Manager Training

11.3Q The System Manager training course will be a comprehensive program designed to familiarize the Radio System Managers with all available features, reports, and diagnostics.

11.3R The System Manager course must include, at a minimum, the following topics:

- ◆ System Overview
- ◆ Operational theory of all system components
- ◆ Detailed discussion of system failure modes
- ◆ Basic troubleshooting techniques
- ◆ Available features
- ◆ Available reports
- ◆ Available diagnostics
- ◆ Development and maintenance of system databases
- ◆ Detailed discussion of alarm system
- ◆ Hands-on familiarization with all of the above
- ◆ Fleetmapping of system
- ◆ Disable/enable radios in their department
- ◆ System utilization by their radios and talkgroups
- ◆ Basic report generation

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11.4 Delivery Methods and Materials

11.4A All training shall occur in the Houston area at the most appropriate location for the venue. The Contractor will provide all necessary training equipment, computers, projectors, radio units, manuals, workbooks and test equipment. Coordination for filling training courses will be completed by the City in accordance with a predetermined schedule. A single point of contact will be provided to the chosen Contractor, and the Contractor will provide a single point of contact for all training activities. Appropriate documentation of the attendees will be provided to the City. At the conclusion of each class an opportunity will be provided for the attendees to give training feedback. This feedback will be reviewed prior to the next course to determine if a curriculum change may be needed.

Classroom Instruction

11.4B Classrooms of the appropriate size and environment will be provided by the City in accordance with a predetermined schedule. The Contractor is to provide all training materials for the course.

Field Instruction

11.4C Many of the courses need to have access to system equipment, such as a dispatch console system or system manager, or in a location where equipment is being installed. These courses must be identified and coordinated by a predetermined schedule. Appropriate documentation of the attendees will be provided to the City.

On-Line

11.4D It may be appropriate for some classes to be in a webinar type format or a self-paced on-line format due to timing constraints with City personnel. In general hands-on is the preferred means, but some prerequisites may be accomplished in a virtual classroom.

Off-Site

11.4E For all off-site training courses, please list the courses available, the cost of the class for individual personnel or groups, duration, and locations of each course offered. Off Site training availability will not be considered as part of the proposal, but may be used for informational purposes.

Course Materials

11.4F The actual materials for each course will vary widely. The Contractor will provide the appropriate training material as indicated on the Course Worksheet at the end of this section.

11.4G Documentation for System Overview, Operator Training and Dispatch/Console Operator Training must be prepared specifically for the configuration of the new City of Houston radio system. All instruction books shall be clearly written and illustrated to instruct the proper use of all standard features available for specific equipment and operation. Operators manuals provided in hard copy will also be provided in electronic PDF (Portable Document Format) to be read with the Adobe Acrobat Reader software.

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11.5 Course Information and Worksheet

	Audience	Functional Context
Level 1	Executives	Courses designed to give project sponsors an understanding of how the system operates, including the various capabilities and benefits.
Level 2	Operators	Courses for personnel who use subscriber portable radios and mobile radios in their day-to-day activities and for use during emergency events.
Level 3	Dispatch/Console Operators	Courses detailing the "how-to" of console operations in all scenarios, including instruction for new operators, experienced operators and supervisors.
Level 4	1st Echelon Maintenance	Courses for personnel engaged in radio programming, installation, customer interface and first level of maintenance.
Level 5	System Technician	Courses for technicians who are responsible for maintaining the systems operability to include determining points of failure, replacing defective components and/or reprogram components.
Level 6	System Manager	Courses for technical managers who are responsible for managing user access, programming various capabilities and compiling system reports.

Training Course Worksheet

System Overview	
Number of sessions	
Number Students/session	
Course Duration	2 hours
Training Material / Quantity	
Training Audience Level	1, 2, 3, 4, 6
Delivery	Classroom / Lecture
Location	Houston
OPERATOR TRAINING	
Number of sessions	
Students/session	
Course Duration	2 hours
Training Material / Quantity	

Training Audience Level	2, 3, 4, 6
Delivery	Classroom / Hands-On Instruction
Location	Houston
Dispatch Console Systems	
Number of sessions	
Students/session	
Course Duration	4 hours
Training Material / Quantity	
Training Audience Level	3, 6
Delivery	Console Position / Hands-On Instruction
Location	Houston
1st Echelon Technician Training	
Number of sessions	
Students/session	
Course Duration	4 Days
Training Material / Quantity	
Training Audience Level	4, 6
Type	Classroom / Hands-On Instruction
Location	Houston
System Technician	
Number of sessions	
Students/session	
Course Duration	2 Weeks
Training Material / Quantity	
Training Audience Level	5, 6
Type	Field Location / Hands-On Instruction
Location	Houston
System Manager Training	
Number of sessions	
Students/session	
Course Duration	2 Weeks
Training Material / Quantity	
Training Audience Level	5, 6
Type	Network Manager / Hands-On Instruction
Location	Houston

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**Section
12****Warranty and System
Maintenance****12.1 Warranty**

- 12.1A The City of Houston is requiring a "System Warranty" that encompasses all equipment, facilities, and services provided. The Contractor shall warrant that all equipment, facilities, and services provided shall conform to the proposed specifications and/or all warranties as stated in the Uniform Commercial Code and be free from all defects in material, software, workmanship, and title.
- 12.1B The Contractor shall warrant that all equipment and installation conforms to the specifications provided within this RFP, or the manufacturer's published specifications, whichever is most stringent, that it shall be free from defects in materials, functionality and workmanship for a period of at least one (1) year from the date of final system acceptance. Interim periods between the manufacturer's standard warranty and the date of acceptance will be the Contractor's responsibility.
- 12.1C Contractors shall warrant and guarantee further that the equipment furnished hereunder is of good workmanship and materials and that the same is properly designed, operable and equipped for the proposed use by the City of Houston, and is in strict conformity with the detailed Request for Proposal except as agreed upon within the contract documents.
- 12.1D All test equipment used in the provision or delivery of warranty and maintenance services provided to the City of Houston, shall at all times be functioning properly and have current equipment calibration certificates. Technicians using the equipment shall be properly trained to utilize the equipment. Technicians that are dispatched or assigned to service City facilities shall be familiar with the City's system and configuration.
- 12.1E Contractors shall provide a copy of provisions and terms of the proposed warranty in compliance with applicable state and local codes. A description of available warranty options shall be included in the proposal. The Contractor shall be the single point of contact for all warranty claims.
- 12.1F Warranty repairs on all furnished equipment and systems shall be made at no cost to the City for parts or labor for a period of one (1) year from the date of Final System Acceptance. The Contractor shall be responsible for any shipping costs incurred to send components or equipment to manufacturers for repair or replacement. The City reserves the right to closely monitor and observe warranty repair service.
- 12.1G During the warranty period, the Contractor shall maintain adequate staff and spare parts inventory, both located within the Houston area to assure prompt warranty service. Response times during the warranty period shall be the same as that listed for "Maintenance".

- 12.1H Warranty service shall be provided on the same basis as stated in Section 12.2.1, below. The Contractor shall certify that its proposed service facilities shall, within the time required herein be able to diagnose any system failure, that repair will be completed at the earliest possible opportunity upon receipt of necessary parts, and any system critical part or sub-system that is not locally stocked as a spare part will be available on an express basis within no more than twenty-four hours.
- 12.1I Any subcontractor costs for first-year warranty of any system hardware or software component covered under the above warranty requirements shall be included within the basic system cost. The City, prior to acceptance of the system, shall pay no warranty or maintenance costs to any Contractor or Subcontractor.

12.1.1 Service Under Warranty

- 12.1.1A If it becomes necessary for the City of Houston to contract with another Subcontractor for warranty repairs, due to inability or failure of the Contractor to perform such repairs, the Contractor shall promptly reimburse the City for all invoices for labor, materials required and the shipping/handling costs thereof, to perform such repairs, within 30 days from presentation of such City invoices. This shall only occur after the Contractor has been given written notice, reasonable time and fair opportunity to respond and correct the problem. The cost limitation for such repairs will not exceed the parts and labor replacement costs of the repair.

Fully Compliant Partially Compliant Non-Compliant

12.2 Maintenance

12.2.1 System Maintenance, Repair, and Service Facilities

- 12.2.1A The Contractor shall be responsible for preventative and remedial maintenance of the communication system for a period of one (1) year following Final System Acceptance of the system by the City. Maintenance shall include parts, labor and travel to communications sites or the City facilities to repair fixed equipment. Mobiles and portables will be delivered to the local service facility, which shall be located within the City of Houston.
- 12.2.1B Each Contractor shall detail in its system proposal the name, location and capabilities of the service facility, which will provide any or, all of the installation, service and maintenance, both initially and on a continuing basis. Contractors shall also include a thorough description of the proposed service facilities, the size and location of the facilities, the size and qualifications of its staff, the number of years in business and a list of customers (with names and telephone numbers) who operate systems of similar size and complexity for whom installation and maintenance services are performed. The Proposer shall specifically identify what experience the facility and its staff have in working on or with the specific type (Project 25 simulcast trunked, etc.) of system that is proposed to the City. This information is required to demonstrate to the City that the proposed local service facilities are capable of installing, optimizing and maintaining the proposed system.

- 12.2.1C Contractors shall describe the ongoing level of factory engineering and service support that will be available to the local service facility during the installation and maintenance of the system.
- 12.2.1D The factory organization that provides such support shall be thoroughly described in the proposal. Contractors shall also detail the response times of factory support, should it be required by the local service facility. The factory support referenced here will be provided directly to the local service facility for assistance in fulfilling the terms of the installation and maintenance agreements; costs for factory support shall be included in your cost proposal.
- 12.2.1E If a maintenance contract is extended or desired after the initial warranty period, the payments for the maintenance contract will be made by the City on a monthly basis.
- 12.2.1F The Contractor shall provide a discount level (off list price) and terms at which the City can purchase service and maintenance equipment.
- 12.2.2 System Availability
- 12.2.2A The importance of a well-defined maintenance program for this system cannot be overstated. Successful system operation depends on consistent, comprehensive routine maintenance backed up by expedient remedial action in response to fixed equipment failures. Your proposal shall define a preventative maintenance program that assures, to the extent possible, failure free operation for a period of not less than ten (10) years, barring sabotage or natural disasters.
- 12.2.2B The City also understands that 100% failure-free operation cannot be afforded by most government agencies, due to the expense involved in achieving multiple levels of redundancy and maintaining full-time repair crews at all sites.
- 12.2.2C Therefore, the City expects that the utmost care and attention will be given to maximizing the system network availability, despite the failure of individual components. In addition to thoroughly describing your proposed system design's incorporated redundancy and fallback scenarios, your proposal shall include an initial recommended maintenance schedule to minimize likelihood that your system will revert to any of the fallback modes. No single point of failure in the system infrastructure may be allowed to completely isolate site from the network or a user from voice communications with the dispatch center during the life of this system.
- 12.2.3 Major and Minor Failure Definitions
- 12.2.3A A Major Failure is defined by the following:
- Loss of Master Site or switchover to Backup Master Site
 - Loss of one Master Controller or switchover to Redundant Master Controller
 - Master Site LAN/WAN/Audio Distribution Equipment Failure
 - Loss of one Simulcast Prime Trunking Controller or switchover to Redundant Simulcast Prime Trunking Controller
 - Failure resulting in any Simulcast sub-system reverting to "Site-Trunking"

- Loss of two (2) or more System Manager/Alarm Terminals
- Loss of two (2) or more Dispatch Consoles
- Loss of "Full-Featured" Dispatch capability (revert to RF Dispatch control)
- Logging Recorder Interface failure
- Microwave system failure resulting in path switch or revert to standby radio
- Master Site or Simulcast Prime Site UPS or DC Power System Failure
- Loss of Simulcast or Multicast Repeater site
- Repeater Site Antenna System Failure adversely affecting multiple channels
- Any component or module failure which results in loss of 20% or more of trunked channel resources

12.2.3B A Minor Failure is defined by the following:

- Loss of single Repeater
- Loss of one (1) System Manager/Alarm Terminal
- Loss of one (1) Dispatch Console
- Any component or module failure which results in loss of the availability of a single trunked channel resource

12.2.4 Service Response

12.2.4A Service response on the system shall be provided as follows:

12.2.4B Trunked system infrastructure including but not limited to master network controller, site controllers and remote site controllers, base repeaters, antenna systems, control stations and communications center equipment, voting receiver equipment, microwave equipment, dispatch console system, and simulcast control and optimization equipment, shall be provided service twenty-four (24) hours per day, seven (7) days a week. Response to a major system failure, as defined above, shall be made within 30 minutes of notification by the City or other source of failure indication. Response to minor system failures, as defined above, shall be made within four (4) hours. Response is defined as having a factory certified technician on-site at the City's facility where the failure occurred.

12.2.4C Failure to respond within thirty minutes to a major failure shall result in a deduction of one (1) week's maintenance contract fees for each 30-minute period or fraction thereof beyond the 30 minute point. Failure to respond within four (4) hours to a minor system failure will result in a deduction of one (1) day's maintenance fees from the next month's maintenance payments. These fees shall be deducted from the City's annual maintenance contract. This clause shall be invoked at the sole discretion of the City.

12.2.4D In the event of an impending disaster or the Mayor declares an emergency, the Contractor needs to provide on-site technicians 24 hours prior to the event. The technicians need to be dedicated to the City facility prior to the event, during and for a minimum of 24 hours after.

- 12.2.4E A sufficient local supply of spare parts shall be maintained to allow rapid restoration of operation of the system infrastructure. In the event that these parts are consumed, they will be replaced promptly. Replacement stock shall also be available via emergency request with expedited delivery within twenty-four (24) hours of the equipment failure.
- 12.2.4F Failure to ship essential parts within twenty-four (24) hours shall result in a penalty of \$2500 per day for major outages, and \$500 per day for minor outages, until the system is restored. Penalty fees will be assessed against the maintenance contract payments.
- 12.2.4G Mobile and portable equipment shall be serviced in the Contractor's service facility during normal working hours, Monday through Friday. The rate per hour for mobile and portable repair outside of normal business hours must be provided. Repairs shall be completed within three (3) business days.
- 12.2.4H Failure to complete repairs within three (3) business days from delivery of the radio to the service facility shall result in repairs being made free of charge. If repairs take more than five (5) business days, \$100/day will be assessed for each day or fraction thereof that the repair is late.
- 12.2.4I Contractors shall certify that infrastructure replacement parts shall be available for a minimum period of ten (10) years following the date of product discontinuance by the Contractor. Mobile, portable, and control station radio parts and accessories shall be available for at least seven (7) years after the date of product discontinuance. The location of the parts depot that stocks parts for the system shall be specified in the proposal.
- 12.2.4J Should replacement parts be unavailable as outlined above, such that the radio system components cannot be repaired, the Contractor shall replace that item with a current year, equivalent model of the same item, with the same features and capabilities, at the last contract price of the component. If the current year item is not compatible with a portion of the system, that portion of the system or subsystem will be replaced. These replacements shall be made at no charge to the City.
- 12.2.4K If equipment is proposed which contains microprocessors, large scale integrated circuits (LSI) or very large scale integrated circuits (VLSI) devices which cannot be field diagnosed and repaired, or which require special instrumentation or devices to repair, the Contractor shall specify how such assemblies will be repaired at a central facility. The guaranteed turn around time for return of an exchange or repaired circuit card or other assembly shall be three (3) days or less. Equipment will be packed, shipped, received, and checked by the Contractor. The Contractor shall pay all shipping costs.
- 12.2.4L Failure to return an exchange or repaired unit within three (3) days shall result in the repairs being made free of charge. If repairs take more than five (5) days, then \$100/day will be deducted from the next month's maintenance contract.
- 12.2.4M Contractors shall recommend a list of essential spare parts to be maintained by the City after the warranty period to assure rapid restoration of systems operations in the event of component failure. In addition to parts, Proposals shall include a list of

recommended test equipment required to maintain the proposed system. Automated test equipment is preferred for mobile/portable equipment. A detailed itemized price list shall be provided for both the recommended parts inventory and the recommended test equipment.

- 12.2.4N Stocking of spare parts shall remain the responsibility of the local maintenance provider, who will need parts on hand to avoid any of the above penalties.
- 12.2.4O Maintenance shall include keeping all system and equipment software current and up to date. At the end of the first year of warranty/ maintenance service, all software shall be of the latest version, release, and service release that applies to the equipment provided.
- 12.2.4P Five (5) complete sets of programming software, cables, and required interface devices shall be provided for each model of software programmable equipment included in the system. Provide **a complete list, including model number and price, for each piece of software and equipment required to program the new equipment and any associated passwords required to maintain the system.**
- 12.2.4Q Any penalties incurred during the warranty period will be based on the rates for the first year of maintenance following the warranty period, and will be deducted from the 1st year of maintenance, or billed to the Contractor if no maintenance agreement is purchased.
- 12.2.4R The Contractor shall specify the methods for maintaining the 700 / 800 MHz trunked radio system and the microwave connectivity system to include hardware, operating system and applications software. Such methodology shall define any user responsibilities necessary for total system operation. Performance of any such defined user responsibility shall not be required to qualify for or maintain express or implied warranties or performance guarantees specified within the proposal.
- 12.2.5 Maintenance Manuals
- 12.2.5A The Contractor shall supply three (3) paper copies of complete sets of system maintenance manuals and three (3) electronic copies. One (1) additional paper copy of a complete set of maintenance manuals and one (1) electronic copy will be provided for placement at each site.
- 12.2.5B Three (3) paper copies (in 3-ring binders) and three (3) electronic copies of manuals for OEM hardware shall be provided for each component of the system by the manufacturer, showing the system layout and architecture and describing the function of each major item.
- 12.2.5C Any unique wiring configurations or circuit modifications ("specials"), which are not part of the standard product offering or the associated equipment documentation provided, shall be included in the ring binder. All information as described in the previous paragraph shall be included, in addition to the theory and method of operation.
- 12.2.5D Each mobile radio, hand held radio, control station, and dispatch console shall be provided with one (1) original printed user/operator manual. Photocopies of manuals are not acceptable. Three (3) electronic copies of the manuals in Adobe Acrobat PDF format on CD or DVD media shall be provided.

12.2.6 City Provided Maintenance

12.2.6A The City currently operates three independent City radio communications repair shops (Police, Fire, and Public Works & Engineering), which include a staff of radio technicians. The City is interested in exploring the possibility of having its radio shop personnel become certified to provide factory authorized warranty repair service.

12.2.6B Contractors shall describe the process by which the City's radio shops can become factory authorized warranty repair stations. Your description shall include:

- ◆ A description of the skills and level of training required
- ◆ A description of courses available to reach this level of training, including length of time and cost

12.2.6C Courses shall cover all equipment supplied to the City by the Contractor. Your technician training program should include hands-on instruction on the actual system, as it is being installed and optimized.

12.2.6D The technician training courses are described in Section 11.3.

12.2.6E Training shall be conducted with substantial hands-on involvement, using equipment provided by the Contractor or third party suppliers as part of this system.

12.2.6F For all off-site training courses, please list the courses available, the cost of the class, the cost for additional personnel, and the dates, duration, and locations of each course offered.

12.2.6G As the City may elect to service and maintain infrastructure equipment only, user equipment only, or both, your description of training requirements should be broken down by equipment model.

12.2.7 Optional Extended Warranty

12.2.7A Each Contractor shall include an option to extend system maintenance on an annual basis for up to five (5) years following expiration of the system warranty. Maintenance terms and conditions shall be the same as those described for the first year of warranty coverage.

12.2.7B The optional extended maintenance quotation shall be broken down by year, and divided into at least two major categories:

- ◆ Infrastructure
- ◆ User Equipment

12.2.7C Prices shall be quoted for each category.

12.2.7D Maintenance proposals shall clearly identify those items covered under the agreement, and clearly delineate items that are not included or conditions that would invalidate the maintenance agreement.

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Section

13

Proposal Response

- 13A The purpose of this section is to provide Proposers with format guidance for preparing the proposal which will help facilitate the development of a complete response. The City of Houston is requiring that seven (7) complete printed copies of the proposal be provided, one (1) of which shall be designated the "Original" with all required original signatures. Seven (7) complete electronic copies on DVD media are also required.
- 13B Each Section and paragraph of this RFP has been numbered for easy referencing. To help facilitate a clear understanding of each proposal response and to help reduce ambiguity, each RFP sub-section is followed by:
- Fully Compliant Partially Compliant Non-Compliant
- 13C Check the box which best describes your company's compliance with each sub-section. If a partially compliant or non-compliant response is proposed, provide a brief explanation of the reason for partial or non-compliance.
- 13D A soft copy of the RFP will be provided in Adobe Acrobat so that Proposers can utilize the document in preparing a point-by-point response to the RFP. You may use the soft copy to "insert" your responses as necessary. Answer all sections. The use of graphics and graphical presentation materials in your proposal will help facilitate a clearer understanding of your proposed system.
- 13E In addition to a point-by-point response, the City requires that each Proposer specifically provide the information outlined in the sections that follow. The Response Section of your proposal shall be bound separately from the remainder of the proposal and labeled as Section 13 Response Section. You may include additional pages as necessary to make your response complete.

13.1 Proposer's Background

13.1A Proposer's Name: _____

Location: _____

Point of Contact for the Proposal:

Name: _____

Title: _____

Telephone: _____

Fax: _____

13.1B Do you manufacture the radio equipment in your proposed system? Yes No

Comments: _____

13.1C Provide a complete description of your proposed project team. List the names of the key personnel you will assign to this project and describe the contribution each will make on your company's behalf, paying particular attention to the project engineers and project manager. Include the percent of each individual's time devoted specifically to this project. Identify who will have overall responsibility for successful completion of the project. List any other projects or commitments that each person is expected to be involved with at the same time.

13.1D Provide company and project references

List and describe five systems of similar size, scope, and technology which were developed and installed by your company. If multiple layers are proposed, the Proposer is encouraged to provide references to systems employing multiple layers.

1. Name of system owner _____
Type of System: _____
System Description _____
Location: _____
Number of Repeater Sites: _____
Frequency Band: _____
Number of Radio Channels: _____
Number of Radios Supported: _____
Agencies using the system: _____
System Connectivity: _____
Number of Dispatch positions: _____
Client Contact: _____
Client Title: _____
Telephone Number: _____
Email Address: _____

System status (awarded, under installation, installation completed, system accepted, system cutover, fully operational, etc.): _____
Date accepted: _____
2. Type of System: _____
Location: _____
Number of Repeater Sites: _____
Number of Radio Channels: _____
Number of Radios Supported: _____
Client Contact: _____
Telephone Number: _____

3. Type of System: _____
Location: _____
Number of Repeater Sites: _____
Number of Radio Channels: _____
Number of Radios Supported: _____
Client Contact: _____
Telephone Number: _____
4. Type of System: _____
Location: _____
Number of Repeater Sites: _____
Number of Radio Channels: _____
Number of Radios Supported: _____
Client Contact: _____
Telephone Number: _____
5. Type of System: _____
Location: _____
Number of Repeater Sites: _____
Number of Radio Channels: _____
Number of Radios Supported: _____
Client Contact: _____
Telephone Number: _____

Proposed Project Manager:

Name: _____

Telephone: _____

Number of Years with your Company: _____

Percent of Project Manager's time dedicated to this project: _____

PMP / PMI certified? Yes No

Provide a brief description of your Project Manager's background including education and related experience in managing a project of this size.

13.1E List three client references for your proposed Project Manager

1. Name: _____
Representing: _____
Telephone Number: _____
2. Name: _____
Representing: _____
Telephone Number: _____
3. Name: _____
Representing: _____
Telephone Number: _____

13.2 Financial Information**13.2A Please provide the following information about your company:**

13.2.A1 A copy of your company's most recent audited financial statement

13.2.A2 A copy of your firm's 10k form

13.2.A3 Two bank references:

1. Bank: _____
Location: _____
Contact: _____
Telephone: _____
2. Bank: _____
Location: _____
Contact: _____
Telephone: _____

13.3 Exceptions or Clarifications Taken to This Specification

13.3A **Note:** The response "fully compliant" is adequate unless exceptions or "clarifications" are taken. Exceptions shall be stated clearly, referencing the section and subsection of the RFP affected, followed by your response. Clarifications may be evaluated as exceptions, depending upon the clarification taken. All exceptions and clarifications in your proposal must be identified in this section of your response. Proposers shall include a compliance matrix in this section. The matrix shall list all sections and subsections along with the particular box checked in the fully compliant, partially compliant, and non-compliant categories.

13.4 Maintenance Support

13.4A Provide a complete description of your maintenance program. Provide a complete description of the maintenance provider proposed. Include the following items in your discussion.

- ◆ Name of Maintenance Organization: _____
- ◆ Address: _____
- ◆ Telephone: _____
- ◆ Contact: _____
- ◆ Description of Facilities: _____
- ◆ Service Center Capabilities:
- ◆ Number of Vehicle Bays in the Houston area for Mobile Installs/Repairs:
- ◆ Description of Test Equipment Maintained by the Facility:
- ◆ Description of Any Continuing Education Program in Effect:
- ◆ Technicians Dispatched From: _____
- ◆ Number of Technicians Trained on the Proposed System in the Area: _____
- ◆ Number of Technicians Trained to do Mobile Installs:
- ◆ Staff Qualifications: _____
- ◆ Customer References (names and telephone numbers) with similar systems in the area for whom installation and maintenance services are performed:
- ◆ Location of Local Spare Parts Inventory:
- ◆ General Description of the Local Parts Inventory:
- ◆ Location of Factory Parts Depot for Parts for the System:
- ◆ Guaranteed Response Times:
 - Major Outage: _____
 - Minor Outage : _____
- ◆ Hourly Rate for Rate Work Done Outside of the Contracted Hours:
 - Normal Business Hours: _____

- Nights, Weekends, Holidays: _____
- ◆ Please describe your repair procedures for parts or equipment that cannot be repaired at or by the proposed local facility, and must be repaired by a centralized repair facility.
- ◆ State your guaranteed return time for items sent to such a centralized facility.
- ◆ State your guaranteed return time for mobile and portable radio repairs.
- ◆ Describe the ongoing level of factory engineering and service support that will be available to the local service facility during the installation and maintenance of the system.
- ◆ Please describe the factory organization that provides such support.
- ◆ Please indicate the response time on site of factory support should it be required by the local service facility.
- ◆ Please provide an itemized price list of essential spare parts to be maintained to assure rapid restoration of the system in the event of component failure.
- ◆ Please provide an itemized price list of test equipment to be used to maintain your proposed system.

13.5 Subcontractors

13.5A Identify any and all subcontractors performing installation of any equipment or subsystems. Provide a brief overview of their contribution to the project. Outline the subcontractors experience and qualifications to perform the associated tasks.

13.6 Project Schedule

13.6A Describe your company's ability and willingness to comply with the City's project timeframe. If any items in your proposal are currently unavailable you must fully describe how the product availability will affect your ability to complete the project on schedule. Include your proposed schedule here. The project schedule and Gantt Chart should be developed in accordance with Section 8.

13.6B Please provide a narrative to accompany your timeline. Include in your discussion key milestones and deliverables that must be met by the City in order to stay on schedule. Please discuss your cutover plans in this section.

13.6C Please discuss your proposed method for managing the integration of the various City agencies with the system. Please describe who will have primary responsibility for their successful implementation, including programming and installation.

13.6D Please describe your proposed method of installing the mobile radios for the various City agencies. In your discussion, please describe the number of units that could be installed per day, where they would be installed, who would perform the work, where extra labor

would come from if necessary, who would supervise and what your quality control and inventory control processes would be.

13.7 Proposed System Architecture

13.7A Thoroughly describe the type of system proposed for the City. Your discussion must provide a system overview (including block diagrams) for your proposal/system configuration, followed by a breakdown of the equipment and facilities proposed for each site. At a minimum, the following items must be addressed. If there are specific requests for information elsewhere in this RFP that fits in this section, please include here.

- ◆ System Configuration (Simulcast Subsystems, Multicast Sites, Layers etc.)
- ◆ Narrative of site selection process
- ◆ Narrative and rationale for system capacity and loading analysis
- ◆ Number of RF Channels per site (proposed and expansion capacity)
- ◆ Number, location, and configuration of all repeater sites including backup sites
- ◆ Propagation Maps displaying coverage and TDI analysis
 - Describe the propagation model used to prepare your coverage maps.
 - Include a data sheet for each plot included in your proposal, including all gains, losses, and other factors. Minimum signal thresholds for each colored coverage area on proposed maps must be identified in the margin of each map.
 - Method of providing radio coverage in required buildings.
 - Discussion of coverage design for downtown tunnel system and airports
 - Provide a discussion on the impact of repeater site separation as proposed on a future migration to Project 25 Phase II architecture.
- ◆ If multiple layers are proposed, provide a detailed discussion on the system's ability to prevent capacity from being compromised by talkgroup members being spread across the multiple layers.
- ◆ Provide a detailed description of the methodology with which the radio units roam among subsystems and sites, including:
 - The methodology by which the radio unit acquires and uses the system's control channel frequencies for the purposes of switching among subsystems/sites.
 - How the radio unit avoids remaining on a low signal site when in range of a higher-signal site.

- The radio unit's algorithm for accessing a site upon power-up and upon requiring a site change.
- Any features in the radio unit's roaming algorithm, which might provide for more efficient system operation (automatically favoring a higher-capacity site, etc.).
- If the proposed system architecture relies upon radio unit registration, then describe how the system protects from conditions that might entail numerous radios registering simultaneously, thus potentially overloading the system.
- ◆ Comprehensive failure mode analysis and reliability features. Vendor shall follow the structure dictated in Section 2 of this RFP. All potential single points of failure, however unlikely, must be identified.
- ◆ Failure indications at supervisory console
- ◆ Switching process to backup controllers and backup master site
- ◆ Provide information on maximum number of sites per simulcast subsystem, maximum number of channels per site/subsystem, maximum number of sites, subsystems, etc. per Master Network Controller
- ◆ Thoroughly describe the channel expansion process, per site, per channel. Provide additional costs per channel, and describe any savings associated with adding larger numbers of channels at one time.
- ◆ Listing and description of all equipment proposed for each site
- ◆ Detailed response to the requirements of Section 2 of this RFP relating to Spectrum Efficiency, Future Migration Paths, Project 25 Phase I and Phase II. Proposer shall refer to these Section 2 requirements and provide a response which addresses all requests.
- ◆ Thoroughly describe your proposed Interoperability/Mutual Aid system as required in Section 2.
- ◆ Guaranteed Channel Access Time, from Push-to-Talk to Receiver Open and Ready to Receive. Include a transaction timing diagram depicting the worst case scenario within your proposed system design with your discussion. Include a separate timing diagram for the digital mode and digitally encrypted mode.
- ◆ Thoroughly describe your proposed AES encryption scheme. Describe your Over-The-Air-Rekeying (OTAR) feature. Describe the proposed Key Management system.
- ◆ Itemize the cost of encryption on a per channel basis.
- ◆ All components proprietary to the vendor must be identified.
- ◆ Identify dealers licensed to distribute the Proposer's subscriber units.
- ◆ Identify manufacturers and dealers of subscriber radios compatible with the proposed system.

13.8 Proposed Mobile Radios

13.8A Describe each of your proposed mobile radios. At a minimum, the following items must be addressed. If there are specific requests for information elsewhere in this RFP that fits in this section, please include here.

- ◆ Quantity Proposed per Agency
- ◆ Manufacturer
- ◆ Make and Model Number, per agency
- ◆ Analog/Digital
- ◆ Project 25 Phase I, Phase II – state specifically if the proposed radios provide Project 25 Phase II operation. If not, whether the radios are upgradeable to Phase II operation at additional cost.
- ◆ Ability to program Project 25 trunking control and/or compatibility with non-Project 25 trunking control.
- ◆ RF Power Output
- ◆ Number of Systems
- ◆ Number of modes
- ◆ Encryption capability, OTAR, code key management
- ◆ Talk-around
- ◆ Priority Scan
- ◆ Dynamic Regrouping
- ◆ Ability to program conventional channels
- ◆ Call Alert (Paging via Signaling Channel)
- ◆ Individual Call
 - Indicate if Individual Call list is separate from Call Alert list
 - Indicate maximum size of each
- ◆ Display Type
- ◆ Emergency Button
- ◆ Unit ID
 - Indicate ability to display alias of calling party (include limitations)

- Indicate maximum number of aliases that can be programmed
- ◆ System capability failure indications
- ◆ Provide a specification compliance matrix for each proposed mobile (required).

13.9 Proposed Handheld Radios

13.9A Describe each of your proposed handheld radios. At a minimum, the following items must be addressed. If there are specific requests for information elsewhere in this RFP that fits in this section, please include here.

- ◆ Quantity Proposed per Agency
- ◆ Manufacturer
- ◆ Make and Model Number
- ◆ Analog/Digital
- ◆ Project 25 Phase I, Phase II – state specifically if the proposed radios provide Project 25 Phase II operation. If not, whether the radios are upgradeable to Phase II operation at additional cost.
- ◆ Ability to program Project 25 trunking control and/or compatibility with non-Project 25 trunking control.
- ◆ RF Power Output
- ◆ Number of Systems
- ◆ Number of Modes
- ◆ Encryption capability, OTAR, code key management
- ◆ Talk-around
- ◆ Priority Scan
- ◆ Dynamic Regrouping
- ◆ Ability to program conventional channels
- ◆ Call Alert (Paging via Signaling Channel)
- ◆ Individual Call
 - Indicate if Individual Call list is separate from Call Alert list
 - Indicate maximum size of each

- ◆ Display Type
- ◆ Rechargeable battery (Capacity, Recharge Rate, etc.)
- ◆ Carrying Devices (NOTE: If a particular carrying device is required to achieve your proposed coverage, the devices must be clearly described.)
- ◆ Emergency Button
- ◆ Unit I.D.
 - Indicate ability to display alias of calling party
 - Indicate maximum number of aliases that can be programmed
- ◆ System capability failure indications
- ◆ Options (Speaker Mic with and without antenna, Vehicular Charger with Mic, Antenna, Headsets, etc.)
- ◆ Include a discussion of headsets available for use by the Fire Department and other City agencies.
- ◆ Provide a specification compliance matrix for each proposed handheld radio (required).

13.10 Proposed Control Stations

13.10A Describe your proposed control stations. At a minimum, the following items must be addressed. If there are specific requests for information elsewhere in this RFP that fits in this section, please include here.

- ◆ Quantity Proposed per Agency
- ◆ Manufacturer
- ◆ Make and Model Number
- ◆ Analog/Digital
- ◆ Project 25 Phase I, Phase II – state specifically if the proposed radios provide Project 25 Phase II operation. If not, whether the radios are upgradeable to Phase II operation at additional cost.
- ◆ Ability to program Project 25 trunking control and/or compatibility with non-Project 25 trunking control.
- ◆ RF Power Output
- ◆ Number of Systems
- ◆ Number of modes
- ◆ Encryption capability, OTAR, code key management

- ◆ Talk-around
- ◆ Priority Scan
- ◆ Dynamic Regrouping
- ◆ Ability to program conventional channels
- ◆ Call Alert (Paging via Signaling Channel)
- ◆ Individual Call
 - Indicate if Individual Call list is separate from Call Alert list
 - Indicate maximum size of each
- ◆ Display Type
- ◆ Desk Mic
- ◆ Emergency Button
- ◆ Unit ID
 - Indicate ability to display alias of calling party
 - Indicate maximum number of aliases that can be programmed
- ◆ System capability failure indications
- ◆ Provide a specification compliance matrix for each proposed control station (required).
- ◆ Proposed 4-hour rechargeable power system including manufacturer, operating capacity (time), recharge time, required maintenance, type of battery.

13.11 Proposed Equipment Shelters

13.11A Describe the proposed equipment shelters. At a minimum, the following items must be addressed. If there are specific requests for information elsewhere in this RFP that fits in this section, please include here.

- ◆ Quantity and location of each Proposed Shelter
- ◆ Manufacturer
- ◆ Size
- ◆ Type of Construction and Finish
- ◆ Slab and Fence
- ◆ Climate Control
- ◆ Bulkhead panels
- ◆ Grounding System
- ◆ Ice Shield and Waveguide Bridge
- ◆ Lighting and Electrical System
- ◆ Surge Suppression (AC, Coaxial, Control Ckts.)
- ◆ Doors & Locks
- ◆ Vent Fans
- ◆ Detectors (Smoke, Fuel Leak, etc.)
- ◆ Security system

Include scale drawings of the floor plan, rack layouts, and exterior elevations.

13.12 Proposed Power Systems

13.12.1 Uninterruptible Power Supply (if proposed, see Section 4)

13.12.1A Describe your proposed UPS'. At a minimum, the following items must be addressed. If there are specific requests for information elsewhere in this RFP that fits in this section, please include here.

- ◆ Quantity proposed and location of each UPS
- ◆ Manufacturer, Make & Model #
- ◆ Rated output
- ◆ Operating time at full load
- ◆ Alarm outputs provided and monitored
- ◆ Floor loading
- ◆ Recharge time
- ◆ Battery life (years)

13.12.2 DC Power Systems (if proposed, see Section 4)

13.12.2A Describe your proposed DC Power System. At a minimum, the following items must be addressed. If there are specific requests for information elsewhere in this RFP that fits in this section, please include here.

- ◆ Quantity proposed and location of each piece of equipment
- ◆ Equipment Manufacturer, Make & Model #
- ◆ Associated features
- ◆ Rack face drawing of power system layout
- ◆ Operating voltage
- ◆ Operated time at full load
- ◆ Charging system
- ◆ Battery type
- ◆ Floor loading

13.12.3 AC Power Generators

13.12.3A Describe your proposed AC Power Generators. At a minimum, the following items must be addressed. If there are specific requests for information elsewhere in this RFP that fits in this section, please include here.

- ◆ Quantity Proposed and location of each generator
- ◆ Manufacturer
- ◆ Model
- ◆ Type of Fuel & Storage Tank
- ◆ Fuel Capacity
- ◆ KW Rating
- ◆ Run time at full load
- ◆ Remote starting capability

- ◆ Transfer switch
- ◆ Exhaust system
- ◆ Surge protection

13.13 Proposed Microwave System

13.13A Describe the microwave system configuration and equipment you are proposing. At a minimum, the following items must be addressed. If there are specific requests for information elsewhere in this RFP that fits in this section, please include here.

- ◆ Configuration of your proposed system (site locations, redundant operation)
- ◆ Manufacturer
- ◆ Model Radios
- ◆ Capacity
- ◆ Equipped Capacity (MUX)
- ◆ Orderwire
- ◆ BER Performance
- ◆ Calculated Fade Margin per Hop, predicted faded Bit Error Rate, and Fade Margin Calculation Worksheet, Path Profiles
- ◆ Battery Plant Type, Capacity in Hours, Recharge Time
- ◆ Alarm System
- ◆ Multiplexor manufacturer, make and model #
- ◆ Antenna manufacturer, make and model #
- ◆ Past experience with the proposed equipment

13.14 Proposed Main and Backup Dispatch Consoles

13.14A Describe the proposed main dispatch consoles proposed. At a minimum, the following items must be addressed. If there are specific requests for information elsewhere in this RFP that fits in this section, please include here.

- ◆ Console system architecture (GUI/CRT-based, LAN connected, control switch, etc.)
- ◆ Manufacturer
- ◆ Make and Model
- ◆ Number of Operator Positions Proposed
- ◆ Maximum number of operator positions supported by system architecture
- ◆ Number of talkgroups and conventional channels supported on each dispatch console screen, folder, etc.
- ◆ Conventional channel expansion capability

- ◆ Number of unit ID's and aliases supported per switch and/or operator position
- ◆ Number of simultaneous patches per operator position supported and discussion relating to the City of Houston's Interoperability and Mutual Aid channel requirements.
- ◆ Functional Capabilities
- ◆ Provide sample screen shots
- ◆ Provide an example of how the City of Houston dispatch console resource folders might look and operate relating to backup RF control, backup dispatch center, etc.
- ◆ Available Headsets
- ◆ Capability to combine dispatch and telephone audio into headset
- ◆ Logging Recorder and Interface
- ◆ System Alarm Panel
- ◆ Centralized time base
- ◆ Backup Control Stations

13.14B Describe the type of display unit provided. Include the following in your discussion:

- ◆ Type of display unit (control station, PC, etc.)
- ◆ Characteristics, scrolling list, momentary display during PTT, etc.
- ◆ Source of displayed information
- ◆ Describe the proposed methods of providing interoperability between various agencies in and around Houston.

13.15 Proposed Trunked Site Antenna Systems (700/800 MHz)

13.15A Describe your proposed repeater antenna systems. At a minimum, the following items must be addressed. If there are specific requests for information elsewhere in this RFP that fits in this section, please include here.

- ◆ Combiners (make, model, number of channels)
- ◆ Multicoupler (make, model, number of channels)
- ◆ Tower Top Amp – failure protection and detection, test port operation
- ◆ Transmit Antenna (make, model, gain, height, and orientation)
- ◆ Receive Antenna (make, model, gain, height, and orientation)
- ◆ Transmission Line Used
- ◆ Surge suppression devices proposed

13.16 Proposed System Manager/Information Management System

13.16A Describe your proposed system/network management system. At a minimum, the following items must be addressed. If there are specific requests for information elsewhere in this RFP that fits in this section, please include here.

- ◆ Computer Platform Provided:
- ◆ Number of Terminals Proposed:
- ◆ Number of Terminals Supported:
- ◆ Dial-up and/or remote LAN Capability:
- ◆ Functional Capabilities:
- ◆ Please provide complete and thorough descriptions of the operation of each of the following functions:

Dynamic talkgroup reconfiguration

- ◆ # of pre-programmed plans available
- ◆ Time to regroup each unit
- ◆ Method of verifying successful regroup
- ◆ Radio indications following a regroup

Selective Inhibit/Uninhibit

- ◆ Method of disabling a unit
- ◆ How long the system will “search” for a targeted unit
- ◆ Unit’s capabilities while disabled
- ◆ Unit indications while disabled
- ◆ Steps to re-enable a disabled unit

Activity Reporting and Archiving

- ◆ Information available
- ◆ Sample reports

Report Generation Printing

- ◆ Manufacturer, make and model at proposed printers

Database Maintenance

- ◆ Parameters controlled
- ◆ Describe unit and talkgroup site access privilege capabilities. Be specific about how this process works. Does it require that the radio unit register before the change takes place, etc?
- ◆ Number of separate databases that must be maintained for user authentication, user ID aliasing, alarm ID aliasing, etc.

Controller Updating

- ◆ Remote capabilities

- ◆ Password protection, # of access levels

System Diagnostic and Alarm Reporting

Graphical User Interface

13.17 Programming Software

13.17A Describe your programming software packages. At a minimum, the following items must be addressed. If there are specific requests for information elsewhere in this RFP that fits in this section, please include here.

- ◆ Model number and price for each piece of software and equipment.
- ◆ Remote programming capabilities of your system, including:
 - Backbone/Network equipment
 - Repeater site equipment
 - Dispatch Center equipment
 - Subscriber equipment
 - Indicate which items/features can be programmed over the air, through the backbone distribution network, through dial up lines, through dedicated leased lines, or only by being on location with the equipment.

13.17.1 Alarm System

13.17.1A Describe your proposed alarm system. At a minimum, the following items must be addressed. If there are specific requests for information elsewhere in this RFP that fits in this section, please include here.

- ◆ Manufacturer, make and model of all equipment
- ◆ Quantity proposed and proposed location of all equipment
- ◆ Functional capabilities
- ◆ Diagnostics displayed
- ◆ Alarm conditions displayed
- ◆ Sensors provided and monitored
 - Radio Equipment
 - Dispatch Center Equipment
 - Power Systems
 - Microwave Systems
 - Sites
 - Proposed communications medium for your alarm system

13.18 Proposed Fleet/Sub Fleet Mapping Plan

13.18A Describe the fleet mapping capabilities of the proposed system, including conventional operation. Identify fleet or sub fleet boundaries or limitations in size.

13.19 Proposed Training Program

13.19A Describe your proposed training program. At a minimum, the following items must be addressed. If there are specific requests for information elsewhere in this RFP that fits in this section, please include here.

- ◆ System Overview
 - Number of Sessions
 - Duration Each
 - Class Size
 - Location
 - Media Used
 - Proposed Number of Instructor Hours
 - Proposed Cost
- ◆ Operator Training
 - Number of Sessions
 - Duration Each
 - Class Size
 - Location
 - Media Used
 - Proposed Number of Instructor Hours
 - Proposed Cost
- ◆ Dispatch Console Operator Training
 - Number of Sessions
 - Duration Each
 - Class Size
 - Location
 - Media Used
 - Proposed Number of Instructor Hours
 - Proposed Cost
- ◆ 1st Echelon Technician Training
 - Number of Sessions
 - Duration Each
 - Class Size
 - Location
 - Media Used

- Proposed Number of Instructor Hours
- Proposed Cost

- ◆ System Technician Training
 - Number of Sessions
 - Duration Each
 - Class Size
 - Location
 - Media Used
 - Proposed Number of Instructor Hours
 - Proposed Cost

- ◆ System Manager Training
 - Number of Sessions
 - Duration Each
 - Class Size
 - Location
 - Media Used
 - Proposed Number of Instructor Hours
 - Proposed Cost

13.19B Please provide client references that have been trained by your proposed instructors.

13.19C Please provide an hourly rate for any additional supplemental training

13.20 Acceptance Testing Procedures

13.20A Please provide a completed, thorough Coverage Acceptance Test Plan. Please provide an outline of your proposed Functional Acceptance Test Plan. Test scripts are not required for your proposal, but will be required prior to contract execution.

13.21 Proposed Radio Towers

13.21A Please provide a complete description of your proposed radio towers. At a minimum, the following items must be addressed. If there are specific requests for information elsewhere in this RFP that fits in this section, please include here.

- ◆ Number of towers proposed and locations
- ◆ Make, model, type, and tower height of each tower
- ◆ Tower lighting
- ◆ Grounding
- ◆ Site construction, including fencing, landscaping, access, etc.

13.21B Include site and tower drawings for each proposed tower site.

Fully Compliant Partially Compliant Non-Compliant

Section 14—Proposed Pricing..... 2

14.1 General.....2

Section

14

Proposed Pricing

14.1 General

- 14.1A The City does not anticipate requesting best & final offers. It is the City's intent to evaluate and score your proposed pricing submitted with your proposal. Any discounts, trade-ins, cost incentives or signing bonuses you intend to extend to the City should be contained in your proposal.
- 14.1B The Proposer must submit all pricing for its proposal(s) based on the following pricing worksheets. The forms provided in these worksheets serve as the basis for the proposed pricing of all equipment and all services including, but not limited to, equipment delivery, freight, installation, programming, optimization, project management, engineering, training, testing, Contractor travel and per-diem, supplies, etc. Submission of a proposal shall be conclusive evidence that the Proposer has investigated and is satisfied as to the conditions to be encountered in performing the work.
- 14.1C The Proposer should expand on the specifics of these forms and duplicate the forms as required to adequately portray the proposed architecture. The Proposer must be as descriptive as possible and include equipment model names, supplier names and model numbers for 3rd-party equipment, etc. Please include equipment shelter sizes, tower heights, UPS and generator sizes, etc. on the worksheets.
- 14.1D Proposals should clearly and effectively communicate system concept, infrastructure configuration and user equipment options. Pricing should reflect both system and component level costs.
- 14.1E Round all costs to the nearest dollar!

14.1.1A – HEC Master Site Equipment

HEC Master Site Equipment	Site Name: HEC		
Description	Qty	Unit Cost	Extended Cost
Master Site Trunking Controller (Redundant)		\$	\$
Master Site Audio Switch, LAN, WAN Equipment		\$	\$
Master Site Server/Client Equipment		\$	\$
Master Site Alarm Monitoring Equipment		\$	\$
Master Site Other Equipment		\$	\$
System Management/Alarm Terminals 1 – HEC Master Control Point 1 – HEC Police Supervisor's position 1 – Police Radio Shop 1 – HEC Fire Supervisor's position 1 – Fire Radio Shop 1 – HEC Emergency Operations Center 1 – Public Works and Engineering Radio Shop 1 – HAS George Bush Intercontinental Airport	8	\$	\$
Master Site Microwave Equipment		\$	\$
Computer-Based Logging Recorder for System with Capacity to Record all Talkgroups for Two (2) Weeks, Two User Terminals		\$	\$
Services: Upgrade to Master Site Equipment Shelter		\$	\$
Services: Installation, Project Management, Engineering, Optimization, Programming, and other Services Related to HEC Master Site		\$	\$
Total HEC Master Site Equipment and Services			\$

14.1.1B – Backup Master Site Equipment

Backup Master Site Equipment	Site Name: HEC		
Description	Qty	Unit Cost	Extended Cost
Backup Master Site Trunking Controller (Redundant)		\$	\$
Backup Master Site Audio Switch, LAN, WAN Equipment		\$	\$
Backup Master Site Server/Client Equipment		\$	\$
Backup Master Site Alarm Monitoring Equipment		\$	\$
Master Site Other Equipment		\$	\$
Backup Master Site Microwave Equipment		\$	\$
Backup Master Site UPS		\$	\$
Backup Master Site Tower		\$	\$
Backup Master Site Equipment Shelter		\$	\$
Backup Master Site – Site Work		\$	\$
Services: Installation, Project Management, Engineering, Optimization, Programming, and other Services Related to Backup Master Site		\$	\$
Total Backup Master Site Equipment and Services			\$

14.1.1C – Simulcast Subsystem #1, Prime Site

Simulcast Subsystem #1, Prime Site		<i>Subsystem Name:</i>	
		<i>Site Name:</i>	
		<i>No. Sites:</i>	
		<i>No. Channels:</i>	
Description	Qty	Unit Cost	Extended Cost
Simulcast Prime Trunking Controller (Redundant)		\$	\$
Simulcast Prime LAN, WAN Equipment		\$	\$
Simulcast Prime Audio Distribution		\$	\$
Simulcast Prime Receiver Voting		\$	\$
Simulcast Prime Simulcast Sync Equipment		\$	\$
Simulcast Co-Located Remote Trunking Controller		\$	\$
Simulcast Co-Located Remote LAN, WAN Equipment		\$	\$
Simulcast Co-Located Remote Audio Distribution		\$	\$
Simulcast Co-Located Remote Sync Equipment		\$	\$
Simulcast Co-Located Remote Base Stations		\$	\$
Simulcast Co-Located Remote Antenna System		\$	\$
Simulcast Subsystem Alarm Monitoring Equipment		\$	\$
Simulcast Subsystem Microwave Equipment		\$	\$
Simulcast Subsystem Site DC Power System		\$	\$
Simulcast Subsystem Site Tower		\$	\$
Simulcast Subsystem Site Equipment Shelter		\$	\$
Simulcast Subsystem Site – Site Work		\$	\$
Services: Installation, Project Management, Engineering, Optimization, Programming, and other Services Related to Simulcast Subsystem Prime Site		\$	\$
Total Simulcast Subsystem #1 Prime Site Equipment and Services			\$

14.1.1D – Simulcast Subsystem #1, Remote Site #1

Simulcast Subsystem #1, Remote Site #1		<i>Subsystem Name: Site Name:</i>	
Description	Qty	Unit Cost	Extended Cost
Simulcast Remote Site Trunking Controller		\$	\$
Simulcast Remote Site LAN, WAN Equipment		\$	\$
Simulcast Remote Site Audio Distribution		\$	\$
Simulcast Remote Site Sync Equipment		\$	\$
Simulcast Remote Site Base Stations		\$	\$
Simulcast Remote Site Antenna System		\$	\$
Simulcast Remote Site Alarm Monitoring Equipment		\$	\$
Simulcast Remote Site Microwave Equipment		\$	\$
Simulcast Remote Site DC Power System		\$	\$
Simulcast Remote Site Tower		\$	\$
Simulcast Remote Site Equipment Shelter		\$	\$
Simulcast Remote Site – Site Work		\$	\$
Services: Installation, Project Management, Engineering, Optimization, Programming, and other Services Related to Simulcast Remote Site		\$	\$
Total Simulcast Subsystem #1 Remote Site #1 Equipment and Services			\$

14.1.1E – Simulcast Subsystem #1, Remote Site #N

Simulcast Subsystem # 1, Remote Site # N		<i>Subsystem Name: Site Name:</i>	
Description	Qty	Unit Cost	Extended Cost
Simulcast Remote Site Trunking Controller		\$	\$
Simulcast Remote Site LAN, WAN Equipment		\$	\$
Simulcast Remote Site Audio Distribution		\$	\$
Simulcast Remote Site Sync Equipment		\$	\$
Simulcast Remote Site Base Stations		\$	\$
Simulcast Remote Site Antenna System		\$	\$
Simulcast Remote Site Alarm Monitoring Equipment		\$	\$
Simulcast Remote Site Microwave Equipment		\$	\$
Simulcast Remote Site DC Power System		\$	\$
Simulcast Remote Site Tower		\$	\$
Simulcast Remote Site Equipment Shelter		\$	\$
Simulcast Remote Site – Site Work		\$	\$
Services: Installation, Project Management, Engineering, Optimization, Programming, and other Services Related to Simulcast Remote Site		\$	\$
Total Simulcast Subsystem #1 Remote Site #N Equipment and Services			\$

14.1.1F – Simulcast Subsystem #N, Prime Site

Simulcast Subsystem # N Prime Site		<i>Subsystem Name:</i>	
		<i>Site Name:</i>	
		<i>No. Sites:</i>	
		<i>No. Channels:</i>	
Description	Qty	Unit Cost	Extended Cost
Simulcast Prime Trunking Controller (Redundant)		\$	\$
Simulcast Prime LAN, WAN Equipment		\$	\$
Simulcast Prime Audio Distribution		\$	\$
Simulcast Prime Receiver Voting		\$	\$
Simulcast Prime Simulcast Sync Equipment		\$	\$
Simulcast Co-Located Remote Trunking Controller		\$	\$
Simulcast Co-Located Remote LAN, WAN Equipment		\$	\$
Simulcast Co-Located Remote Audio Distribution		\$	\$
Simulcast Co-Located Remote Sync Equipment		\$	\$
Simulcast Co-Located Remote Base Stations		\$	\$
Simulcast Co-Located Remote Antenna System		\$	\$
Simulcast Subsystem Alarm Monitoring Equipment		\$	\$
Simulcast Subsystem Microwave Equipment		\$	\$
Simulcast Subsystem Site DC Power System		\$	\$
Simulcast Subsystem Site Tower		\$	\$
Simulcast Subsystem Site Equipment Shelter		\$	\$
Simulcast Subsystem Site – Site Work		\$	\$
Services: Installation, Project Management, Engineering, Optimization, Programming, and other Services Related to Simulcast Subsystem Prime Site		\$	\$
Total Simulcast Subsystem #N Prime Site Equipment and Services			\$

14.1.1G – Simulcast Subsystem #N, Remote Site #1

Simulcast Subsystem # N, Remote Site # N		<i>Subsystem Name: Site Name:</i>	
Description	Qty	Unit Cost	Extended Cost
Simulcast Remote Site Trunking Controller		\$	\$
Simulcast Remote Site LAN, WAN Equipment		\$	\$
Simulcast Remote Site Audio Distribution		\$	\$
Simulcast Remote Site Sync Equipment		\$	\$
Simulcast Remote Site Base Stations		\$	\$
Simulcast Remote Site Antenna System		\$	\$
Simulcast Remote Site Alarm Monitoring Equipment		\$	\$
Simulcast Remote Site Microwave Equipment		\$	\$
Simulcast Remote Site DC Power System		\$	\$
Simulcast Remote Site Tower		\$	\$
Simulcast Remote Site Equipment Shelter		\$	\$
Simulcast Remote Site – Site Work		\$	\$
Services: Installation, Project Management, Engineering, Optimization, Programming, and other Services Related to Simulcast Remote Site		\$	\$
Total Simulcast Subsystem #N Remote Site #1 Equipment and Services			\$

14.1.1H – Simulcast Subsystem #N, Remote Site #N

Simulcast Subsystem # N, Remote Site # N		<i>Subsystem Name: Site Name:</i>	
Description	Qty	Unit Cost	Extended Cost
Simulcast Remote Site Trunking Controller		\$	\$
Simulcast Remote Site LAN, WAN Equipment		\$	\$
Simulcast Remote Site Audio Distribution		\$	\$
Simulcast Remote Site Sync Equipment		\$	\$
Simulcast Remote Site Base Stations		\$	\$
Simulcast Remote Site Antenna System		\$	\$
Simulcast Remote Site Alarm Monitoring Equipment		\$	\$
Simulcast Remote Site Microwave Equipment		\$	\$
Simulcast Remote Site DC Power System		\$	\$
Simulcast Remote Site Tower		\$	\$
Simulcast Remote Site Equipment Shelter		\$	\$
Simulcast Remote Site – Site Work		\$	\$
Services: Installation, Project Management, Engineering, Optimization, Programming, and other Services Related to Simulcast Remote Site		\$	\$
Total Simulcast Subsystem #N Remote Site #N Equipment and Services			\$

14.1.11 – Multicast Remote Site # 1

Multicast Remote Site # 1	Site Name:		
Description	Qty	Unit Cost	Extended Cost
Multicast Remote Site Trunking Controller		\$	\$
Multicast Remote Site LAN, WAN Equipment		\$	\$
Multicast Remote Site Audio Distribution		\$	\$
Multicast Remote Site Base Stations		\$	\$
Multicast Remote Site Antenna System		\$	\$
Multicast Remote Site Alarm Monitoring Equipment		\$	\$
Multicast Remote Site Microwave Equipment		\$	\$
Multicast Remote Site DC Power System		\$	\$
Multicast Remote Site Tower		\$	\$
Multicast Remote Site Equipment Shelter		\$	\$
Multicast Remote Site – Site Work		\$	\$
Services: Installation, Project Management, Engineering, Optimization, Programming, and other Services Related to Multicast Remote Site		\$	\$
Total Multicast Remote Site #1 Equipment and Services			\$

14.1.1J – Multicast Remote Site #N

Multicast Remote Site # N	Site Name:		
Description	Qty	Unit Cost	Extended Cost
Multicast Remote Site Trunking Controller		\$	\$
Multicast Remote Site LAN, WAN Equipment		\$	\$
Multicast Remote Site Audio Distribution		\$	\$
Multicast Remote Site Base Stations		\$	\$
Multicast Remote Site Antenna System		\$	\$
Multicast Remote Site Alarm Monitoring Equipment		\$	\$
Multicast Remote Site Microwave Equipment		\$	\$
Multicast Remote Site DC Power System		\$	\$
Multicast Remote Site Tower		\$	\$
Multicast Remote Site Equipment Shelter		\$	\$
Multicast Remote Site – Site Work		\$	\$
Services: Installation, Project Management, Engineering, Optimization, Programming, and other Services Related to Multicast Remote Site		\$	\$
Total Multicast Remote Site #N Equipment and Services			\$

14.1.1K – HEC Dispatch Equipment

HEC Dispatch Equipment	Site Name:		
Description	Qty	Unit Cost	Extended Cost
IP-Based CRT Touch-Screen Dispatch Consoles (HEC for Police)	20	\$	\$
IP-Based CRT Touch-Screen Dispatch Consoles (Police Administration Building for Police)	2	\$	\$
IP-Based CRT Touch-Screen Dispatch Consoles (HEC for Fire)	22	\$	\$
IP-Based CRT Touch-Screen Dispatch Consoles (Fire Administration Building for Fire)	2	\$	\$
IP-Based CRT Touch-Screen Dispatch Consoles (HEC Telemetry Room for Fire)	9	\$	\$
IP-Based CRT Touch-Screen Dispatch Consoles (HEC Training Room)	12	\$	\$
IP-Based CRT Touch-Screen Dispatch Consoles (small footprint) (HEC Emergency Operations Center)	2	\$	\$
IP-Based CRT Touch-Screen Dispatch Consoles (Field Emergency Operations Center Bus) (Connectivity to be provided by City of Houston)	1	\$	\$
HEC Console LAN/WAN/Electronics (Please describe for the architecture proposed)		\$	\$
HEC Instant Recall Recorders (one per console)	70	\$	\$
Racked RF Control Stations interfaced into HEC Dispatch Consoles for Backup	37	\$	\$
HEC Logging Recorder Interface For All System Talkgroups	1	\$	\$
Fire Alerting Functionality fro Dispatch Consoles	1	\$	\$
Master Time Source Recommendation	1	\$	\$
Services: Installation, Project Management, Engineering, Optimization, Programming, and other Services Related to Dispatch Equipment		\$	\$
Total HEC Dispatch Equipment and Services			\$

Please describe available Dispatch Console Headsets

14.1.1L - Public Works & Engineering Dispatch Equipment

Public Works & Engineering Dispatch Equipment	Site Name:		
Description	Qty	Unit Cost	Extended Cost
IP-Based CRT Touch-Screen Dispatch Consoles (Public Works & Engineering)	12	\$	\$
IP-Based CRT Touch-Screen Dispatch Consoles (Wastewater Division on Groveway St.)	2	\$	\$
PW&E Console LAN/WAN/Electronics (Please describe for the architecture proposed)		\$	\$
PW&E Instant Recall Recorders (one per console)	14	\$	\$
Logging Recorder Interface For All System Talkgroups	1	\$	\$
Services: Installation, Project Management, Engineering, Optimization, Programming, and other Services Related to Dispatch Equipment		\$	\$
Total PW&E Dispatch Equipment and Services			\$

14.1.1M – Backup Police/Fire Dispatch Equipment

Backup Police/Fire Dispatch Equipment	Site Name:		
Description	Qty	Unit Cost	Extended Cost
IP-Based CRT Touch-Screen Dispatch Consoles (Police)	20	\$	\$
IP-Based CRT Touch-Screen Dispatch Consoles (Fire)	22	\$	\$
Console LAN/WAN/Electronics (Please describe for the architecture proposed)		\$	\$
HEC Instant Recall Recorders (one per console)	42	\$	\$
Services: Installation, Project Management, Engineering, Optimization, Programming, and other Services Related to Dispatch Equipment		\$	\$
Total Backup Police/Fire Dispatch Equipment and Services			\$

14.1.1N – Interoperability and Mutual Aid Equipment

<i>Interoperability and Mutual Aid Equipment</i>	<i>Site Name:</i>		
Description	Qty	Unit Cost	Extended Cost
700 MHz Interoperability Conventional Repeaters with Antenna Systems <i>(Located at HEC)</i>	8	\$	\$
Services: Installation, Project Management, Engineering, Optimization, Programming, and other Services Related to Dispatch Equipment		\$	\$
Total Interoperability and Mutual Aid Equipment and Services			\$

Note: The City of Houston currently has another project which will provide interoperability control stations, base stations, and repeaters to be located at the HEC. Thus, for the interoperability portion of this project, Proposers are required to provide only the following:

1. The 700 MHz Interoperability conventional repeater systems/services referenced above.
2. A conventional station interface into the proposed Dispatch Consoles which allows the City to add up to fifty (50) conventional tone, DC, or local controlled devices at a later date.

14.1.10 – Recommended Spares for Infrastructure Equipment

<p><i>Please list and price Proposer-recommended spare equipment separately so that the City understands the extent of spare equipment contained in the system. The City recognizes that spares are required for proper warranty service and ongoing maintenance of the system. Sufficient spares must be provided such that the required "service response times" for restoring outages are met. Please provide spares even for equipment that is proposed with redundant component..</i></p>	
	\$
	\$
	\$
	\$
	\$
	\$
	\$
	\$
	\$
	\$
	\$
	\$
	\$
	\$
Total Recommended Spares for Infrastructure Equipment	\$

14.1.1P – Police Mobile Radios –Tier 1

<i>Police Mobile Radios –Tier 1</i>			
Description	Qty	Unit Cost	Extended Cost
Digital Project 25 700/800MHz Mobile Radio	50	\$	\$
Dash Mount	50	\$	\$
Trunk Mount	0	\$	\$
Motorcycle	0	\$	\$
Dual Control Head	0	\$	\$
256 Modes Minimum (trunked and conventional)	50	\$	\$
Alphanumeric Display	50	\$	\$
Full Keypad	50	\$	\$
PTT-ID	50	\$	\$
Emergency Alert	50	\$	\$
Priority Scan	50	\$	\$
Individual Call and Call Alert	50	\$	\$
Signal Level Indicator	50	\$	\$
AES Single-key Voice Encryption	0	\$	\$
AES Multikey Voice Encryption	50	\$	\$
AES Over The Air Rekeying (OTAR)	50	\$	\$
External Relay Control	0	\$	\$
External Speaker	50	\$	\$
Services: Installation, Programming, and other Services Related to Radios		\$	\$
Total Police Mobile Radios Tier 1 and Related Services			\$

14.1.1Q – Police Mobile Radios –Tier 2

<i>Police Mobile Radios –Tier 2</i>			
Description	Qty	Unit Cost	Extended Cost
Digital Project 25 700/800MHz Mobile Radio	5060	\$	\$
Dash Mount	5000	\$	\$
Trunk Mount	0	\$	\$
Motorcycle	60	\$	\$
Dual Control Head	0	\$	\$
128 Modes Minimum (trunked and conventional)	5060	\$	\$
Alphanumeric Display	5060	\$	\$
Partial Keypad	5060	\$	\$
PTT-ID	5060	\$	\$
Emergency Alert	5060	\$	\$
Priority Scan	5060	\$	\$
Individual Call and Call Alert	0	\$	\$
Signal Level Indicator	5060	\$	\$
AES Single-key Voice Encryption	0	\$	\$
AES Multikey Voice Encryption	5060	\$	\$
AES Over The Air Rekeying (OTAR)	5060	\$	\$
External Relay Control	0	\$	\$
External Speaker	5060	\$	\$
Services: Installation, Programming, and other Services Related to Radios		\$	\$
Total Police Mobile Radios Tier 2 and Related Services			\$

14.1.1R – Fire/EMS Mobile Radios –Tier 1

<i>Fire/EMS Mobile Radios –Tier 1</i>			
Description	Qty	Unit Cost	Extended Cost
Digital Project 25 700/800MHz Mobile Radio	50	\$	\$
Dash Mount	50	\$	\$
Trunk Mount	0	\$	\$
Motorcycle	0	\$	\$
Dual Control Head	0	\$	\$
256 Modes Minimum (trunked and conventional)	50	\$	\$
Alphanumeric Display	50	\$	\$
Full Keypad	50	\$	\$
PTT-ID	50	\$	\$
Emergency Alert	50	\$	\$
Priority Scan	50	\$	\$
Individual Call and Call Alert	50	\$	\$
Signal Level Indicator	0	\$	\$
AES Single-key Voice Encryption	0	\$	\$
AES Multikey Voice Encryption	50	\$	\$
AES Over The Air Rekeying (OTAR)	50	\$	\$
External Relay Control	0	\$	\$
External Speaker	0	\$	\$
Services: Installation, Programming, and other Services Related to Radios		\$	\$
Total Fire/EMS Mobile Radios Tier 1 and Related Services			\$

14.1.1S – Fire/EMS Mobile Radios –Tier 2

Fire/EMS Mobile Radios –Tier 2			
Description	Qty	Unit Cost	Extended Cost
Digital Project 25 700/800MHz Mobile Radio	850	\$	\$
Dash Mount	850	\$	\$
Trunk Mount	0	\$	\$
Motorcycle	0	\$	\$
Dual Control Head	400	\$	\$
128 Modes Minimum (trunked and conventional)	850	\$	\$
Alphanumeric Display	850	\$	\$
Partial Keypad	850	\$	\$
PTT-ID	850	\$	\$
Emergency Alert	850	\$	\$
Priority Scan	850	\$	\$
Individual Call and Call Alert	850	\$	\$
Signal Level Indicator	0	\$	\$
AES Single-key Voice Encryption	0	\$	\$
AES Multikey Voice Encryption	850	\$	\$
AES Over The Air Rekeying (OTAR)	850	\$	\$
External Relay Control	0	\$	\$
External Speaker	850	\$	\$
Services: Installation, Programming, and other Services Related to Radios		\$	\$
Total Fire/EMS Mobile Radios Tier 2 and Related Services			\$

14.1.1T – Public Works & Engineering Mobile Radios

Public Works & Engineering Mobile Radios			
Description	Qty	Unit Cost	Extended Cost
Digital Project 25 700/800MHz Mobile Radio	3736	\$	\$
Dash Mount	3736	\$	\$
Trunk Mount	0	\$	\$
Motorcycle	0	\$	\$
Dual Control Head	0	\$	\$
256 Modes Minimum (trunked and conventional)	3736	\$	\$
Alphanumeric Display	3736	\$	\$
Partial Keypad	3736	\$	\$
PTT-ID	3736	\$	\$
Emergency Alert	3736	\$	\$
Priority Scan	3736	\$	\$
Individual Call and Call Alert	3736	\$	\$
Signal Level Indicator (preferred)	3736	\$	\$
AES Single-key Voice Encryption	0	\$	\$
AES Multikey Voice Encryption	0	\$	\$
AES Over The Air Rekeying (OTAR)	0	\$	\$
External Relay Control	0	\$	\$
External Speaker	3736	\$	\$
Services: Installation, Programming, and other Services Related to Radios		\$	\$
Total Public Works & Engineering Mobile Radios and Related Services			\$

14.1.1U – Police Portable Radios –Tier 1

<i>Police Portable Radios –Tier 1</i>			
Description	Qty	Unit Cost	Extended Cost
Digital Project 25 700/800MHz Portable Radio	50	\$	\$
256 Modes Minimum (trunked and conventional)	50	\$	\$
Alphanumeric Display	50	\$	\$
Full Keypad	50	\$	\$
PTT-ID	50	\$	\$
Emergency Alert	50	\$	\$
Priority Scan	50	\$	\$
Individual Call and Call Alert	50	\$	\$
Battery Power Level Indicator	50	\$	\$
Signal Level Indicator	50	\$	\$
AES Single-key Voice Encryption	0	\$	\$
AES Multikey Voice Encryption	50	\$	\$
AES Over The Air Rekeying (OTAR)	50	\$	\$
Intrinsically Safe	0	\$	\$
Ruggedized (not yellow)	50	\$	\$
Ruggedized (yellow)	0	\$	\$
Single Unit Charger 1-Hour	10	\$	\$
Vehicular Charger	40	\$	\$
Multi-Unit Charger	2	\$	\$
Speaker Microphone (no antenna)	50	\$	\$
Spare Batteries	100	\$	\$
Leather Carrying Case	50	\$	\$
Services: Installation, Programming, and other Services Related to Radios		\$	\$
Total Police Portable Radios Tier 1 and Related Services			\$

14.1.1V – Police Portable Radios –Tier 2

<i>Police Portable Radios –Tier 2</i>			
Description	Qty	Unit Cost	Extended Cost
Digital Project 25 700/800MHz Radio	5000	\$	\$
128 Modes Minimum (trunked and conventional)	5000	\$	\$
Alphanumeric Display	5000	\$	\$
Partial Keypad	5000	\$	\$
PTT-ID	5000	\$	\$
Emergency Alert	5000	\$	\$
Priority Scan	5000	\$	\$
Individual Call and Call Alert	5000	\$	\$
Battery Power Level Indicator	5000	\$	\$
Signal Level Indicator	5000	\$	\$
AES Single-key Voice Encryption	0	\$	\$
AES Multikey Voice Encryption	5000	\$	\$
AES Over The Air Rekeying (OTAR)	5000	\$	\$
Intrinsically Safe	0	\$	\$
Ruggedized (not yellow)	5000	\$	\$
Ruggedized (yellow)	0	\$	\$
Single Unit Charger 1-Hour	1000	\$	\$
Vehicular Charger	3000	\$	\$
Multi-Unit Charger	525	\$	\$
Speaker Microphone (no antenna)	5000	\$	\$
Spare Batteries	5000	\$	\$
Leather Carrying Case	4000	\$	\$
Services: Installation, Programming, and other Services Related to Radios		\$	\$
Total Police Portable Radios Tier 2 and Related Services			\$

14.1.1W – Fire/EMS Portable Radios –Tier 1

<i>Fire/EMS Portable Radios –Tier 1</i>			
Description	Qty	Unit Cost	Extended Cost
Digital Project 25 700/800MHz Portable Radio	50	\$	\$
256 Modes Minimum (trunked and conventional)	50	\$	\$
Alphanumeric Display	50	\$	\$
Full Keypad	50	\$	\$
PTT-ID	50	\$	\$
Emergency Alert	50	\$	\$
Priority Scan	50	\$	\$
Individual Call and Call Alert	50	\$	\$
Battery Power Level Indicator	0	\$	\$
Signal Level Indicator	0	\$	\$
AES Single-key Voice Encryption	0	\$	\$
AES Multikey Voice Encryption	50	\$	\$
AES Over The Air Rekeying (OTAR)	50	\$	\$
Intrinsically Safe	50	\$	\$
Ruggedized (not yellow)	0	\$	\$
Ruggedized (yellow)	50	\$	\$
Single Unit Charger 1-Hour	50	\$	\$
Vehicular Charger	50	\$	\$
Multi-Unit Charger	4	\$	\$
Speaker Microphone (no antenna)	0	\$	\$
Spare Batteries	50	\$	\$
Leather Carrying Case	0	\$	\$
Services: Installation, Programming, and other Services Related to Radios		\$	\$
Total Fire/EMS Portable Radios Tier 1 and Related Services			\$

14.1.1X – Fire/EMS Portable Radios –Tier 2

<i>Fire/EMS Portable Radios –Tier 2</i>			
Description	Qty	Unit Cost	Extended Cost
Digital Project 25 700/800MHz Portable Radio	1650	\$	\$
128 Modes Minimum (trunked and conventional)	1650	\$	\$
Alphanumeric Display	1650	\$	\$
Partial Keypad	1650	\$	\$
PTT-ID	1650	\$	\$
Emergency Alert	1650	\$	\$
Priority Scan	1650	\$	\$
Individual Call and Call Alert	1650	\$	\$
Battery Power Level Indicator	0	\$	\$
Signal Level Indicator	0	\$	\$
AES Single-key Voice Encryption	0	\$	\$
AES Multikey Voice Encryption	1650	\$	\$
AES Over The Air Rekeying (OTAR)	1650	\$	\$
Intrinsically Safe	1650	\$	\$
Ruggedized (not yellow)	0	\$	\$
Ruggedized (yellow)	1650	\$	\$
Single Unit Charger 1-Hour	150	\$	\$
Vehicular Charger	500	\$	\$
Multi-Unit Charger	300	\$	\$
Speaker Microphone (no antenna)	0	\$	\$
Spare Batteries	1650	\$	\$
Leather Carrying Case	0	\$	\$
Services: Installation, Programming, and other Services Related to Radios		\$	\$
Total Fire/EMS Portable Radios Tier 2 and Related Services			\$

14.1.1Y – Public Works & Engineering Portable Radios –Tier 1

Public Works & Engineering Portable Radios –Tier 1			
Description	Qty	Unit Cost	Extended Cost
Digital Project 25 700/800MHz Portable Radio	7	\$	\$
256 Modes Minimum (trunked and conventional)	7	\$	\$
Alphanumeric Display	7	\$	\$
Full Keypad	7	\$	\$
PTT-ID	7	\$	\$
Emergency Alert	7	\$	\$
Priority Scan	7	\$	\$
Individual Call and Call Alert	7	\$	\$
Battery Power Level Indicator	7	\$	\$
Signal Level Indicator (preferred)	7	\$	\$
AES Single-key Voice Encryption	0	\$	\$
AES Multikey Voice Encryption	7	\$	\$
AES Over The Air Rekeying (OTAR)	7	\$	\$
Intrinsically Safe	0	\$	\$
Ruggedized (not yellow)	0	\$	\$
Ruggedized (yellow)	0	\$	\$
Single Unit Charger 1-Hour	7	\$	\$
Vehicular Charger	7	\$	\$
Multi-Unit Charger	1	\$	\$
Speaker Microphone (no antenna)	7	\$	\$
Spare Batteries	7	\$	\$
Leather Carrying Case	0	\$	\$
Services: Installation, Programming, and other Services Related to Radios		\$	\$
Total Public Works & Engineering Portable Radios Tier 1 and Related Services			\$

14.1.1Z – Public Works & Engineering Portable Radios –Tier 2

Public Works & Engineering Portable Radios –Tier 2			
Description	Qty	Unit Cost	Extended Cost
Digital Project 25 700/800MHz Portable Radio	2793	\$	\$
256 Modes Minimum (trunked and conventional)	2793	\$	\$
Alphanumeric Display	2793	\$	\$
Partial Keypad	2793	\$	\$
PTT-ID	2793	\$	\$
Emergency Alert	2793	\$	\$
Priority Scan	2793	\$	\$
Individual Call and Call Alert	2793	\$	\$
Battery Power Level Indicator	2793	\$	\$
Signal Level Indicator (preferred)	2793	\$	\$
AES Single-key Voice Encryption	0	\$	\$
AES Multikey Voice Encryption	0	\$	\$
AES Over The Air Rekeying (OTAR)	0	\$	\$
Intrinsically Safe	0	\$	\$
Ruggedized (not yellow)	0	\$	\$
Ruggedized (yellow)	0	\$	\$
Single Unit Charger 1-Hour	2793	\$	\$
Vehicular Charger	2793	\$	\$
Multi-Unit Charger	7	\$	\$
Speaker Microphone (no antenna)	0	\$	\$
Spare Batteries	2793	\$	\$
Leather Carrying Case	0	\$	\$
Services: Installation, Programming, and other Services Related to Radios		\$	\$
Total Public Works & Engineering Portable Radios Tier 2 and Related Services			\$

14.1.1AA – Police Control Station Radios

<i>Police Control Station Radios</i>			
Description	Qty	Unit Cost	Extended Cost
Digital Project 25 700/800MHz Control Station Radio	50	\$	\$
128 Modes Minimum (trunked and conventional)	50	\$	\$
Alphanumeric Display	50	\$	\$
Partial Keypad	50	\$	\$
PTT-ID	50	\$	\$
Emergency Alert	50	\$	\$
Priority Scan	50	\$	\$
Individual Call and Call Alert	50	\$	\$
Signal Level Indicator	50	\$	\$
AES Single-key Voice Encryption	0	\$	\$
AES Multikey Voice Encryption	50	\$	\$
AES Over The Air Rekeying (OTAR)	50	\$	\$
Battery Backup 4-Hour	50	\$	\$
Antenna System, Lightning Protection, Grounding	50	\$	\$
Services: Installation, Programming, and other Services Related to Radios		\$	\$
Total Police Control Station Radios and Related Services			\$

14.1.1BB – Fire/EMS Control Station Radios

<i>Fire/EMS Control Station Radios</i>			
Description	Qty	Unit Cost	Extended Cost
Digital Project 25 700/800MHz Control Station Radio	150	\$	\$
128 Modes Minimum (trunked and conventional)	150	\$	\$
Alphanumeric Display	150	\$	\$
Partial Keypad	150	\$	\$
PTT-ID	150	\$	\$
Emergency Alert	150	\$	\$
Priority Scan	150	\$	\$
Individual Call and Call Alert	150	\$	\$
Signal Level Indicator	0	\$	\$
AES Single-key Voice Encryption	0	\$	\$
AES Multikey Voice Encryption	150	\$	\$
AES Over The Air Rekeying (OTAR)	150	\$	\$
Battery Backup 4-Hour	150	\$	\$
Antenna System, Lightning Protection, Grounding	150	\$	\$
Services: Installation, Programming, and other Services Related to Radios		\$	\$
Total Fire/EMS Control Station Radios and Related Services			\$

14.1.1CC – Public Works & Engineering Control Station Radios

<i>Public Works & Engineering Control Station Radios</i>			
Description	Qty	Unit Cost	Extended Cost
Digital Project 25 700/800MHz Control Station Radio	85	\$	\$
256 Modes Minimum (trunked and conventional)	85	\$	\$
Alphanumeric Display	85	\$	\$
Partial Keypad	85	\$	\$
PTT-ID	85	\$	\$
Emergency Alert	85	\$	\$
Priority Scan	85	\$	\$
Individual Call and Call Alert	85	\$	\$
Signal Level Indicator (preferred)	85	\$	\$
AES Single-key Voice Encryption	0	\$	\$
AES Multikey Voice Encryption	0	\$	\$
AES Over The Air Rekeying (OTAR)	0	\$	\$
Battery Backup 4-Hour	85	\$	\$
Antenna System, Lightning Protection, Grounding	85	\$	\$
Services: Installation, Programming, and other Services Related to Radios		\$	\$
Total Public Works & Engineering Control Station Radios and Related Services			\$

14.1.1DD – Training

<i>Please list and price a Training plan as described in Section 11 (Training) of this RFP. Please be descriptive on each line item so that the City understands the extent of training proposed in the system.</i>	
	\$
	\$
	\$
	\$
	\$
	\$
	\$
	\$
	\$
	\$
	\$
	\$
	\$
	\$
Total Training	\$

14.1.1EE – Pricing Summary

<p><i>This worksheet summarizes all of the previous the pricing worksheets to derive a Total Project Cost. Proposers are encouraged to provide cost reduction measures in the form of Trade-In allowances and/or other cost reduction Incentives. After establishing this "Base Total Project Cost, the Proposers are also encouraged to provide creative and meaningful "Cost Reduction Options" which, in the Proposer's opinion, change the scope of equipment, features, and/or services in the project while still meeting the intent of the City's functional requirements.</i></p>	
Total HEC Master Site Equipment and Services	\$
Total Backup Master Site Equipment and Services	\$
Total Simulcast Subsystem #1 Prime/Remote Sites and Services (xx sites, yy channels)	\$
Total Simulcast Subsystem #N Prime/Remote Sites and Services (xx sites, yy channels)	\$
Total Multicast Remote Sites and Services (xx sites)	\$
Total Dispatch Equipment and Services	\$
Total Recommended Spares for Infrastructure Equipment	\$
Total Police Mobile, Portable, Control Station Radios and Related Services (all Tiers)	\$
Total Fire/EMS Mobile, Portable, Control Station Radios and Related Services (all Tiers)	\$
Total PW&E Mobile, Portable, Control Station Radios and Related Services (all Tiers)	\$
Total Training	\$
Total Base Project Cost <i>before Cost Adjustments</i>	\$
Trade-In Allowance	\$ ()
Cost Reduction Incentives	\$ ()
Total Base Project Cost <i>after Cost Adjustments</i>	

14.1.1GG – Recommended Corrective and Preventative Maintenance

<i>The basis for this form is that Year 1 is the warranty year for the proposed system. For each maintenance program offered, the Proposer must provide the following costs for years 2-5 maintenance. Separate corrective vs. preventative maintenance figures. An escalation factor is required for maintenance after 5 years.</i>			
	Corrective Maintenance	Preventative Maintenance	Total Maintenance
Year 2			
Infrastructure Equipment (exclude Dispatch)	\$	\$	\$
Microwave Radio Equipment	\$	\$	\$
Dispatch Equipment (exclude Control Stations)	\$	\$	\$
Mobile, Portable, and Control Station Equipment	\$	\$	\$
Software Maintenance Agreement	\$	\$	\$
Year 3			
Infrastructure Equipment (exclude Dispatch)	\$	\$	\$
Microwave Radio Equipment	\$	\$	\$
Dispatch Equipment (exclude Control Stations)	\$	\$	\$
Mobile, Portable, and Control Station Equipment	\$	\$	\$
Software Maintenance Agreement	\$	\$	\$
Year 4			
Infrastructure Equipment (exclude Dispatch)	\$	\$	\$
Microwave Radio Equipment	\$	\$	\$
Dispatch Equipment (exclude Control Stations)	\$	\$	\$
Mobile, Portable, and Control Station Equipment	\$	\$	\$
Software Maintenance Agreement	\$	\$	\$
Year 5			
Infrastructure Equipment (exclude Dispatch)	\$	\$	\$
Microwave Radio Equipment	\$	\$	\$
Dispatch Equipment (exclude Control Stations)	\$	\$	\$
Mobile, Portable, and Control Station Equipment	\$	\$	\$
Software Maintenance Agreement	\$	\$	\$
Escalation Factor After 5 Years %			%
% Discount off of list Price given to the City for ongoing Service and Maintenance Equipment			%

14.1.1HH – Breakout of Services

<i>Please breakout the price of various services for the project as shown below. It is understood that these costs are already distributed throughout the pricing worksheets. They are requested here for informational purposes.</i>	
Project Management	\$
Engineering	\$
System Staging	\$
Functional Acceptance Testing	\$
Coverage Acceptance Testing	\$

14.1.1II – Cost Reduction Options

<i>After establishing this "Base Total Project Cost, the Proposers are also encouraged to provide creative and meaningful "Cost Reduction Options" which, in the Proposer's opinion, change the scope of equipment, features, and/or services in the project while still meeting the intent of the City's functional requirements.</i>	
Total Base Project Cost after Cost Adjustments (Trade-In, Incentives)	\$
Cost Reduction Option #1 (remove all microwave equipment and services)	\$ ()
Cost Reduction Option #2 (remove all site work, towers, equipment shelters)	\$ ()
Cost Reduction Option #3 (change backup battery time from 4 hour to 2 hour for all sites)	\$ ()
Cost Reduction Option #N (please describe)	\$ ()
Total Project Cost after Cost Adjustments and Cost Reduction Options	\$

14.1.1JJ – Long-Term Pricing Discount %

The Proposer is required to provide guaranteed discount levels off of their List Price for various system segments for a period of three (3) years. Use the structure below and adapt as necessary comply with this request. The Trade-In is a suggested mechanism for offering additional savings to the City over the guaranteed percentage off List Price. The Proposer may offer alternative mechanisms for additional savings.

System Segment	% Discount off List Price	Years Guaranteed
Infrastructure Components	%	
<i>Infrastructure Components Trade-In</i>		
3rd Party Infrastructure Components	%	
<i>3rd Party Infrastructure Components Trade-In</i>		
Subscriber Family # 1	%	
<i>Subscriber Family #1 Trade-In</i>		
Subscriber Family # N	%	
<i>Subscriber Family # N Trade-In</i>		

Fully Compliant Partially Compliant Non-Compliant

Section 15—700 MHz Project Goals and Objectives 2

Section

15

Project Goals and Objectives

The single most important concern for any public safety radio project is to ensure that when a first responder pushes the transmit button on his/her radio that the transmission is successful the first time, every time. The existing systems have reached the end of their useful life and must be replaced. The current systems do not have sufficient capacity to meet the needs of the existing users, let alone any new users. However, no project with a large investment of funds should be undertaken without a clear understanding of the goals and objectives, and a plan to achieve them.

There are four main goals for the 700 MHz Radio project. The following summarizes the Goals and Objectives:

1. Improve coverage
 - a. conduct assessment and verify results of geographic coverage requirements
 - b. acquire additional radio sites for improved coverage
 - c. conduct rigorous acceptance testing striving for the greatest degree of objectivity possible
2. Provide sufficient reliability through system capacity
 - a. complete detailed system requirements based on user needs
 - b. secure sufficient 700 MHz frequencies for city use
3. Ensure cost effectiveness
 - a. Identify and negotiate partnerships to reduce capital system investment
 - b. Develop a sophisticated organizational capacity to effectively manage an evolving radio technology and FCC mandates with increasingly expensive radio devices
 - c. Select the most cost effective models for:
 - i. system operations and maintenance;
 - ii. subscriber equipment operations and maintenance; and
 - iii. annual technology refresh beginning in the fifth year after system go-live
 - d. Emphasize the critical need for measures that make this system viable by reducing costs in a manner that does not significantly impair functionality.
4. Increased Interoperability

The following provides detailed descriptions of these three goals and the supporting objectives.

Improved Coverage

Coverage is one of the most important things to consider during the construction of any radio system especially a system that provides services for public safety. Coverage is by far the largest cost driver. As discussed further in the Site Development section, coverage is mostly a product of tower proximity. Since construction and equipping of a new tower location is costly, each additional site needed has a large impact on the cost. Conversely, lack of coverage is the largest source for complaints regarding system performance. As stated in the opening of this document, the overarching goal of any public safety system is to ensure that when a first responder pushes the transmit button on his/her radio that the transmission is successful the first time, every time.

Needs Assessment

The first objective to be met to ensure improved coverage is to conduct a needs assessment. Coverage needs assessment was done as part of the RCC report produced in 2003. The Technical Committee verified and updated the assessment results. These needs were used to develop coverage requirements for the upcoming RFP. The requirements include expected coverage levels by geographic area of the city as well as specific buildings and tunnels that are considered critical and should be covered regardless of signal level required. To maximize the competitive environment and prepare the industry, the City's coverage requirements were published in pre-RFP release in April 2007.

Site Acquisition

The placement of towers for the new radio system will undoubtedly be one of the most difficult parts of the project. Like success in business, radio coverage is dependent upon three important things, location, location, location. Adequate radio coverage can only be achieved by having tower sites near the areas where you need coverage. Although backhaul and site connectivity can be adjusted based on tower placement, these adjustments will not plug coverage holes. This is further complicated by the City's need for a system with capacity for thousands of users.

Before further discussions about tower placement, it is important to understand the relationship of capacity to coverage as it relates to the new system. Public Safety radio systems have some practical limitations due to the extremely critical need for low latency call processing. Radio calls on a public safety system are processed in less than half a second, in most cases about one fourth of a second. This low latency requirement effects many design elements but the one that is applicable to this discussion is the limit on the number of frequencies (30) within a group of simulcast sites. This limitation is almost always addressed by dividing up the area into multiple simulcast cells (groups of towers) and restricting most users in that geographic area to use of the towers within that area. The number of users a system has, coupled with the geographic area equates to the number of cells needed.

Large buildings in most cities are concentrated into one general area (usually downtown). Houston having several urbanized hubs with large buildings makes coverage much more difficult. Currently, the City's various radio systems employ about 20 tower sites. The conceptual design of the proposed system calls for between 30 and 40 tower sites. Although estimating radio wave propagation (coverage prediction) is based on the laws of physics, it is as much an art as science. Each vendor has their own slant on predicting coverage.

The hurdles with this objective will be great. The City has a very strict tower ordinance and citizens don't want to see ugly radio towers dotting their neighborhoods. This can be illustrated by the proposed tower at the Houston Emergency Center. The project was funded in 2004 and the RFP has yet to be released. Although the City is exempt from the ordinance for just this reason, we will still make every effort to adhere to the ordinance and be sensitive to the citizens.

As part of the needs assessment activities, we worked with planning to develop some possible suitable locations for tower sites. Using the conceptual design prepared by RCC, planning looked for suitable sites that complied with the City's strict tower ordinance. Several sites were identified and provided to the vendors in the Coverage Requirements documents released in May, 2007. During this process, Planning identified a process for doing the site analysis and will be able to assist with similar analysis based on the vendor proposals received. However, in the end, it is almost a certainty that we will need towers in some locations that do not fall within the ordinance and that citizens will not be happy about.

If the City already owned all the needed sites, System design and implementation could be completed in 2-3 years. However, we have estimated a project timeline of 3-5 years to allow for the time necessary to acquire and construct the needed sites. Site acquisition will require proactive efforts in the education of our appointed and elected officials and in outreach to the community

Coverage Acceptance Testing

Good coverage can be a matter of interpretation. Radio signals are fickle. A signal may be sufficient in one area and not sufficient just a few feet away. Complicating that further, is that characteristics of a useful signal can change with environment factors and the presence of other competing signals. There are a number of ways to measure signal strength with varying results depending on the method chosen.

Working with our consultant, RCC, we have developed a methodology for testing that involves dividing the City into grids and then employing multiple testing methods to ensure compliance with our coverage requirements.

System Capacity

Needs Assessment

The first objective to be met to ensure sufficient system capacity is to conduct a needs assessment. On behalf of the City, RCC consultants produced two different reports detailing the present conditions of the various radio systems owned and operated by the City and a detailed, high-level analysis of the needs for a new system. In January 2007, the Project Technical Committee was formed and began

bi-weekly meetings to develop detailed user needs information as the basis for drafting an RFP. The RFP is scheduled to be published in August, 2007.

Frequency Availability Assessment

The second objective for ensuring sufficient system capacity is to conduct a frequency availability assessment. Again, this was done as part of the RCC report produced in 2006. The City currently owns two systems that operate in the 450 MHz band, one 800 MHz band, and the airport uses the County's 800 MHz system. There were an insufficient number of frequencies available in either the 450 MHz or the 800 MHz band to meet the city's current or future radio capacity needs. This left the 700 MHz band as the only viable option. Since all public safety radios currently being manufactured have the capability of operating on both 700 and 800 MHz, the use of 700 MHz also ensures that we will be able to continue to use the existing 800 MHz frequencies licensed by the City of Houston.

Securing 700 MHz Frequencies

The Federal Communications Commission (FCC) has divided the country into 55 regions and mandated the formation of a committee in each region for the purpose of developing and administering a plan for allocation of the 24 megahertz of spectrum allotted to public safety in the 700 MHz frequency band. The region for the Houston area is Region 51. The plan contains a pre-allotment of frequencies that can be used to assist the committee in planning the actual allotment. This pre-allotment is done geographically (by county) not by entity. There are 172 frequencies pre-allotment for Harris County. It is estimated that the City of Houston could need about 100-110 of those frequencies. Again, this should not be an issue because this is only the number of frequencies within Harris County. Each of the other counties in the region also has frequencies allotted. This leaves at least 40-70 frequencies for use within Harris County and many other frequencies left for use in other areas of the region.

The Harris County system serves a total of nine counties in this region and most of the agencies within those counties. That system currently operates on 800 MHz frequencies. Since 800 MHz is adjacent to 700 MHz, most the systems being manufactured today allow the use of both frequency bands in the same system and end user equipment. This means that since those agencies are already using and can continue to use 800 MHz frequencies their demand for new 700 MHz frequencies will be less.

According to the regional plan, frequencies can only be licensed if there is a valid need and a project plan with identified funding. These provisions make holding licenses very difficult.

At the committee meeting on April 25, 2007, the committee members in attendance voted unanimously to approve the draft plan. This first of several major milestones that must be accomplished before frequencies can actually be licensed. The following is a list of the remaining tasks:

1. The plan must be sent to the adjacent regions for official concurrence.
2. Once concurrence has been received, the plan must be officially filed with the FCC.
3. The committee must address all changes dictated by the FCC.
4. If changes are of a substantive nature, the process must resume at step one.
5. The plan receives FCC approval

Generally, the above listed process takes about six to eight months. The Region 51 draft plan was sent via overnight delivery to the chairs of the adjacent regions on May 2, 2007 with a request for response in less than 60 days.

This timetable lines up with our project schedule as we should be in receipt of the vendor proposals near the projected time of FCC approval of the plan. The vendor proposals will provide us a more definitive picture regarding the number of frequencies it will take to meet our capacity needs. There is little risk regarding the delay of this plan approval because the frequencies do not need to actually be licensed until the final stages of design review which should be in the fall of 2008.

Cost Effectiveness and Equipment Reliability

Partnerships

A critical component in the effort to control costs is the identification and successful negotiation of system partnerships. In 2003, RCC delivered a report based on an exhaustive needs assessment they conducted. This report titled The Strategic Wireless System Study (SWiSS) detailed the radio needs as well as several alternatives (with different costs) to meet those needs. This report was refreshed in 2006 and one particular alternative was advocated with an estimated cost of roughly \$150 million. RCC also identified a possible partnership with Harris County as a means of reducing that cost. There may be other partnership opportunities that could further reduce the cost to the City.

There have been initial discussions with Harris County and others. However, we believe it to be in the City's overall best interest to refrain from further discussions until the City is in receipt of the vendor proposals toward the end of 2007. The public safety radio market has a very limited number of vendors. Since some potential partners already have existing relationships with vendors, it is believed that further discussions prior to receipt of vendor proposals could damage the competitive environment and ultimately cost the City more money.

The Project Budget

RCC, based on their conceptual design, came up with a budgetary estimate of over \$100 million in 2003 and updated it again in 2006. While there are almost certainly some opportunities to trim that estimate, it is prudent to leave the estimate in place until we receive the vendor proposals. At that time, we can better estimate the overall cost and develop a strategy to reduce that cost as much as possible. One of the worst things we could do is force the system design into a specific budget up front

and possibly end up with a system that does not meet the needs of the users. Each proposal will be go through a stringent evaluation project based on the following criteria ranked by order of importance:

1. Guaranteed Radio Coverage and Capacity
2. System Pricing for all equipment and Services
3. System Design-Reliability, Fault Tolerance, Redundancy, Failback Modes of Operation
4. System Features and Functional Requirements
5. Installation Management, Maintenance and Support
6. Proposer Qualifications and Experience with Similar Projects

Optimizing the budget is of great importance in a project of this magnitude. We must emphasize to all involved the critical need for measures that make this system viable by reducing costs in a manner that does not significantly impair functionality.

New State of the Art Equipment

Radio spectrum is a finite commodity. The FCC is charged with managing the nation's spectrum resources and has been narrowing the frequency bandwidth used for land mobile radios in order to stave off allocating additional spectrum to this usage. As cellular phones, mobile computers, and other wireless devices become more and more popular, the pressure remains on the FCC to continue squeezing public safety and other land mobile radios users into smaller and smaller slices of the spectrum. Radios must continue to evolve in order to meet the increased technical requirements of operating on smaller amounts of spectrum. The typical frequency bandwidths for the last 30 years have been 25 kHz or larger. The FCC has mandated a deadline of 2013 for all land mobile radios to operate at 12.5 kHz and have recently indicated that they intend to mandate a 6.25 kHz standard shortly thereafter. In fact, they are encouraging users to skip the 12.5 kHz step and go straight to 6.25 kHz. These changes have a direct impact on the radio equipment available for land mobile radio.

Like other items in the technical field, radio equipment has evolved rapidly over the last couple of decades. Gone are the vacuum tubes of component based radios replaced by circuit boards and special software. Radios today are required to be more frequency efficient and are equipped with many more features. Intelligence is now built into each radio. Instead of monitoring one analog channel and receiving all communications on that frequency, radios now must be digital capable and normally are assigned frequencies dynamically based on communications that are intended for that particular radio.

Normally when consumer electronic equipment improves, costs tend to trend lower. However, in highly specialized markets like public safety radio, the opposite tends to be true. Public safety radios are required to have very strenuous operational specifications and frequency usage parameters. These vigorous specifications coupled with new advanced features like encryption make public safety radios very expensive. The average cost for new public safety radios range from \$3,500-\$5,000 depending on features.

Operating/Maintaining System

The City is moving from operating and maintaining four separate systems to one. Each of these systems is maintained by individual departments. Maintenance of the new system will be centralized into a new organization reporting to the Deputy Director of Radio Communication Services. The actual structure of the organization will be developed as the project develops.

There are options for system maintenance. The two most likely options are outsourced and internal maintenance. The vendors will be asked to provide various options for system maintenance as part of the RFP process. Unlike some systems, radio systems typically have proprietary elements and are mostly maintained by the manufacturers or their affiliated service providers. Due to the increased costs, this is likely to be an option of last resort. Maintaining the system with City personnel is a viable option. This option is typically less expensive and provides some flexibility.

Operating/Maintaining Subscriber Equipment

Maintenance of the subscriber equipment can be outsourced, done via the decentralized model or could be centralized into the organization that will be created to operate and maintain the system. Each option has pros and cons.

As part of their system maintenance offerings, the vendors will also be asked to provide various options for subscriber maintenance as part of the RFP process. Outsourced maintenance can be more expensive and requires a detailed service level agreement. Radio subscribers typically have proprietary elements and are mostly maintained by the manufacturers or their affiliated service providers.

Maintaining the subscribers with City personnel is the model the City currently uses for all its systems. This option is typically less expensive and provides some flexibility.

Sustainment and Technology Refresh

As discussed earlier, radio equipment is evolving. The typical public safety radio is akin to a computer with the shape and functionality of a hand held radio. As such, most of the functionality of the radios is based in software. As with computers everywhere, radio software needs to be updated on a regular basis to fix bugs, update security, and install new features.

Technology refresh can be accomplished two ways. Software subscription/maintenance is the most popular way. This method requires the system

owner to pay an annual subscription fee to be entitled to all software releases and the support for implementing them. Software can be upgraded on an individual purchase basis. This leaves the timing of the purchase up to the system owner. However, this option can be much more expensive. Although the timing of the purchase is mostly up to the system owner, the vendors do have support lifecycles that might force the purchase in order to receive continued support.

Safeguarding the Investment and Controlling Future Costs

Coverage and capacity are the two largest cost drivers for any wireless communication system. As we have previously discussed, to achieve coverage it is absolutely necessary to locate towers throughout the City.

The placement of tower sites is impacted mostly by the need for in-building coverage. Larger buildings tend to be constructed with denser materials and therefore require greater signal levels to achieve acceptable coverage. Therefore, the presence of large buildings equals more tower sites. The initial system design will take into account existing buildings but there is little means of accurately predicting the location of future buildings. Although we are requesting a certain minimum amount of radio coverage for the entire City, we could not afford to build sufficient coverage to account for large buildings that might be built in any given area.

Some governments have passed regulations mandating the addition of in-building amplification systems for buildings over a certain size in an effort to ensure adequate radio coverage for their first responders and safeguard their investments in radio infrastructure. There are a couple of downsides to these systems. They would most likely be rendered inoperable by fire or prolonged loss of electrical service at potentially the exact time the first responders need them the most. They can also be somewhat expensive, especially if not designed into the buildings during initial construction. The City may need to consider such an alternative in order to protect the initial investment and more importantly the first responders and citizens of the City.

Capacity as another major cost driver is somewhat easier to predict. It is a direct correlation to the number of users. Therefore, we can look at historical trends and make assumptions regarding the increased number of users. The real issue with capacity is not predicting the future capacity. It is deciding how much capacity to initially design into the system. In other words, how much do we want to spend now to stave off future incremental spending? Since adding to a live system that can not be taken down is difficult and expensive, it is normally prudent to plan for the capacity needed over the life of the system in the initial design. However, that means that you are paying for capacity that you will not need for years to come. Also, with the developing Radio over Internet Protocol (RoIP) technology beginning to enter the market place on a limited basis, it further complicates the planning assumptions.

RoIP is a relatively new technology that is still immature in the market place. Although all the major manufacturers are using some form of IP to process radio signals and network control on their systems, RoIP in the truest sense is still very young. We see some significant challenges with end-to-end RoIP, such as latency, that make the technology less than viable for public safety applications at this time. The real question is when or if it will ever become the technology of choice for public safety voice. Comparing radio (especially public safety radio) with telephony can lead

to erroneous conclusions but from a technology evolution standpoint, there are some significant parallels. Voice over Internet Protocol (VoIP) was also not a technology of choice five to ten years ago for large systems. However, it rapidly evolved into the technology of choice for most organizations. This rapid adoption occurred mostly due to economic incentives gained by deployment. At the moment, RoIP does not have those same incentives. Once (if) the technology matures to the point of solving the technical hurdles the economics will probably change and rapid adoption should follow.

Our strategy with the new system is to attempt to match the technological advancements with the future capacity need. The goal would be to be able to augment traditional system capacity with RoIP based infrastructure and user devices when that becomes viable. This will potentially lower both the risk and the incremental cost of adding capacity.

Improved Interoperability

Improved interoperability is not only a safety issue for our first responders, it is also provides a potential opportunity to save money. As mentioned earlier, partnerships with other area agencies can lead to cost sharing and potential reduced operating costs. Interoperability has been described as only occurring on the rare occasion when a major incident happens similar to events on September 11, 2001 and more recently Hurricane Katrina. While that is true and has been identified as a glaring weakness in our disaster response capabilities, one often overlooked aspect of interoperability is the day-to-day needs.

Bank robberies, vehicle pursuits, and other types of public safety incidents happen every day in and around the City of Houston. This daily interoperability is especially needed for law enforcement issues that occur within the City. There are many law enforcement agencies that operate within the City. There are Harris County Constable Deputies, Harris County Sheriff Deputies, Metro Officers, Houston Independent School District Officers, various college officers that have varying missions that often times overlap causing them to respond to the same incidents. Often times, this duplicate response is unknown to the different agencies. Again, this is especially true in those areas/neighborhoods that contract to other agencies for increased law enforcement presence. Improved interoperability added to some other information sharing projects that are underway at HPD could dramatically reduce this duplication of police responses and make all agencies involved more efficient.