

## Transmitter Sites

### 8.0 Transmitter Sites

#### 8.1 OVERVIEW

This section summarizes the deliverables for installation of facilities at tower sites for the Commonwealth of Virginia Statewide Agencies Radio System (STARS). It contains information that describes the tower site facilities as well as features and functionality that will be delivered to the Commonwealth. The tower site facilities will house the IV&D, and microwave equipment. Microwave Path Surveys will be conducted for each site to ensure that the site is capable of providing connectivity via the microwave design. Once the microwave path surveys are completed, each raw land or new tower site will require FAA submittal and approval before any architectural and engineering (A & E) work can begin. The preliminary A&E services and site design will then be performed on each site before site construction and installation can proceed.

Once microwave surveys, FAA clearance, and A&E work have been completed, installation of tower site facilities including site preparation, radio towers, radio buildings, HVAC, backup power system (UPS, generator and DC Power systems), and other work as defined in the detailed statement of work will commence. This document is based upon generic STARS designs and associated statement of work for new sites and site upgrades that are required to support the communication systems described in other sections of the Contract. If there are any deviations from the generic STARS designs and statement of work, Motorola will submit to the Commonwealth a proposal for cost adjustments.

#### 8.2 SCOPE

After execution of the Contract, Motorola will visit the sites it intends to use for the STARS project in Appendix 4. After visiting these sites and finalizing microwave path surveys, FAA clearances for each new tower, and completion of the A&E services, Motorola will modify its designs to incorporate the specific site details. Motorola will then submit the design work to the Commonwealth for review.

Upon the Commonwealth's approval of design work for each site, Motorola will conduct a pre-construction conference with its sub-contractors to define the requirements. Motorola intends to conduct its transmitter site preparation while the infrastructure equipment manufacturing and staging processes are underway to ensure that the sites are ready for installation when the equipment ships from the Motorola staging facility.

As the construction work at the site progresses, Motorola will provide updates to the Commonwealth regarding progress of work. Should the Commonwealth desire to make site visits during the progress of work, Motorola will provide the STARS Program Director (PD) with notices of progress schedule.

At the conclusion of the site preparation work at each site, Motorola's Project Installation Supervisor will review each site, make assessments for the scheduling of required work, and ensure that the sites are ready for installation by the time the system components ship from the factory staging facility. Motorola and a Commonwealth representative will then conduct a final site inspection, to determine readiness to install radio communications equipment. Tests will be conducted to check the operational characteristics of the UPS, grounding, generator, and transfer switch. Motorola will then submit to the Commonwealth a report to document the test results along with the as-built documentation package for each site.

### **8.2.1 Locations**

The Transmitter site facilities intended for use on the STARS project are listed in Appendix 4.

### **8.2.2 Design Services**

#### **8.2.2.1 Site Plan Construction Engineering Submittals**

Motorola will modify the Generic STARS Site Plans inserted at the end of this section to incorporate the specific site conditions and the detailed design for each site. The detailed design will include as a minimum the following:

- Access road
- Parking and turnaround area
- Location plan for the site
- Erosion and Sediment Control Plan
- Grading and Utility Plan
- Landscaping Plan
- Utility easements and site power design Grounding design
- Tower & shelter designs
- Back-up power source designs
- Propane tank location

#### **8.2.2.2 Site Inspections**

Motorola will conduct site inspections to collect pertinent information from the sites (e.g., location of telco, power, existing facilities etc.) and provide civil, structural, and electrical A/E services to prepare site construction drawings, showing the layout of various new and existing site components.

### **8.2.2.3 Survey**

Motorola will conduct a complete topographic and utility survey of the area where transmitter sites will be constructed or modified. Motorola will verify coordinates and actual elevation of tower location, and the required landscaping, easements, and erosion concerns. Surveyors will be registered in the Commonwealth of Virginia.

### **8.2.2.4 Geotechnical Investigation**

Motorola is responsible for obtaining subsurface investigations for sites. Geotechnical investigations previously performed on some sites may be adequate, and additional test borings, as determined by a Geotechnical Engineer, may not be required. Motorola will conduct up to 40' deep soil boring tests at each tower leg, and such additional borings as may be required by the Geotechnical Engineer, at an additional cost. Motorola will provide an appropriate geotechnical report for all sites requiring new shelters and physical additions of towers at no additional cost. These investigations and reports will be signed by Geotechnical Engineers who are registered in the Commonwealth of Virginia. Geotechnical investigations and reporting will be in accordance with the American Society for Testing and Materials, ASTM D 420, "Standard Guide to Site Characterization for Engineering Design and Construction Purposes" for new work. Geotechnical reports will be submitted to Commonwealth, for review and comment, and the building and tower manufacturers.

### **8.2.2.5 Existing Tower Analysis**

Motorola will document structural condition, existing antennas, and other loads for existing towers that have been identified in this Contract to be reused for the STARS. The inspection will also document antennas for a required computer model study. The documentation will consist of a general evaluation from the initial review of documentation and visual review, plus any structural analyses done on authorized towers.

Towers that exceed 85 percent of their capacity based on individual member stresses will be categorized "Tower Replacement Necessary." The report will indicate the number of members that are overstressed (exceeding 85-percent capacity) to aid in determining if reinforcing existing tower is feasible.

Motorola will provide to the STARS PD five (5) hard copies of the report and one (1) electronic copy, containing photographs, schematic drawings, and descriptions of:

- Existing tower condition
- Existing tower foundations
- Identification of any defective members
- Methodology and acceptance criteria used in the analysis
- Capacity of tower and foundation to support loading
- Recommendations regarding reinforcement, as appropriate
- Calculations

#### **8.2.2.5.1 Upgrade Existing Towers**

Motorola will evaluate existing towers to determine if they can be utilized as is, or require an upgrade in order to meet the same requirements specified for new towers during the design review process. Evaluations will bear a seal by an engineer registered in the Commonwealth of Virginia. If upgrades are required, Motorola will provide to the STARS PD a design change recommendation for accommodating the upgrades.

#### **8.2.2.5.2 Replacement Policy**

Where towers are replaced, guyed towers will be replaced with either guyed towers, using existing space available at site, monopoles, or self-supporting towers. Self-supporting towers will be replaced with self-supporting towers or monopoles. Monopoles will be used only with the approval of the STARS PD. Tower replacements require the concurrence of the STARS PD.

#### **8.2.2.6 Phase I Environmental Site Assessment**

For new tower properties purchased by the Commonwealth, Motorola will perform a Phase I Environmental Site Assessment (ESA) to identify obvious and reasonably likely on-site and/or off-site potential sources of contamination and prepare a report summarizing observations, findings, and conclusions for each site assessed. This study does not include Phase II assessments, risk/cost evaluations, and permitting assistance that may be required if risk factors are indicated.

#### **8.2.2.7 Archaeological/Historical Survey**

Motorola will perform an archaeological/historical survey to determine if any challenges and/or restrictions exist that can impact the development of each individual site.

### **8.2.2.8 NEPA Threshold Screening**

For new tower sites Motorola will perform a NEPA Threshold Screening including limited literature and records search, limited field studies and brief reporting to identify sensitive natural and cultural features referenced on the FCC Environmental Checklist that may be potentially impacted by the construction activity. For existing towers only a limited NEPA screening will be conducted, if existing NEPA documentation is not available. This does not include the additional field investigations to document site conditions relating to the question answered "yes" in the FCC Checklist. Should further investigations be required by the FCC at any site, Motorola will provide a proposal for addressing any additional costs and schedule impact necessary for supporting this work. Review and approval by the Commonwealth will be required prior to Motorola proceeding with such work.

### **8.2.3 Design Review and Approval**

Unless otherwise specified herein, Motorola will submit for review and approval to the STARS PD documents describing a 35-percent design and a final design. Within one (1) week of submission of each of the aforementioned design phases, Motorola and the STARS PD will conduct a joint design review for the purpose of presenting and discussing the design submittal. Within one (1) week of the joint design review, the Commonwealth will submit design comments to Motorola along with acceptance of the submitted documents as amended by the Commonwealth's design comments. Unless approved by STARS PD, the Commonwealth will not be responsible for commenting on/or accepting more than five (5) site design documents per week. Review comments requiring significant changes to site design and specification will be accommodated by an adjustment to the schedule for additional time to complete the design modifications. The final design packages will include any required cost adjustments that result from design requirements that deviate from the scope of work and the information, assumptions, and maximum quantities identified in Appendix 4. Commonwealth directed changes to site designs previously accepted by the Commonwealth will be accommodated by an adjustment for additional time and cost to complete the design modifications. The Commonwealth will, at its option, submit documented review comments addressing deficiencies in the documentation within 30 days from each design phase submittal. Motorola will incorporate said document review comments into its next design submission.

Commencement of demolition and construction is assumed to be contingent upon issuance of the necessary permit(s) by the appropriate authorities. The 35-percent design will consist of drawings, catalog cuts, manufacturer's information and other documents that describe the size and character of the project construction at each site. The 100% submission will be complete, detailing aspects of construction and identifying materials and equipment by such information as name, size, and manufacturer's catalog number. After the review process has been completed satisfactorily, Motorola will issue five (5) sets of final drawings and specifications and one (1) electronic copy of drawings and specifications for the Commonwealth to use specifically for this Contract.

Work will not start prior to this approval unless agreements have been reached through the course of the project, during project meetings or other documented means. After completion of construction, as-built drawings and electronic files will be provided to the Commonwealth within sixty (60) days of site acceptance.

### **8.2.3.1 Existing Tower Analysis Report Review**

A meeting or teleconference will be held with Motorola and the STARS PD, to discuss findings outlined in our report. Upon completion of this review, the STARS PD will provide written documentation within 10 working days to Motorola on what actions will be taken for each tower.

Five (5) hardcopies of the final report will be delivered to the STARS PD. One (1) copy of the report in Adobe Acrobat Format (PDF) will be delivered to the STARS PD. Upon final approval by the Commonwealth for actions to be taken, Motorola will provide the following:

- Design development documents for replacing or upgrading agreed upon towers, including such items as structural elements and rerouting of cables. Motorola will furnish to the Commonwealth five (5) hard copies and one (1) electronic copy with 35-percent design submission.
- Upon approval of design development documents, Motorola will furnish five (5) hard copies and one (1) electronic copy of 100-percent design documents to the STARS PD to review. Motorola will provide an independent engineer registered in the Commonwealth of Virginia to review and approve the design, and attend the review conference in Richmond, VA for the 100-percent design documents.
- Upon approval of design documents by the STARS PD, Motorola will provide five (5) hard copies and one (1) electronic copy of final design documents.

For new towers and tower upgrades, Motorola will supply tower design drawings that are sealed by an engineer registered in the Commonwealth of Virginia.

### **8.2.3.2 Building Submittals**

Motorola will submit shop drawings, to the STARS PD, for approval ninety (90) days prior to building delivery. Within one (1) week of submission of shop drawings, Motorola and the STARS PD will conduct a joint review for the purpose of presenting and discussing the submittal. Within one (1) week of the joint review, the Commonwealth will submit comments to Motorola along with acceptance of the submitted documents as amended by the Commonwealth's comments. Unless approved by STARS PD, the Commonwealth will not be responsible for commenting on/or accepting more than five (5) shop drawing documents per week. Electrical and Bonding Submittals Sixty days (60) before construction of the building is complete, Motorola will provide for approval five (5) hard copies and one (1) electronic copy of Operations and Maintenance Manuals for the electrical system to the STARS PD. This information will include such items as the UPS, automatic transfer switches, emergency generators, batteries, and battery chargers. Within thirty-(30) days after they have been approved, Motorola will provide five (5) final hard copies and one (1) electronic copy of these manuals to the STARS PD. Electronic copies of the manuals will be in Adobe Acrobat Format (PDF).

### **8.2.4 Construction**

Upon approval of documentation for the site and tower designs and/or improvements, Motorola will be responsible for development of each of the tower site facilities. The scope of work identified in this section is based upon the information, assumptions, and maximum quantities included in Appendix 4 - "STARS Transmitter Sites Matrix". Appendix 4 – STARS Transmitter Sites Matrix identifies the following:

- Equipment Enclosures and Towers by Site
- Microwave Antenna Equipment by Site
- RF Antennas by Site
- Tower Specifications
- Transmitter Site Enclosure Specifications

#### **8.2.4.1 Permits, Permissions, & Services**

Fees and costs associated with facility permits, permissions, and services are the responsibility of Motorola without cost to the Commonwealth, unless specifically noted elsewhere. Motorola will obtain the permits such as electrical, building and construction permits, and any inspections that may need to be coordinated with the local authorities to complete site development work.

### **8.2.4.2 Zoning**

The schedule is developed with the assumption the Commonwealth is exempt from all zoning requirements within the Commonwealth. Should any zoning changes be required at a particular site, it is the Commonwealth's responsibility to secure proper zoning approval at that location.

### **8.2.4.3 Clearing and Grubbing**

The site compound area will be cleared of trees (less than 3" in trunk diameter) topsoil, shrubs, brush, rubbish, roots, and organic material that will hinder development of the site. During the site design review, Motorola will determine if heavy clearing consisting of logging, clearing of trees with trunk diameter greater than or equal 3", and removal of heavy debris is required and provide a change order proposal, if necessary. Depressions made by grubbing will be filled with suitable material and compacted as required.

### **8.2.4.4 Grading**

Motorola is responsible for grading the site compounds to provide a level, solid, undisturbed surface for installation of site components.

### **8.2.4.5 Disposal of Material**

Unsuitable material and material resulting from clearing and grubbing operations will be completely removed from each site and disposed of by Motorola. Material will be removed in accordance with all federal and state noise, dust, waste disposal, environmental, and any other applicable legal requirements.

### **8.2.4.6 Blasting**

Blasting is permitted only if approved by the STARS PD.

### **8.2.4.7 Fills**

Where concrete slabs are placed on grade, with or without porous fill, Motorola will remove and dispose of loam, organic material, and unsuitable material. Where fill is required to raise subgrade for concrete slabs, fill material will be placed in horizontal layers not exceeding 6 inches in compacted thickness. Frozen material will not be used.

#### **8.2.4.7.1 Suitable Material for Fill, Subgrade Preparation, and Backfill**

Soils will be classified by test procedures outlined in ASTM D 2487, and moisture-density relations for fill material will be established in accordance with ASTM D 1557 to ensure its suitability.

Suitable material for fill and backfill beneath buildings, structures, and towers; for backfill adjacent to buildings, structures, and towers; for trench backfill in every location; and for subgrade preparation will be GW, GP, GM, GC, SW, SP, SM, SC, ML, or CL, as classified by the Unified Soil Classification System in accordance with ASTM D 2487. Largest particles in this fill and backfill will be no greater than 3 inches in diameter. Suitability of materials from on-site excavations will be determined by soil classification, by test procedures outlined in ASTM D 2487, and by moisture-density relations in accordance with ASTM D 1557.

Suitable material for general and overlot fill can consist of unclassified material from the excavations.

#### **8.2.4.7.2 Backfilling Trenches**

Trenches will be backfilled with suitable materials, free from large clods of earth and rock fragments. Trenches will be backfilled following a visual inspection by the Commonwealth's representative and prior to pipeline testing. Motorola will notify the STARS PD at least seven (7) days prior to notice of inspection. The STARS PD will coordinate with Motorola to have an inspector present. Material will be deposited in six (6)-inch horizontal layers and thoroughly and carefully tamped until pipe and conduit have a cover of not less than one (1) foot of material.

Wrapped, coated, and plastic material will be backfilled with sand or other finely graded material 6 inches above utility line. For trenches in open areas, remainder of backfill material will be placed in the trench in 1-foot horizontal layers.

Motorola will not dislocate utility line from installed positions. For trenches beneath pavements, buildings, and structures, entire depth of trench will be filled in 6-inch horizontal layers. Each layer will be moistened or dried and compacted, as specified in this document. Where settlement occurs in trenches or where trenches are improperly backfilled, trenches will be reopened to depth required for proper compaction, refilled and compacted, with surface restored to required grade and compaction. These reopened trenches will be mounded over in open areas and smoothed off.

#### **8.2.4.7.3 Compaction**

Degree of compaction required is expressed as a percentage of maximum density obtained by test procedure presented in ASTM D 1557. Fill and backfill materials will be moistened or aerated as necessary to provide a moisture content that falls within 3 percent of either side of optimum, unless otherwise approved in writing by the STARS PD.

Minimum compaction effort required for various fills, backfills, and subgrades will be as follows:

<u>Fill, Backfill, and Subgrade Compaction</u>	<u>Percent of Maximum Density</u>
Under buildings, structures, or towers; or adjacent to buildings, structures, or towers	95
Under exterior concrete slabs, including related utility trench backfill and scarified subgrades	90
Under utility trench backfill in other areas	85

Field-density tests will be performed in sufficient number to ensure that specified density is being obtained. Tests will be performed in accordance with ASTM D 1556 or with ASTM D 2922 and ASTM D 3017. Written reports of each test and its location will be submitted to the STARS PD within 5 days of test completion. At least one field-density test will be performed per lift for each 2,000 square feet of fill or subgrade under buildings and structures and for each 4,000 square feet under embankments, but not less than 1 test per lift. At least one field-density test per lift will be performed for each 500 linear feet of fill placed under roadways. Locations of field-density tests will be referenced to the construction baseline system. If tests indicate that required density has not been obtained, material will be removed, replaced, and recompacted to specify density and retested for correct density, as specified hereinbefore.

Field-density check tests may be performed by the STARS PD to ensure compliance with requirements specified above. If tests indicate that required density has not been obtained, Motorola will remove, replace, and recompact material to specified density at no additional expense to Commonwealth.

#### **8.2.4.8 Soil Sterilization and Graveling**

Areas specified to receive cover material will be sterilized with a pre-emergent herbicide solution. Treatment will be applied on subgrade before cover material is placed. Application will be in accordance with manufacturer's recommendations.

#### 8.2.4.9 Erosion Control

Motorola will construct swales around the compound to control soil erosion.

#### 8.2.4.10 Fenced Area Ground Cover

Inside site fence, geotextile fabric will be installed in areas not occupied by concrete. Geotextile fabric will extend three (3) feet outside fence. Fabric will be installed in accordance with manufacturer's instructions. Area under fabric will be cleared and sterilized. Top covering over fabric will be six (6) inches of No. 57 aggregate compacted by roller.

#### 8.2.4.11 Fencing

Motorola will supply and install fencing around the transmitter site compound. Appendix 4c - "STARS Transmitter Site Enclosure Specifications Final" provides the specifications and dimensions of the fencing to be provided for each specific type of site.

#### 8.2.4.12 Plastic Marking Tape

Warning tapes will be installed directly above pipe and conduit at a depth of 6 inches below finished grade, unless otherwise indicated. Tape color will be as specified and will bear a printed inscription describing specific utility.

<u>Utility</u>	<u>Color</u>
Electric Conduits	Red
Water Systems	Blue
Telephone	Orange
Sewer Systems	Green

#### 8.2.4.13 Utilities

Motorola will coordinate, obtain, and pay installation fees for electric power, if required. Electric power services on site, including services between a generator enclosure and an equipment shelter, will be located in underground conduit when reasonably possible. Motorola will interface with the commercial utility provider up to a running average of fifty (50) feet from the equipment enclosure location. Should utility termination be located greater than fifty (50) feet, Motorola may submit to Commonwealth a cost proposal for any additional conduit and cabling work.

The Commonwealth will pay monthly electric bills at existing sites, and Motorola will pay monthly electric bills at new sites until the sites are accepted or ready for the installation of system equipment, regardless of punchlist items, provided those punchlist items do not impact the utility of the site.

Electrical and cabling work for each shelter will be installed in accordance with R56 Installation Guidelines and will conform to applicable codes, the National Electrical Code (NFPA 70), the National Electrical Safety Code, ANSI C2, and local utility company standards.

Cable will be labeled at both ends, and equipment will have unique equipment identification numbers. This numbering system will be documented in final design drawings and as-built drawings.

At each new site, two additional underground service entry conduits will be placed from the site service to a point inside the fence. Location will be indicated on drawings and approved by the STARS PD during the site design meetings.

Whenever a product is commercially available, as an UL-listed device, UL-listed device will be chosen, unless indicated through mutual agreement.

#### **8.2.4.14 Site Grounding**

Motorola will install grounding system for new facilities (equipment enclosures, towers, generators, fuel tanks, fence etc.) that it supplies and installs. Motorola will utilize the Motorola Standards and Guidelines for Communication Sites (R56), including the amendments identified in the Statement of Work Section of the Contract, herein after referred to as “R56 Standards and Guidelines” in the design of this grounding system.

At existing sites, Motorola will inspect and test the existing external ground system for compliance with R56 and identify corrective actions necessary for such compliance. Motorola equipment when installed will be grounded to the existing ground system.

Motorola will also conduct testing after installing the ground system for new facilities.

Since ground resistivity data for each site, new or existing, is not available at this time, Motorola can not determine that the ground resistance of 5 ohms or less can be met by installing the ground system in accordance with the National Electric Code and the amended R56 Installation Standards. Should the tests indicate that a ground resistance of 5 ohms or less has not been achieved, Motorola will provide a change order proposal for implementing a reasonable effort to improve the grounding resistance to 5 ohms or less. Motorola's reasonable effort to comply with this 5 ohm requirement includes providing and installing up to 8 chemical rods and 5 cubic yards of ground enhancement material as engineered at each site where required. Upon completion of the installation of the grounding system, the grounding system will be tested to ensure continuity and to verify that ground resistances do not exceed 5 ohms. If 5 ohms still can not be obtained after conducting this additional grounding process, Motorola will meet with the Commonwealth to review and determine what grounding solutions are still available, and its associated impact to cost and schedule .

#### **8.2.4.15 Upgrade/Repair of Existing Site**

Upgrade and repair work performed to an existing site will conform to standards for new construction. However, Motorola will not be responsible for bringing existing sites into compliance with current construction standards or current building codes. Motorola will perform the repair and construction necessary to certify that portions of existing facilities reused for the Commonwealth system will meet the specifications herein after survey and analysis of said facilities has been completed and the Commonwealth has approved any additional costs required to meet the specifications.

#### **8.2.4.16 Access Road Upgrade/Repair**

Motorola will repair damage to existing roads, if caused by Motorola during construction. Motorola will identify any existing roads requiring upgrade and a plan for implementation of upgrades.

#### **8.2.4.17 Scope of Work for New Towers**

STARS will utilize a combination of new and existing towers to support the antenna and line equipment at each site. Appendix 4 - "STARS Transmitter Sites Matrix" provides the details on the tower type being used at each site. Motorola will construct tower foundations for a self supported tower (three legs) including excavation, rebar, and concrete up to a maximum quantity of cubic yards for concrete foundation as identified in Appendix 4 - "STARS Transmitter Sites Matrix". Tower foundation cost is based on pier and pad foundations for all three legs on EIA/TIA-222 normal soil conditions.

#### **8.2.4.18 Scope of Work for New Shelters**

Motorola will construct various new equipment enclosures at the transmitter sites. Appendix 4 provides the details on the equipment enclosure type being used at each site. The following scope of work is being provided at these sites.

Construct (1) 6 inch concrete slab (s) at 4000 psi with turndown footings of 18 inch minimum, or to frost depth at an additional cost, with reinforcing steel necessary for foundations of equipment and generator enclosure (s) on EIA/TIA-222 normal soil conditions.

- For below ground installations, excavate and prepare hole for an underground LP Vapor fuel tank(s) based on EIA/TIA-222 normal soil conditions with water table below the bottom level of hole.
- Supply and install the fuel tank, fill with fuel and connect to generator along with fuel tank monitors.
- Supply and install concrete enclosure(s) for equipment room and generator room per Appendix 4. Coordinate the installation of electrical service for each new equipment enclosure type.

- Provide all trenching, conduit, and cabling necessary for underground hookup of power to the equipment enclosure from nearby utility termination located within 50' (running average) of the equipment enclosure.
- Provide two (2) additional 4-inch conduits for underground service entry to the equipment enclosure from nearby utility termination located within 50' (running average) of the equipment enclosure.
- Supply and install grounding system around the equipment enclosure tied to the fence and other new metal structures within compound.
- Conduct (1) three-point grounding test of the site with a ground-resistance test instrument.
- Supply, install, and ground one freestanding 24-inch wide cable/ice bridge from tower to the equipment enclosure.
- Work with the Commonwealth to develop a plan acceptable to both parties, to remove or relocate any existing facilities (if required) at locations where new tower install is approved by the Commonwealth to create space for new tower.

#### **8.2.4.19 Responsibilities of Commonwealth of Virginia at Commonwealth Owned/Leased Properties**

The Commonwealth will have the following responsibilities to assist in the development of the transmitter sites.

- Provide property deed, boundary survey and lease information.
- Provide reasonably adequate access for transportation of equipment and personnel
- Assist Motorola with permitting for sites, as owner/lessee.
- Provide reasonably adequate additional space, permanent or temporary, for construction of new tower.
- Work with Motorola to develop a plan to remove or relocate any existing facilities (if required) at locations where new tower install is approved by the Commonwealth to create space for new tower.
- Secure site lease/ownership and easements for tower property. This responsibility of the Commonwealth will be contingent upon, and governed by, the Code of Virginia.
- Provide personnel to observe construction progress and testing of site equipment according to the schedule provided by Motorola as agreed to by the STARS PD.

## 8.2.5 Construction Administration

### 8.2.5.1 Preconstruction Meeting and Monthly Meetings or Teleconferences

Prior to start of construction, Motorola will participate in a pre-construction meeting for each site at a location coordinated with the STARS PD. These meetings will be held a minimum of 60 days prior to start of construction unless otherwise agreed to in specific cases. In addition, Motorola and the appropriate vendors will participate in monthly teleconferences. Other meetings may be requested by either party to address specific site issues that may arise.

### 8.2.5.2 Entering Sites

Prior to initial entering of any existing site, Motorola will notify and coordinate with the STARS PD a minimum of seven (7) days in advance.

### 8.2.5.3 Site Access

For purposes of pricing and scheduling for this Contract, Motorola has assumed that the Commonwealth will provide access to all the Commonwealth owned/leased sites of work as defined in this Contract subject to any limitations in existing site leases. This includes but is not limited to:

- Provide escort at no charge, if escorts are required at any particular site. The availability of such escort will not be unreasonably withheld.
- Arrange site permission for equipment enclosure delivery purposes and crane access/placement for equipment enclosure lift at all sites.
- Provide keys to the locks at site gates to cleared personnel. Motorola recommends common keying for all structures during construction period.
- Arrange access/site location permission for Motorola to construct equipment enclosures/towers at all sites provided in this Contract.
- Sufficient space will be available at the site for these vehicles to maneuver under their own power, without assistance from other equipment, and that there is adequate space at the new sites to satisfy the following requirements:
  - 1) 70' turning radius for tractor-trailers and 100-ton cranes.
  - 2) Load-bearing surfaces for vehicles with a gross weight of 140,000-lbs.
  - 3) 14' road width from major highway to the site.
  - 4) Overhead power lines, overhanging trees or other obstructions will not block maneuverability of construction vehicles.

The usage of unimproved roadways (unpaved surfaces) may incur additional charges if special equipment has to be used for access to the site. Any such charges will be handled through the change order process.

## **8.2.6 Acceptance Testing**

### **8.2.6.1 Concrete and Soil Testing**

#### ***8.2.6.1.1 Independent Testing Firms***

Motorola will contract directly with independent testing firms for soil compaction and concrete testing. Motorola will provide the STARS PD with a schedule of testing and the testing firm assigned to each site.

The Commonwealth may provide an independent inspector to monitor, report on construction progress and activities. The inspector will immediately notify Motorola's on-site supervisor and the STARS's PM of any discrepancies but will not be authorized to direct, halt, or otherwise interfere with construction activities at the site.

#### ***8.2.6.1.2 Civil Inspection***

The Commonwealth will be notified of excavations and reserves the right to inspect excavations and reinforcement placement. Concrete and soil testing reports will be submitted to the STARS PD for review and comment and returned within 10 working days.

### **8.2.6.2 Control of Measuring and Test Equipment**

Measuring and test equipment used for installation and/or for determining compliance with quantitative values is part of a documented calibration control program. Torque wrenches, which are used whenever a torque value is specified, are included in the calibration program. Multimeters used for checking continuity will not be included in calibration program; however, multimeters used for measuring quantitative values are included in calibration program. Rulers, tape measures, and bubble levels will be in good condition; however, they will not be included in calibration program.

### **8.2.6.3 Generator Certification Test**

Upon completion of engine-generator set installation and after providing thirty-(30) day's prior notice, Motorola will conduct performance testing. Tests are in accordance to NFPA 110. The STARS PD or representative(s) will witness testing. The following tests will be conducted:

- Simulation of power failure by removing power service to normal side of transfer switch
- Startup and cool-down demonstration (5 minutes)
- Load testing consisting of 5 minutes at 50-percent rated load and 15 minutes at 100-percent rated load utilizing a load bank
- Simulation of power return by reapplying power service to normal side of transfer switch
- Crank-cycling performance test as specified in NFPA 110, Cycle Crank Test

### **8.2.6.4 Generator Certification Test Report**

Following performance tests and prior to final acceptance, Motorola will submit a report showing test results, including the following:

- Readings of instruments on generator under test conditions
- Settings of time delays and actual timing of operations
- Date and time of tests and a list of people witnessing test and their company affiliation or representation
- List of failures that occurred during test
- Other pertinent information or commentary regarding tests that may aid in describing test circumstances or results

## **8.3 DESIGN BASIS**

### **8.3.1 General**

Motorola's approach to the design and installation of the tower site facilities is closely tied to the environmental needs of its equipment. Therefore, Motorola has developed its internal recommended standards regarding the installation of fixed network equipment that are based on industry standards, building, electrical and safety codes, and Motorola's own experience. These standards are intended to ensure proper equipment and system performance, system reliability, equipment longevity and a safe working environment for installation and maintenance personnel. These standards are contained in the R56 Installation Standards and Guidelines for Communication Sites, as amended by specific provisions of this Contract.

Where insufficient information was available, Motorola has made certain assumptions, chosen design criteria, and defined maximum sizes and quantities, which have been listed below and in Appendix 4. Deviations from the assumptions or site design criteria may result in changes in pricing of sites, which must be agreed upon between the Commonwealth and Motorola prior to making these deviations.

### **8.3.1.1 Standards**

Standards, codes, and regulations referred to in this section will be the latest revision in effect as specified in the Terms and Conditions.

### **8.3.1.2 Site Utilization Assumptions**

Motorola has assumed normal soils (EIA/TIA-222, 4000 psf) in the design of foundations for the tower, equipment enclosure and fuel tank. Motorola will conduct geotechnical testing for new towers. If after geotechnical testing it is observed that the abnormal soil conditions exist at site locations resulting in redesign of new foundations to be significantly different, then the costs associated with these site changes and/or delays including, but not limited to; re-engineering, schedule delays, soil abnormalities, re-mobilization, etc. will be identified in a “Memorandum of Change” and will be negotiated with the Commonwealth.

Thirty-six (36) of the sites utilized in the design are currently not in use as VSP transmitter sites. Base line pricing for this Contract assumes that the sites currently in use will require grading of less than 2% to provide a level, stable surface for installation of site components, and that the remaining sites will require grading of no more than 10% to provide a level, stable surface. Motorola has included unit prices for grading, excavation and removal and replacement of soils in its Price List in the event that additional site work is necessary. Extra work will be identified after the site visits and soil tests and priced according to unit prices identified in the Contract price list.

### **8.3.1.3 Access Road**

During site designs, Motorola will evaluate each site and determine if additional reasonable improvements are required for access roads. The Commonwealth will be responsible for upgrades to access roads or compensating Motorola for such upgrades as specified in 8.2.5.3.

During the site design review, Motorola will also evaluate if entrance barriers sufficient to stop a car will need to be installed across the access road where it enters the main road. If barriers are required Motorola will install them, reflectors will be installed on barriers to enhance their visibility at night. Motorola will provide a lock for these barriers. Entrance barriers will have adequate sight distances at their connection to roadway.

The access roads will allow for the reasonable delivery of site equipment shelters to the site. Motorola will provide recommended changes to the Commonwealth for accommodating any required adjustments to costs and/or schedule as a result of the utilization of helicopters or other means for transporting shelters. Motorola has provided optional pricing per 100 linear feet for installing gravel roads, should access roads be required at any sites. The use of entrance barriers and gates will be evaluated during the site design review. Final determination on how and where entrance barriers and gates will be installed will be based upon the feasibility and potential locations that each site's characteristics allow.

#### **8.3.1.4 Parking Area**

With the assumption that property space is available, Motorola will provide, outside each new fenced site, adequate space for parking and turnaround for a minimum of two pickup trucks. Area will be cleared, sterilized, and covered with 6 inches of No. 57 aggregate cover material, compacted by vibratory roller.

#### **8.3.1.5 Chain-Link Fencing**

##### **8.3.1.5.1 General**

Motorola will provide chain-link fencing, locking gates, and the accessories required to provide fencing and security for radio sites. Fencing will be provided for new sites and where required for additions to existing sites. Fencing will be required at communication tower guy anchors. Gates will be equipped with light reflectors to increase their visibility at night. Signage in accordance 47CFR and the Commonwealth of Virginia RF Radiation Exposure Compliance Plan will be provided. Motorola will provide locks for gates into sites upon acceptance. Unrestricted access by the Commonwealth is required for any site where active communications equipment is located.

##### **8.3.1.5.2 Fence Submittals**

For each site, Motorola will submit for review, to the STARS PD, site-specific drawings and catalog data for each fence component.

#### **8.3.1.6 Erosion Control**

Motorola will design and implement an erosion control system to protect adjacent and downstream property, in accordance with State Standards and Specifications for Soil Erosion and Sediment Control, current edition, and applicable regulations for local jurisdiction. The construction of new tower site facilities have been designed with a basic soil erosion control system consisting of silt fencing to protect the adjacent and downstream property. Any extensive soil erosion control design and installation (if required) will be incorporated by Motorola during the site design and implemented after additional costs are approved by the Commonwealth.

Areas disturbed by construction activities will be seeded. Motorola will apply for and obtain a permit from the Soil Conservation District having jurisdiction for each site if site is not on state-owned land. When site has been stabilized and erosion control measures are no longer necessary, erosion control measures will be removed.

### **8.3.1.7 Foundations**

Motorola will provide final foundation designs, to the STARS PD that are best suited for chosen structures and most economical for subgrade conditions and site. Foundations for steel towers will be designed in accordance with TIA/EIA-222. Calculations, Motorola's working drawings, location plans, and shop drawings of foundations will be sealed by an Engineer registered in the Commonwealth of Virginia.

#### **8.3.1.7.1 Construction Foundation Submittals**

Sealed drawings, supporting calculations, and associated documentation will be submitted, to the STARS PD, for approval for the following:

- Concrete Mix Design
- Building Foundation Slab (including anchors)
- Concrete Pads for Exterior Equipment (including anchors)
- Tower Foundations (including anchors)
- Structure Excavation
- Reinforcing Steel Placement

#### **8.3.1.7.2 Concrete**

##### **8.3.1.7.2.1 Code Requirements**

Concrete will be designed and installed in accordance with the following:

- American Concrete Institute (ACI) 301, Specifications for Structural Concrete for Buildings
- American Concrete Institute (ACI) 318, Building Code Requirements for Reinforced Concrete
- American Concrete Institute (ACI) 302, Guide for Concrete Floor and Slab Construction

##### **8.3.1.7.2.2 Concrete Requirements**

Cement will conform to ASTM C 150, Specification for Portland Cement. Aggregate will conform to ASTM C 33, Specification for Concrete Aggregates. Reinforcing bars will conform to applicable ASTM standard. Water will be potable. The Commonwealth will approve admixtures prior to their use.

### **8.3.1.8 Towers**

Motorola has reviewed the VSP Infrastructure Evaluation Report and made a determination as to which towers may be “usable” as listed in Appendix 4 - “STARS Transmitter Sites Matrix”. During the site design review, Motorola will further evaluate the “usable” towers and provide supporting data either, to upgrade existing towers, or to provide new towers at the locations, as required.

In the absence of site visits, Motorola has relied on the evaluation and reuse potential ratings provided by the Commonwealth in the VSP Infrastructure Evaluation Report in determining the acceptability of existing site facilities and associated costs.

#### **8.3.1.8.1 Evaluation Criteria**

Motorola intends to use the existing towers for the new LMR, mobile data and microwave equipment at sites that met the following criteria:

- An evaluation rating of 4 or higher was given for the reuse potential of the site to support significant expansion.
- The existing tower height was sufficient to provide coverage required.

At the existing towers chosen by using the above criteria, Motorola has assumed that tower strength, cable support facilities and space availability is sufficient to support the new antenna, cables, and ancillary equipment. Motorola has also assumed the antenna locations for the LMR design identified in Appendix 4 - “STARS Transmitter Sites Matrix” will be made available by the Commonwealth for its antenna equipment at sites where existing towers are being used and will address relocation of existing antennas in migration plans.

To determine the suitability of a tower to support an additional load, Motorola will conduct a tower analysis at the existing towers it plans to use for the new antenna equipment. If, after such analysis, it is determined that tower upgrade will be necessary to support additional loads, Motorola will prepare a proposal for such additional upgrade work, identifying scheduling and pricing impact, for review and approval by the Commonwealth prior to proceeding with such work.

Motorola is providing new towers at all other sites where the existing tower is deemed not usable to install the new antenna equipment.

For new towers, the following criteria are being used:

- Self-supported towers will be provided at new tower sites to use minimum possible space at the site.
- All towers have been designed based on wind and ice loading recommended by Electronics Industry Association (EIA)/Telecommunications Industry Association (TIA) standards EIA/TIA-222F. Local codes have not been considered.

- Only the antenna loads specified in Appendix 4 are considered in the design of new towers. Existing collocated and legacy antenna requirements will be considered in the design of new towers during project meetings on a site by site basis.
- Dual lighting has been used for all new towers except the ones in which the height of the tower is less than 200' in height, unless identified by the FAA as requiring lighting. For these towers, no tower lighting has been included, as Federal Aviation Administration (FAA) typically does not require lighting unless the structure height exceeds 200'. Should obstruction marking for new towers or lighting for new towers less than 200' in height be required by FAA or desired by the Commonwealth at any site, Motorola will provide a proposal for accommodating any additional costs and schedule impact associated with this work, for review and approval by the Commonwealth prior to proceeding with such work.
- An external climbing ladder has been included with the new towers.

### **8.3.1.8.2 Existing Towers**

Motorola is providing a generic scope of work for reuse of existing towers at existing sites. Prior to co-locating at any existing RF site, Motorola will perform site quality audits and tower analysis to determine the feasibility and MPE of such co-location. After visiting the tower sites, Motorola will modify these generic designs and scope of work to incorporate site-specific conditions and provide detailed design for each site at the detailed design review. Should the revised design be significantly different, resulting in additional costs, Motorola will submit to the STARS PD a revised proposal, identifying scheduling and pricing impact, for review and approval prior to proceeding with the work.

Motorola is planning on reusing existing towers per Appendix 4.

#### **8.3.1.8.2.1 Detailed Evaluation of Existing Towers**

Motorola personnel will inspect the existing towers categorized as “usable” to determine physical condition of members, to verify existing member size and position when compared to recorded drawings, and to verify location of existing antennas. Should high electromagnetic exposure (EME) radiation levels make it impossible to safely access a tower, the STARS PD will coordinate with co-located users to reduce power levels so that inspection can be accomplished.

Motorola will provide the following services:

- Climbing measurement and inspection of existing towers
- Verification of drawings/reports of the tower, if provided by – the STARS project team
- Digital photo documentation of tower, including designed antennas, mounts, and waveguide/cables
- Structural analysis of towers and their foundations/guy anchors and their ability to support designed loads. Analysis will be sealed by an engineer registered in the Commonwealth of Virginia.

- 
- Analysis of grounding and lightning protection, both existing and as needed for designed additions
- Ultrasonic thickness testing of all towers to be reused (15 sites)
- Report to document findings

If documentation is not available for the existing towers, or if the size and thickness measurement of tower elements has not been included, an ultrasonic thickness micrometer will be used to accurately measure wall thickness of pipe and tubing members.

#### ***8.3.1.8.2.2 Foundation Analysis***

Motorola will visually observe exposed portions of the tower foundation to establish its condition. Motorola will analyze any foundation drawings available and to use other means, if required, to determine foundation capacity of each tower to be reused. If special methods are required to determine foundation capacity it will be determined by Motorola during the site design review, and Motorola would then submit a change order proposal, identifying scheduling and pricing impact for conducting this work.

#### ***8.3.1.8.2.3 Stress Analysis***

Based on conditions determined by the site evaluation, Motorola will perform a computer stress analysis on existing towers remaining in the system. The analysis will be performed in accordance with the latest revision, in effect at the time of the site visit, of TIA/EIA-222 to determine if the tower is stressed to a maximum of 85 percent of its capacity, by each structural member, if available, or if the tower does not exceed sway or twist limitations established by TIA/EIA-222. Loading conditions will be based on final configuration of new and existing antennas. Load requirements will be the same as those specified for new towers. The analysis will also include development of recommendations for any structural modifications necessary to upgrade towers to new condition.

#### ***8.3.1.8.3 New Towers***

##### ***8.3.1.8.3.1 New Self Supported Tower Design Specifications***

In absence of specific information regarding the sites, Motorola has categorized the towers into different heights, based on the Commonwealth requirements for an IV&D, and microwave system design. The designed antenna and line loads for the Motorola provided towers can be found in Appendix 4.

The tower designs are based upon 95 MPH basic wind speed with 1/2-inch radial ice per ANSI/EIA-222-F and the loading assumption set forth in Appendix 4. All tower steel will be hot-dip galvanized after fabrication. In addition, all new towers were designed and priced to include:

- All necessary tower sections.
- Anchor bolts and templates.
- Safety Climbing Device
- One waveguide ladder 8 hole 4' spacing
- Leg dish mounts with support material for one tie-back per dish for each designed dish load
- Beacon/cap plates.
- Design drawings, foundation designs and calculations with state PE seals based on submitted soils report.
- Towers will not be loaded beyond 85% capacity on any structural member.

Conventional foundation designs consisting of pier & pad foundation have been used at all sites. Site specific designs based on site-specific requirements will be conducted after geotechnical investigation.

Motorola will provide ten (10) full body climbing harnesses.

#### **8.3.1.8.3.2 Basic Code Requirements:**

Loads for towers will be in accordance with TIA/EIA-222-F and the Virginia Uniform Statewide Building Code (VUSBC) in affect at the time of final pricing. Where VUSBC and EIA contain conflicting requirements, the more stringent requirements will apply and any variations in the codes between the time of final price submittal and time of construction will require a price review and a change order indicating the change.

#### **8.3.1.8.3.3 Wind Loads**

Basic wind speeds will be as shown in TIA/EIA-222-F, but will be not less than 95 mph or less than local requirements. Local government requirements have not been evaluated, and accommodations for stricter local requirements, if applicable, will require an approved change order in order to be accommodated. Wind forces and pressures will be determined using appropriate coefficients that reflect effects of terrain surrounding each chosen tower site. Loads must be applied to tower attachments, including such attachments as obstruction lighting, cabling, and antennas.

#### **8.3.1.8.3.4 Ice Loads**

Radial ice accumulation with a minimum thickness of 1/2 inch, will be assumed to occur on structural elements and equipment located on steel towers. Local government requirements have not been evaluated prior to Contract, and accommodations for stricter local requirements, if applicable, will require an approved change order in order to be accommodated. Ice accumulation loads will be applied in accordance with TIA/EIA-222-F and will be used to determine gravity loads and projected areas for wind loads. Unit weights of ice will be as specified in TIA/EIA-222-F. Loads will be applied to tower attachments, including such attachments as obstruction lighting, cabling, and antennas.

#### **8.3.1.8.3.5 Additional Loads Reserved for Commonwealth Use**

Required communications equipment on each tower will receive loads and combinations of loads as stated herein, and those loads will be distributed to steel tower. A redesign of the tower and an approved change order will be required if the Commonwealth relocates additional loads on to the new tower. For all antennas that need to be relocated to the new towers, the Commonwealth will provide Motorola with a listing of types and location of the replacement antenna and lines to be accommodated in the tower design. Towers will not be loaded beyond 85% capacity on any structural member. Motorola will provide the STARS PD documentation certifying this for any change to a tower.

#### **8.3.1.8.3.6 Additional Loads Reserved for Future Tenants**

Towers will not be loaded beyond 85% capacity on any structural member.

#### **8.3.1.8.3.7 Existing Loads**

If the Commonwealth determines that existing loads must be transferred to replacement towers, these loads will be included in the final analysis and design. If this requirement becomes necessary, Motorola will work with the Commonwealth to develop a procedure for moving additional tenants during the site design review and provide a change order proposal to the STARS PD for accommodating the additional scope of work. The Commonwealth will be responsible for coordination with the users for cutover to the new antenna system and resolution of any system performance issues related to relocation of antennas.

#### **8.3.1.8.3.8 Tower Manufacturers**

New radio site towers will be self-supporting, monopole, or guyed structures designed by a professional engineer according to industry standards based on TIA/EIA-222-F. Towers will be constructed of steel from one of the following manufacturers or Commonwealth approved equivalent. Self-supporting, monopole, or guyed towers will be used as indicated herein.

- Sabre
- PiRod

#### **8.3.1.8.3.9 Materials**

Tower steel will meet requirements of EIA standard TIA/EIA-222-F. All bolts are Galvanized in accordance with ASTM A153 (Hot dipped) or ASTM B695 Class 50 (Mechanical). All other structural materials are galvanized in accordance with ASTM123.

Other steelwork will receive one shop coat of rust-inhibitive red-oxide or zinc-chromate paint.

#### **8.3.1.8.3.10 Ladder**

When appropriate for the type of tower being furnished, an external ladder furnished with climbing safety devices will be provided for each new tower in accordance with TIA/EIA-222-F. Cable system safety devices manufactured by DB Industries, Safe-Loc, Toledo, or Commonwealth approved equal will be provided.

#### **8.3.1.8.3.11 Obstruction Marking and Lighting**

Where provided, tower obstruction marking and lighting will be in accordance with FAA requirements and FCC radio frequency authorizations. Where an option exists to use a painted tower or strobe lights, strobe lights will be used in lieu of paint. Dual lighting systems will be provided and used where FAA requires this capability. Required notifications will be made before tower is erected. Filing FAA notifications, except for the initial Notice of Proposed Construction or Alteration (FAA Form 7460-1), are Motorola's responsibility. Motorola will assist the Commonwealth in the preparation of the FAA Form 7460-1. FAA notifications for each site are shown as specific milestones on the master schedule. Lighting equipment provided by Motorola will be the same throughout the entire network to permit commonality of spare parts. A lighting control system with required alarms will be provided. These alarms will be wired to the site alarm network. The network Fault Management console will receive notification if any tower light fails.

#### **8.3.1.8.4 Cable Installation materials**

Motorola will provide the following cable installation materials:

- Ice Bridge: Supported with angle brackets and threaded rod assemblies to support the angel brackets.
- Ladders: Separate for Commonwealth and 3rd Party Users.
- Mounts: 3 foot maximum intervals for 100 mph wind rating at 0.5 inch radial icing conditions.
- Hoists: Used at 200 foot maximum intervals.
- Grounding: Minimum of 3 grounding kits will be provided for each transmission line – one at the top of the vertical run, one at the bottom of the vertical run, and one prior to entry into building/shelter. All grounding will meet the requirements of the R56 Standards and Guidelines.
- Cable Entry: For single or multiple entries a rubber boot, clamp and galvanized steel plate will be used.
- Weatherproofing Kits will be used to protect the transmission lines, connectors, and the antenna-to-jumper interface.

All parts will be Andrew or Commonwealth approved equivalent.

### **8.3.2 Building Enclosure**

#### **8.3.2.1 General Design Basis of Tower site facilities**

Motorola will install the new tower site facilities in accordance with all applicable state, local, and national installation regulations, the requirements of this Contract, and in keeping with nationally recognized installation standards.

Motorola is responsible for designing and installing facilities provided under this Contract in accordance with applicable codes, statutes, and ordinances imposed by governmental bodies having jurisdiction. These legal requirements are expected to be augmented by referenced industry standards, this Contract, and Motorola's internally developed design/installation procedures. Where references conflict, the most stringent requirements will be followed or the requirement otherwise agreed to. In the absence of other direction, as a minimum, facilities will be designed and installed in accordance with most recent revision of Virginia Uniform Statewide Building Code, BOCA National Building Code, and the National Electric Code (NFPA 70). Changes in these standards, codes, and regulation after the submission will be accommodated as required to ensure compliance. A change order or other Contract modification documenting the modifications will be executed.

Radio room will be sized to allow system growth. Space will be provided for 100-percent increase in Commonwealth radio channels, plus 20-percent extra floor space. Equipment racks will have a minimum front and back clearance of 36 inches unless racks are front access. Above space will be dedicated to Commonwealth requirements.

Motorola will provide an option for including a minimum 5-foot by 5-foot raised safety grating platform at the side of the exterior door.

### **8.3.2.2 Equipment Buildings and Enclosures**

New radio communications buildings will be bullet resistant (as defined in Section 8.3.2.2.1.5), prefabricated manufactured shelters furnished by OldCastle, Fibrebond, VFP, or other Commonwealth approved manufacturer and the specifications stated herein.

Based on the space, power, heating and growth requirements for the new equipment, Motorola has categorized the new equipment enclosures into different sizes to support the LMR, data and microwave system equipment. Motorola is providing six different types of equipment enclosures and are as follows:

- 12'x20' precast concrete equipment enclosure with attached generator room
- 12'x26' precast concrete equipment enclosure with attached generator room
- 12'x34' precast concrete equipment enclosure with attached generator room
- 12'x32' precast concrete equipment enclosure with independent 12'x10' generator room
- 12'x36' precast concrete equipment enclosure with independent 12'x15' generator room

All the above equipment enclosures are Motorola Standard Buildings (MSB) that have been designed by Motorola for its Land Mobile Radio equipment applications.. The site equipment, power, grounding, receptacles, surge suppression etc. have been pre-planned with the location of Motorola equipment in mind. As a result no field modifications will be required to tailor the equipment enclosures for Motorola equipment.



**Figure 8-1** - Typical pre-fabricated concrete equipment enclosure with attached generator room

One complete set of drawings will be provided with each enclosure, as built.

For new equipment enclosures, Motorola will provide the HVAC, generator, electrical, surge suppression, grounding, and automatic transfer switch. Motorola has provided the specifications for all equipment enclosures and ancillary site equipment being provided with it in Appendix 4. A listing of type of equipment enclosure can be found in Appendix 4. Detailed equipment specifications and scope of work related to site development at the sites that receive new equipment enclosures are listed below.

### **8.3.2.2.1 Equipment Enclosure Specifications**

#### **8.3.2.2.1.1 Dimensions**

The exterior and interior dimensions of the new equipment enclosure and generator rooms can be found in Appendix 4. Generator room has been attached to the equipment for all enclosures with length less than 40 feet. In case of equipment enclosures where its overall length would have exceeded 40 feet after including the generator room, the generator room has been separated from the equipment room, to allow easy transportation and delivery.

For all equipment enclosures whose exterior width is 12 feet or less, the shell of equipment enclosure will ship as one unit. In case of equipment enclosures where its overall width would have exceeded 12 feet, modular equipment enclosures are being provided to allow easy transportation and delivery. These modular units will require assembly in the field.

#### **8.3.2.2.1.2 Equipment Room**

All new equipment enclosures provided by Motorola are precast concrete equipment enclosures designed with equipment to be installed in rows of racks parallel to the short wall. The equipment rooms have been designed based on 22'Wx24'D footprint for the racks with 36 inches of free space in front and back of the each rack. Each equipment room is equipped with the following above each rack location:

- 24" cable ladder for cable routing
- Ten (10) dedicated circuit simplex outlets for powering the equipment
- Equipment ground bus for grounding the equipment
- The rack capacity of each new equipment enclosure can be found in Appendix 4.



**Figure 8-2** - Typical remote Radio Frequency (RF) site showing equipment racks inside of equipment enclosure. Optical Mux is visible in foreground and Quantar base stations in the background.

### 8.3.2.2.1.3 Generator Room

Generators will be installed in a generator room that may be attached to the equipment room, or separate, depending on the size requirements of the equipment contained in the enclosure (refer to Appendix 4 - “STARS Transmitter Sites Matrix” for generator room attachment to equipment enclosure). The generator room will come installed with the following:

- A generator air intake louver with weather hood equipped with a permanent expanded metal dust filter.
- A generator radiator air exhaust louver with weather hood equipped with an exhaust insect screen.
- An exhaust pipe thimble.
- A flexible duct between the generator radiator shroud and a building air exhaust opening.

#### **8.3.2.2.1.4 Loading Specifications**

- Floor load: 300 psf.
- Roof load: 150 psf.
- Walls: 150 mph

#### **8.3.2.2.1.5 Equipment Enclosure Type**

- Precast concrete equipment enclosure:
- Floor: 6"
- Walls: 4" Solid concrete
- Roof: Solid concrete 4" minimum at eave
- Step-joint design.
- Tie down plates
- 5000-psi lightweight concrete.
- Reinforcing steel #4 and #6, #8 bars
- Walls: 2 hr. fire rated
- Ballistics tested for UL-752, (HPR 30.06 point blank range)
- Estimated building weight: Refer to Appendix 4 for gross weight of each new equipment enclosure type

#### **8.3.2.2.1.6 Exterior Finish**

- Walls: Washed aggregate and sealed.
- Roof: Troweled surface and sealed.

#### **8.3.2.2.1.7 Interior Finish**

- Walls: 1/2" Nupoly paneling covered with a white, embossed FRP.
- Floor: Covered with 1/8" x 12" x 12" gray commercial tile and 4" base cover.
- Ceiling: 1/2" Nupoly paneling covered with a white, embossed FRP.

#### **8.3.2.2.1.8 Insulation**

- Walls: R-11
- Ceiling: R-19

### **8.3.2.2.1.9 Doors**

- (2) 42" X 7'0" Bullet resistant doors, painted, galvanized, insulated, Best brand surface mounted dead bolt with a cylinder, Arrow passage lever set, NRP continuous hinge, seals, anti-pick plate, painted galvanized, door bumper, "T" tie back and drip cap. One each for the generator room and the equipment room.

### **8.3.2.2.1.10 Electrical**

At design reviews and with as-built documentation, Motorola will provide one-line electrical diagrams and electrical load calculations for each site, that incorporate service entrance, branch-circuit panels, circuit equipment, and emergency power systems. Motorola will provide additional capacity in the electrical service design of the shelter. Load calculations will be provided to the STARS PD.

End equipment will be associated with one of the following buses:

- Critical (Red) Bus: Radio and other critical equipment powered from the UPS.
- Protected (Orange) Bus: Required peripherals, such as HVAC, with only emergency generator backup or critical equipment having its own battery backup, such as emergency lights.
- Service (Ivory) Bus: Equipment, outdoor lighting, and maintenance power receptacles not required for radio system operation. This bus will be de-energized upon loss of off-site commercial power. Cable for service bus equipment or receptacles is not to be run in the same conduit or raceway with critical or protected bus cable.

Manual switches will be provided to allow complete bypass and isolation of UPS cabinet and automatic transfer switch cabinet. Switches will be configured to allow parallel electrical supply before the components are isolated. This requirement is necessary to allow major maintenance of these single-point failure components without prolonged downtime for a radio site. Out-of-position switches, such as bypass operation, will be an input to the radio system alarms.

### **8.3.2.2.1.10.1 Equipment and Raceways**

Minimum conduit size will be 3/4 inch, and except underground conduit, will be metal with a zinc coating (EMT or heavier construction). Conduits exposed to outside will be rigid, not EMT. Underground conduit will be two (2) inches or larger rigid PVC with a minimum 20-percent excess capacity over code limits, or spare underground conduits will be included. Radio transmission lines will be run neatly on ladders and will be protected by a horizontal ice bridge. Drip loops, or another method that prevents water entry into the shelter, will be utilized.

### **8.3.2.2.1.10.2      *Receptacles and Plugs***

A minimum of one (1), 20-ampere double-duplex receptacle will be provided every 10 feet around the interior perimeter of each shelter. A minimum of two (2), 20-ampere circuits will be provided for this purpose, with one circuit supplied from the protected bus using orange receptacles and one circuit supplied from the service bus using ivory receptacles. One (1) exterior, 20-ampere, GFIC receptacle on its own circuit will be installed on the service bus. With the exception of Type 3 commercial off-the-shelf (COTS) surge protection devices, where power cords are plugged into overhead receptacles, twist-lock components will be used. Motorola will furnish one twist-lock plug for each overhead receptacle installed. Panels will be installed with a minimum 20-percent spare capacity.

### **8.3.2.2.1.10.3      *Surge Suppression***

Motorola will provide Type 1 and Type 2 surge protection on the load side of the transfer switch. Additionally, because of potential operation with the UPS bypassed, critical (red) bus branch circuits will be protected by (COTS) Type 3 surge-protection devices at the equipment end. Devices will be TrippLite or Commonwealth approved equivalent. Any warranty or financial protection will be transferred to the Commonwealth upon conclusion of Motorola's Division warranty period.

### **8.3.2.2.1.10.4      *Electrical Specifications***

The following electrical specifications apply:

- Electrical Service: Refer to Appendix 4 - "STARS Transmitter Sites Matrix" for sizing and type of electrical service on each new equipment enclosure type
- (1) Power exterior elbow LB sized as required shipped loose
- (1) Main service breaker disconnect sized for main electrical service
- (1) Service disconnect secondary surge arrester: Type 2, MOV only
- (1) Surge protector disconnect: 60A, Sq. "D" switch with box
- Install Automatic Transfer Switch: Refer to Appendix 4 - "STARS Transmitter Sites Matrix" for sizing of ATS on each new equipment enclosure type
- (1) Type 2 MOV only surge arrester installed across the AC line between the generator and the automatic transfer switch.
- (1) Main panel surge arrester: Type 1 SAD with MOV
- (1) Load center with branch breakers as required: Refer to Appendix 4 - "STARS Transmitter Sites Matrix" for sizing and breaker capacity of load centers on each new equipment enclosure type.

- Type 3 Surge Suppression: Power Distribution Unit (PDU) with eight (8) separate surge suppressed 120V – 20 Amp circuits. Each circuit is surge protected with surface mount Silicon Avalanche Suppressor Diode (SASD) technology.
- (2) 20A GFI exterior duplex (1) mounted between the air conditioners and (1) by entrance door.
- 20A 120V duplex service outlets - Refer to Appendix 4 - “STARS Transmitter Sites Matrix” for quantity of service outlets on each new equipment enclosure type.
- All electrical conduits will be galvanized EMT, fittings will be compression type and all flex conduit will be sealtight type.

#### **8.3.2.2.1.11 Lighting**

- Interior: 4 ft., 2 bulbs, 40W with X2 tubes, RFI-suppressed fluorescent, with wrap around lens, mounted on the ceiling - Refer to Appendix 4 for quantity of lighting fixtures on each new equipment enclosure type.
- Emergency: (1) Twin bulb with battery EXIT sign located over doorway.
- Exterior Security: (1) 100W HID with photocell on switch.
- Wall switch: (2) 15A
- Tower light circuits will be 2 pole– 30 amp circuits

#### **8.3.2.2.1.12 UPS Power Distribution System**

- (1) 125Amp Service disconnect Sq. “D” breaker with box for each UPS.
- UPS load distribution centers: 200A Main breaker panels, 40 circuits Sq. “D” with (40) 20A branch breakers - Refer to Appendix 4 for number of such load distribution centers on each new equipment enclosure type.
- UPS dedicated circuit distribution: 8 ft. Wiremold “isoduct” aluminum raceway mounted horizontal under cable ladder. Each to contain 20A, 125V RED Duplex receptacles - Refer to Appendix 4 for number of such raceways on each new equipment enclosure type.

#### **8.3.2.2.1.13 Alarm System**

- (1) Dry terminal, 66 block mounted inside box, with hinged cover.
- (1) 25 pair cable with an Amphenol connector
- (1) 25 pair shielded cable with 25-pin Amphenol connecting plug
- (1) Door intrusion, magnetic.
- (1) High/Low temperature.
- (1) Power fail.
- (1) Smoke

#### **8.3.2.2.1.14 Air Conditioning**

HVAC units with integrated heater strips, low ambient control, low-pressure by-pass, and a one-year parts and labor warranty, five year for compressor - Refer to Appendix 4 for number of HVAC units and their size on each new equipment enclosure type.

Lead/Lag controller thermostats - Refer to Appendix 4 for the number of lead lag controllers on each new equipment enclosure type.

#### **8.3.2.2.1.15 Grounding**

Equipment Room Single point system

Interior perimeter ground bus (Halo): #00 bare stranded copper around inside perimeter of building with each end lugged to the master ground bar

Ground bars, and insulators to be installed

Bonding: #6 green insulated wire from metallic items as conduit, electrical boxes, and equipment to perimeter ground bus.

Each single row of equipment will have a separate row ground bus consisting of a #00 solid or stranded green-jacketed copper wire secured to Newton #2106C brackets mounted to the cable ladder

Door grounded with welding cable.

#### **8.3.2.2.1.16 Cable Ladders**

24" wide cable ladder, gold chromate - Refer to Appendix 4 for the total length of cable ladder on each new equipment enclosure type.

#### **8.3.2.2.1.17 Cable Entries**

Eight (8)-port bulkhead entrance panels with cable boots - Refer to Appendix for number of bulkhead panels on each new equipment enclosure type.

Two (2) 3" PVC sleeve cast in concrete for Telco entry.

#### **8.3.2.2.1.18 Fire Protection**

(1) Wall mounted 10 lb. CO2 fire extinguisher

(1) Wall mounted 20 lb. ABC fire extinguisher

FM-200 Fire Suppression system for both generator and equipment areas will be quoted as an option.

### 8.3.2.2.1.19 *Miscellaneous*

- (1) First aid station
- (1) Eye wash station
- (1) Binder Holder for storage of Documentation
- (1) Electro-Magnetic Emission (EME) warning sign
- (1) NO SMOKING warning sign
- (1) 2' x 4' x 3/4" gray color FRP covered plywood telco board

## 8.3.3 Stand-by Power Systems

### 8.3.3.1 General

Motorola will supply a stand-by generator at each transmitter site. With the exception of generators greater than 150Kw in size, fuel sources at each site will be liquid propane from buried tanks. The stand-by generator supplied will meet the requirements for a stand-by system as defined in the National Electric Code (NFPA 70, Article 700). It is also expected that the stand-by generator will meet the requirements for a stand-by power system as defined in the latest edition of the Standard of Emergency and Standby Power Systems (NFPA 110). Under NFPA 110, the stand-by generator will meet the requirements for a Type 60 (initiates within 60 seconds), functions without refueling for 7 days, Level 1 (protection of human life) device. Automatic transfer switch will be provided.

At all transmitter site locations that receive a new equipment enclosure, new generators enclosed within bullet resistant concrete shell have been included.

Motorola will include an exterior mobile generator power receptacle for equipment enclosures at all sites except 24' x 32' equipment enclosures that require a 600 Amp service. Exterior mobile generator power receptacles are not available above 400 Amps. Motorola is providing an external terminal block for the 24' x 32' equipment enclosure only.

New UPS systems with a runtime of fifteen minutes will be provided at all new LMR equipment locations.

All microwave systems have been designed with -48V DC systems described in the microwave Section 5 of the contact.

### **8.3.3.2 Back up Generator**

#### **8.3.3.2.1 Prequalified Manufacturers**

Back up generator will be one of the following or Commonwealth approved equivalent:

- Caterpillar
- Kohler
- Onan

All generators will be from the same manufacturer if possible.

Motorola is providing training, spare parts and maintenance as described in those respective sections. Thirty- (30) days before conducting the training course, Motorola will provide five (5) copies of the course outline to the STARS PD for approval.

#### **8.3.3.2.2 Generator Location**

All equipment enclosure designs will locate the power components (transfer switch, disconnect etc.) close to the cable entry port. Motorola's amended R56 Installation Standards recommend that the electrical service entrance be located close to the cable entry port to allow effective single point of entrance. The system will be designed to facilitate on-site full-load testing. Provision has been made for fueling the generator from an external propane tank, should the primary fuel system be inoperable or empty. Back up generator operating-instructions will be posted in the room.

#### **8.3.3.2.3 Starting System, Crankcase Heater, and Jacket Water Heater**

Batteries will be maintenance-free type with sealed cells. Battery chargers will be a float/equalize design. Crankcase heater and jacket water heater will be provided to facilitate cold weather starting, if recommended by the manufacturer.

#### **8.3.3.2.4 Fuel Tank and Fuel System**

Liquid propane tank is an approved design, and will support a generator runtime of seven days, and will be buried and installed in accordance with applicable building codes. Liquid propane system will also meet requirements of NFPA 58, Liquefied Petroleum Gas Code. Fuel storage tanks will be buried where possible. Motorola will provide optional pricing for surrounding above ground tanks by bullet resistant enclosures. Optional pricing will also be provided for removable metal grating to protect vulnerable portions of fuel system from falling ice. Motorola will be responsible for providing a full fuel tank of generator fuel for a specific site up to the time that individual site has been accepted by the Commonwealth. The Commonwealth will then be responsible for providing the fuel required to support general operation and exercising of the generator.

#### **8.3.3.2.5 Generator Noise Abatement**

Stand-by generators will be of quiet design, with an exhaust silencer and other devices that make the unit suitable for installation in residential locations. All generator units will be supplied with a Critical grade exhaust silencer that reduces noise levels by 31-35 dB. Motorola will provide additional pricing for sound attenuated enclosures should they be required at any site .

#### **8.3.3.2.6 Instrumentation and Alarms**

Safety indications listed in NFPA 110, Table 3-5.5.2(d), will be inputs to the MOSCAD alarm system. Additionally, information on emergency generator run status and a fuel level “low-low” alarm (occurring when there is less than 24 hours of fuel in the tank) will also be inputs to the MOSCAD alarm system.

#### **8.3.3.2.7 Spare Transportable Generators**

Motorola will provide optional pricing for trailer mounted transportable 60 KW generators with LP compatible connectors.

#### **8.3.3.2.8 Periodic Maintenance and Testing**

Motorola will conduct routine maintenance and operational testing of stand-by generators in accordance with NFPA 70, Article 700-4(b), and NFPA 110, Chapter 6, until system acceptance is achieved. Following installation, stand-by generators, including spare transportables referenced above, will be exercised at least once a month to at least 30 percent of their nameplate rating for thirty (30) minutes.

### **8.3.3.2.9 Generator Specifications**

New generators have been included for all new transmitter sites to provide backup power in case of loss of electrical power. Specifics based on generator size and fuel type can be found in Appendix 4.

1% voltage regulation

- "E" control panel displaying:
  - AC volts
  - AC amps
  - Frequency
- Emergency stop switch
- Audible alarm
- Battery charger fuse
- Programmable engine control and monitoring module including:
  - Manual/off/auto switch
  - Four LEDs to indicate:
    - Not In Auto
    - Alarm Active
    - Generator Running
    - Generator Ready
- Data entry keypad with digital display panel and alarm outputs for:
  - Oil pressure
  - Coolant temperature
  - Fuel level (where applicable)
  - DC battery voltage
  - Run time hours
  - High or low AC voltage
  - High or low battery voltage
  - High or low frequency
  - Low or pre-low oil pressure
  - Low water level
  - Low water temperature
  - High and pre-high engine temp
  - High, low and critical low fuel levels (where applicable)
  - Overcrank
  - Overspeed
  - Unit not in "Automatic Mode"
- Communications
  - 8 user programmable digital channels
  - 4 analog user programmable channels
  - Serial communications via RS232, RS485, or external modem
- Electronic isochronous governor with a 0.5% frequency regulation has been included to hold the frequency close 60Hz regardless of load.

- Four-pole alternator
- Main line UL listed circuit breaker - Refer to Appendix 4 for the size of this breaker on generator of each new equipment enclosure type
- Fuel shut-off solenoid valve
- Engine coolant heater
- Solenoid activated starter motor
- Battery charging alternator and cables
- Air cleaner and oil filter with internal bypass
- Oil and antifreeze with drain extensions
- Vibration isolators between engine/alternator and base frame
- Cool flow radiator with fan guards with air duct adapter
- Critical muffler and flex exhaust
- 16 Function Remote Relay Panel, Surface Mtg and Engine Run Relay
- 12vDC Battery

#### **8.3.3.2.10 12vDC Battery Charger Transfer Switch Specifications**

One (1) Transfer Switch with standard features to include:

- ATS Size: - Refer to Appendix 4 for ATS size on each new equipment enclosure type
- Time delay neutral with in phase monitor and safety disconnect switch
- System voltage - Refer to Appendix 4 for output voltage type on each new equipment enclosure type.
- Utility voltage sensing controls:
  - Drop-out and pick-up (70 to 95% adjustable)
  - Utility interrupt delay (.1 to 10 seconds adjustable)
- Two wire start system with adjustable logic control and deluxe exerciser
- NEMA 12 enclosure

#### **8.3.3.2.11 External Generator Receptacle**

- One (1) generator receptacle with manual transfer switch for exterior generator portable hookup - Refer to Appendix 4 - "STARS Transmitter Sites Matrix" for size and voltage of this receptacle on each new equipment enclosure type

#### **8.3.3.3 Uninterruptible Power Supply Specifications**

In order to provide uninterrupted operation of the LMR and data equipment for up to 15 minutes upon loss of power until generator powers up or the electrical service stabilizes, Motorola has provided UPS equipment at these sites for backup power. Additionally, these UPS units will also protect the equipment from transients and other power irregularities on the supply line. Motorola is offering two main types of UPSs in the LMR sites.

### **8.3.3.3.1 System Requirements**

- The UPS will meet requirements of National Electric Code (NFPA 70), Article 700, for Emergency Systems. The UPS will also meet requirements for an emergency power system as defined in latest edition of the Standard on Stored Electrical Energy Emergency and Standby Power Systems (NFPA 111).

The UPS is expected to meet or exceed functional requirements for a Type 0 (no interruption of power), Class 0.25 (functions for 15 minutes at full load), Level 1 (protection of human life) device as specified in NFPA 111.

Motorola will provide a site UPS unit that can continuously protect and condition power for a fully loaded critical bus during normal operation. It will also supply uninterrupted operation for the required time period upon loss of offsite and stand-by generator power. The system will be designed to facilitate on-site full-rated load testing of the UPS unit. Motorola will support on-site full-rated loading test by using the actual load provided by the existing equipment and facilities. Motorola has not included any load banks for full-rated load testing. If required by the Commonwealth, Motorola will provide this service through the change order process.

### **8.3.3.3.2 Emergency Shutoff**

The UPS will have an emergency shutoff switch on its cabinet or through a keypad/display in front of the unit. Additionally, provisions will be made to de-energize the facility by operating a clearly marked emergency switch close to the circuit-breaker panel or through dry contact closures in the communications port on the back of the unit. To prevent inadvertent shut off, two actions are required to engage any emergency UPS shutoff switch, that is, lift a cover then push a switch, or similar action.

### **8.3.3.3.3 Controlled Shutdown**

Near the end of emergency battery power (such as if the standby generator becomes inoperable), there will be a controlled shutdown of the radio system. Upon restoration of power, it will not be necessary to reload or reconstruct files.

The controlled shutdown of the radio system is limited to the equipment connected to the UPS at a particular site and that such controlled shutdown would only require powering down of all components upon loss of battery power.

### **8.3.3.3.4 Bypass Switch**

The UPS will have a bypass switch for use during maintenance or other problems to allow the UPS to be manually bypassed. The switch may either be included as an integral part of the UPS or included in the building's wiring system.

### **8.3.3.4 Uninterruptible Power Supply Specifications**

#### **8.3.3.4.1 UPS with external by-pass switch with the following specifications:**

##### ELECTRICAL INPUT

- Voltage 208-240 V or 200/100, 208/120, 220/110, 240/120 VAC
- Voltage Range 176-276
- Input Power Factor .98
- Frequency 50/60 Hz ( $\pm$  3Hz)

##### ELECTRICAL OUTPUT

- Voltage 208/120 or 240/120
- On Battery Voltage  $\pm$ 3% of nominal
- Efficiency 88% normal operation

##### COMMUNICATIONS

- Communication ports RS232, (DB9) contact closures (std) or usb-2 if available
- SNMP capability SNMP/Web enabled
- Emergency Power off Input for external EPO

##### GENERAL

- Topology True online, double-conversion
- Diagnostics Full system self-test on power up
- UPS Bypass Automatic on overload or UPS failure

##### BATTERY

- Internal Battery Type Sealed, lead-acid; maintenance free
- Battery Replacement Hot-swappable
- Recharge Time <5 hours standard

### **8.3.4 Grounding and Lightning Protection**

Internal ground at existing equipment room will be bonded to the external ground ring, that is assumed to already have a ground resistance of 5 ohms or less.

If upon testing of the grounding system, when installed in accordance with the R56 Standards and Guidelines as amended elsewhere in the contract, the reading of less than 5 ohms is not achieved, the Commonwealth will have the option to upgrade the grounding system based on soil resistivity testing. The cost of such design and modification to the grounding system will be the responsibility of the Commonwealth.

All new equipment enclosures have been designed to include a new internal ground system to be hooked to a new external ground halo around the equipment enclosure.

#### **8.3.4.1 Grounding and Lightning Protection**

Site grounding and lightning protection will be in accordance with the National Electric Code and the R56 Standards and Guidelines as amended. Provision for accessible grounding points for two future site shelters will be made.

Motorola will conduct testing after installing the ground system. Should the tests indicate that a ground resistance of 5 ohms or less has not been achieved, Motorola will provide a change order proposal for implementing a reasonable effort to improve the grounding resistance to 5 ohms or less at a cost not to exceed the guaranteed maximum price shown in the Price List, Appendix 24 for the work outlined below.

Motorola's reasonable effort to comply with this 5 ohm requirement includes providing and installing up to 8 chemical rods and 5 cubic yards of ground enhancement material as engineered at each site where required. Since ground resistivity data for each site is not available at this time, Motorola can not determine that the ground resistance of 5 ohms or less can be met by installing the ground system in accordance with the National Electric Code and the R56 Standards and Guidelines. Upon completion of the installation of the grounding system, the grounding system will be tested to ensure that ground resistance does not exceed 5 ohms. If 5 ohms can still not be obtained after conducting this additional grounding process, Motorola will meet with the Commonwealth to review and determine what grounding solutions are still available, and its associated impact to cost and schedule.

Thirty - (30) days prior to completion, Motorola will submit, to the STARS PD, the measured ground resistance of the grounding system. Ground-resistance measurements will be made in normally dry weather, not less than 72 hours after rainfall, and with ground electrode under test isolated from other grounds. Sample testing will be conducted for verifying path resistance between individual equipment and the grounding system.

For radio sites located at power substations, Motorola will conduct testing after installing the ground system. Should the tests indicate that a ground resistance of 1 ohm or less has not been achieved, Motorola will provide a change order proposal for implementing a reasonable effort to improve the grounding resistance to 1 ohm or less.

Motorola's reasonable effort to comply with this 1 ohm requirement includes providing and installing up to 8 chemical rods and 5 cubic yards of ground enhancement material as engineered at each site where required. Since ground resistivity data for each site is not available at this time, it is understood that Motorola can not determine that the ground resistance of 1 ohm or less can be met by installing the ground system in accordance with the National Electric Code and the R56 Standards and Guidelines.

Existing underground grounding components that are reused will be tested to verify their grounding resistivity does not exceed 5 ohms, and plans will be drawn to document where the existing grounding system is interfaced to new grounding systems. After the grounding system is complete and Motorola testing has been completed, The Commonwealth may test the grounding system and will work with Motorola to rectify deficiencies. During testing, Motorola will furnish a representative to assist the Commonwealth and witness any testing.

Motorola will install grounding system for new facilities (equipment enclosures, towers, generators, fuel tanks, fence etc.) that it supplies and installs as per the amended R56 Standards and Guidelines.

At existing sites, Motorola has assumed that the existing external ground system is adequate for the protection of equipment from both lightning strikes and power surges that may occur.

At these existing sites, Motorola will test the existing external ground system for compliance with amended R56 and, if needed, propose corrective action, identifying schedule impact and cost impact. Motorola equipment when installed will then be grounded to this R56 compliant existing ground system.

### **8.3.5 HVAC Systems**

Since heat loads for existing equipment were not supplied, Motorola was unable to design the size of new air-conditioning required in existing equipment rooms. Therefore, at locations where an existing equipment room is being used no new air-conditioning equipment is being supplied. Should new HVAC equipment be required at any site, Motorola can provide BTU calculations and proposal of additional costs for this work after visiting the sites, for review and approval by the Commonwealth prior to proceeding with such work.

At all other locations wall mounted HVAC systems with a redundant unit have been included with the new equipment enclosures.

Heating and cooling system for radio room will be sized and selected on ambient conditions for 99.6 percent winter and 1 percent summer, as indicated in 2001 ASHRAE Handbook Fundamentals for the nearest area applicable and will also include a minimum of an additional 20-percent capacity for reasonable growth. Equipment will be capable of maintaining an interior temperature between 70 and 75 degrees. Heating equipment for radio room will be sized to heat the room without equipment heat loads being considered. System will consist of redundant units. Redundant lead/lag controls with alternating timer allowing approximately equal operating time on each air-conditioning unit will be provided.

Motorola will include heat load calculations, at design review, along with as-built documentation. Load calculations will include anticipated future loads as specified by the STARS PD.

Sixty – (60) days prior to their installation, Motorola will provide, to the STARS PD, for approval two (2) sets of generic Operating and Maintenance Manuals for mechanical systems. Within thirty - (30) days after manuals have been approved, Motorola will to provide five (5) final sets of these manuals to the STARS PD. One (1) copy of the manuals in Adobe Acrobat Format (PDF) will be delivered to the STARS PD.

### **8.3.6 Access Control Systems**

#### **8.3.6.1 Locks**

[CONFIDENTIAL/PROPRIETARY Information – EXEMPT from public disclosure]

#### **8.3.6.2 Intruder Alarms**

[CONFIDENTIAL/PROPRIETARY Information – EXEMPT from public disclosure]

### 8.3.7 Qualification of Personnel

Design and construction personnel will have appropriate training, experience, and certifications to complete assigned tasks. Motorola will be responsible for overseeing all Motorola personnel, including subcontractors. Design and construction subcontractors will be licensed to perform business in the Commonwealth. Professional registration is required for design submittals. Motorola personnel that work on site will successfully pass a Virginia State Police background check before entering a site. Motorola will provide the information required for background checks of its personnel and contractors to the Commonwealth. The Commonwealth will be responsible for processing such information and providing approvals (or denials) within 45 days of a complete submission.

### 8.3.8 Generic STARS Site Plans

The following attached tables and drawings are the generic STARS site plans provided by the Commonwealth of Virginia. They will provide the initial baseline that all transmitter site designs will be based upon. Motorola will modify these drawings to incorporate the specific changes necessary to support the design plans of each individual site.

**TABLE 8-1**  
**Concrete Schedule**

CHARACTERISTIC	VALUE	TYPES
Specified Strength	f'c = 4000 psi at 28 days f'c = 2500 psi at 28 days	All structural and slabs fence posts
Slump	4"	
Air	4-1/2%	
Water	Potable	
Slabs	Troweled with light broom finish; floor profile quality clarification to be conventional straightedge in accordance with ACI 117.	

**TABLE 8-2**  
**Building Schedule**

<b>CHARACTERISTIC</b>	<b>VALUE</b>
Bullet-resistant Construction	Prefabricated concrete or fiberglass composite
Insulation – Roof	>R19
Insulation - Walls & Floor	>R11
Floor Loading – Distributed	200 psf
Floor Loading – Concentrated	500 pounds
Roof Loading – Distributed	100 psf
Wall Wind Load	In Accordance with Building Codes
Interior Floor Finish	1/8" Commercial-Grade Inlaid Vinyl glued - no self-stick tiles covered with white fiberglass fire-rated paneling
Interior Wall and Ceiling	3/8" fire-rated plywood covered with white fiberglass fire-rated paneling
Roof Finish	Concrete or other approved - 10 year warranty
Door Assembly	3' 6" wide, 2-point locking system Deadbolt Door open alarm Weatherproof



**SITE LOCATION**



# MOTOROLA

**SITE CONTACTS**

**PROJECT MANAGER:**  
MARK CHRISTENSEN  
MOTOROLA  
770-673-5214

**CONSTRUCTION MANAGER:**  
BRETT CREEL  
MCMICHAEL'S CONSTRUCTION  
770-483-1980

**UTILITY CONTACTS**

**ELECTRIC:**  
LARRY DANFIELD  
GEORGIA POWER  
404-512-7717

**TELEPHONE:**  
BEA KELLEY  
BELL SOUTH  
770-402-1676

**LAND OWNERS:**  
ORR VOSSEN  
CITY OF ATLANTA  
404-332-6414

USE: UNMANNED TELECOMMUNICATIONS RELAY EQUIPMENT

**NOTES**

CONTRACTOR SHALL NOTIFY OWNER FOR ACCESS TO SITE. KEEP GATES LOCKED AT ALL TIMES.

CONTRACTOR SHALL VERIFY ALL PLANS AND EXISTING DIMENSIONS AND CONDITIONS ON THE JOB SITE AND SHALL IMMEDIATELY NOTIFY THE ENGINEER IN WRITING OF ANY DISCREPANCIES BEFORE PROCEEDING WITH THE WORK OR BE RESPONSIBLE FOR SAME.

LAT: 33° 46' 55.17"  
LONG: 84° 29' 01.80"

**RAWLAND SELF SUPPORT TOWER SITE**

**BOOK OF DRAWINGS**

T1	COVER SHEET
T2	GENERAL NOTES
T3	GENERAL NOTES
-	SITE SURVEY
C1	SITE LAYOUT PLAN
C2	SITE DETAILS
C3	FENCE DETAILS
C4	TOWER ELEVATION
C5	GENERATOR/FUEL TANK CONCRETE PAI DETAILS
C9	WINDSHIELD BRIDGE DETAILS
C7	GRADING PLAN
O9	SHELTER FOUNDATION
A1	ANTENNA PLACEMENT DETAILS
A2	ANTENNA PLACEMENT DETAILS
A3	ANTENNA PLACEMENT DETAILS
E1	ELECTRICAL PLAN AND NOTES
E2	GROUNDING PLAN AND NOTES
E3	GROUNDING DETAILS
E4	GROUNDING DETAILS
E5	GROUNDING DETAILS
P1	PIPING SCHEMATIC

**SITE VICINITY MAP**



**LOCAL MAP**

**DIRECTIONS TO SITE:**  
TRAVELING I-75 SOUTH, TOWARDS ATLANTA, TAKE 205 WEST  
CONNECTOR TO BARRHEAD HIGHWAY EXIT. GO LEFT ON BARRHEAD  
HIGHWAY (NORCE PERMETER) APPROX. 2 MILES TO SITE WHICH IS  
ON THE LEFT.

<b>LAWGIBB GROUP</b>		<b>MOTOROLA</b>	<b>T1</b>					<b>T1</b>
LAW ENGINEERING & ENVIRONMENTAL SERVICES, INC. 2225 TONY POINT DRIVE KINGSBURN, GEORGIA 30144 PHONE: (770) 421-2420 FAX: (770) 421-2448	SOUTHERN DIVISION 600 BIRMGHAM CITY ROAD, NE ATLANTA, GEORGIA 30308 PHONE: (770) 874-8887 FAX: (770) 874-8889	LAW PROJECT NO: ISSUED: 04/01/00 REVISED: 03/01/00	<b>COVER SHEET</b>					<b>COVER SHEET</b>





































