PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Antennas.
B. Tower top amplifiers.
C. Radio frequency (RF) cables and connectors.
D. Materials and Equipment.
E. Equipment Grounding.
F. Installation, optimization, and field testing.
G. Training and support.

1.02 RELATED SECTIONS

A. Section, 33 83 02, Radio Network / Monopole Antenna Tower
B. Section 01 33 00, Submittal Procedures
C. Section 01 33 23, Shop Drawings, Product Data, and Samples
D. Section 01 43 00, Quality Assurance
E. Section 01 45 00, Quality Control

1.03 MEASUREMENT AND PAYMENT

All work required under this Section will be measured separately and will be paid for as part of the Contract lump-sum price, as part of the related item of work, as indicated on the Bid Schedule of the Bid Form.

1.04 REFERENCES

A. American Society for Testing and Materials (ASTM):

2. ASTM A563 Standard Specification for Carbon and Alloy Steel Nuts
3. ASTM B695 Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
B. Federal Communications Commission (FCC):
   1. FCC Rules and Regulations Title 47 CFR

C. Institute of Electrical and Electronic Engineers (IEEE):

D. National Fire Protection Association (NFPA):
   1. NFPA 70 National Electric Code (NEC):
      a. NEC Article 392 Cable Tray
      b. NEC Article 376 and 378 Metal Wireways and Nonmetallic Wireways

E. National Electrical Manufacturers Association (NEMA):
   1. NEMA VE 1 Metal Cable Tray Systems
   2. NEMA WD 1 General Color Requirements for Wiring Devices

F. Institute of Electrical and Electronics Engineers (IEEE):

G. MACOM Incorporated:
   1. Document AE/LZT 123 4618/1, Site Grounding and Lightning Protection

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures, and Section 01 33 23, Shop Drawings, Product Data, and Samples, for submittal requirements and procedures.

B. The Contractor shall submit the following:
   1. Shop Drawings showing the layout of the system identifying the location of equipment and accessories.
   2. Testing plan for products used for the radio network antenna systems and the full systems from the radios to the antenna, ensuring the designed Radio Frequency (RF) Effective Isotropic Radiated Power (EIRP) is met.
   3. Manufacturer’s product data for manufactured items of materials, equipment, and accessories shown on the Shop Drawings.
   4. Test reports of tests conducted by the Contractor.
5. Certificates certifying that the equipment tested is ready for use.

1.06 QUALITY ASSURANCE

A. Quality Assurance and Quality Control (QA QC) Sections 01 43 00 and 01 45 00 shall be used for QA QC work, testing, and validation.

B. The system shall be designed and installed by an experienced and qualified individual of firm regularly engaged in the design and installation of such systems.

C. Materials shall be clearly marked with the manufacturer’s name, nameplate data or stamp, rating, and conformance with standards, with corresponding standard number clearly marked, as applicable.

D. Material and equipment shall be tested and shall be listed by a nationally recognized testing laboratory.

E. Installed equipment shall be for service in a land mobile radio environment. They shall be of latest types or models, consistent with the present state of the art; and be constructed for service life time of not less than 15 years. The equipment shall employ technologically advanced design techniques to provide an operating system that will perform as specified herein in these specifications.

F. Fully trained, knowledgeable, and qualified technicians and engineers shall be used for the testing to current industry best practices.

1.07 SITE CONDITIONS

A. Verify existing conditions prior to the start of any work. Notify the Engineer to gain entrance to the train control room to inspect the radio equipment including the radio cabinets.

B. Coordinate the installation of the system with other building systems and components to avoid conflicts.

C. Contract Drawings for the radio system are diagrammatic and not necessarily to scale.

PART 2 – PRODUCTS

2.01 ANTENNAS

A. Radio Antenna System shall be as specified in the Contract, and shall be a Designated Matching Product (DMP) with quantities as shown in the Shop Drawings:

1. Transit Antenna

2. Receive Antenna
3. Test Antenna
4. GPS Antenna

2.02 TOWER TOP AMPLIFIER

The tower top amplifier shall be a Designated Matching Product with test port and bandwidth filtering, or an approved equal that meets the radio system’s OEM specifications.

2.03 RADIO FREQUENCY CABLE AND CONNECTORS

A. 7/8-inch Diameter RF Coaxial Cable:
   1. 7/8-inch diameter size or larger.
   2. Low-density foam, dielectric insulation.
   3. Corrugated copper outer conductor material.
   4. Copper-clad aluminum wire inner conductor material.
   5. Special jackets with “plenum” rating.
   6. Heliax LDF 7-50 coaxial cable or equal.

B. 1/2-inch Diameter RF Coaxial Cable:
   1. 1/2-inch diameter size.
   2. Low-density foam, dielectric insulation.
   3. Corrugated copper outer conductor material.
   4. Copper-clad aluminum wire inner conductor material.
   5. Special jackets with “plenum” rating.
   6. Heliax LDF 4-50 coaxial cable or equal.

C. RF Coaxial Connector Type:
   1. As specified in the RF Coverage Design.

2.04 CABLE TRAY

A. Ladder type cable trays shall be provided, and they shall be grounded across joints.
2.05 ACCESSORIES

A. Accessories required for a complete antenna system shall be provided.

2.06 EQUIPMENT GROUNDING

A. The cabinet shall be grounded to the Train Control Room equipment ground bus.
B. The grounding conductor shall be installed in a separate conduit to the train control room ground bus.
C. Ground connections shall be tight, free of paint, and suitably protected from physical damage and corrosion.
D. Ground leads shall be short, direct, and shall have number 6 AWG minimum size.
E. The ground resistance between each bus and prime communications grounding shall be less than 0.5 ohm.
F. The contractor shall record the resistance from each ground connection to the ground bus.
G. Only one path shall exist between the train control room prime ground bus bar and ground. Disconnecting the leads from the bar to ground shall show a dc resistance from the bar to ground of over 100K ohm.
H. Cabinets shall be isolated from other pieces of equipment. 1M ohm shall be the minimum resistance between them.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Contractor shall provide and install all brackets, antennas, tower top amplifier, radio frequency cable, connectors, conduit, cable trays, and other accessories as required and per Contract Drawings.
B. The new monopole shall be installed with antennas and amplifier aligned, cables routed, connectorized, and tested.
C. Overall system shall be placed into service before the existing monopole and equipment mounted to it may be removed.
D. Unless otherwise specified, no old equipment shall be reused in the new installation.
E. RF cable connecting to the new monopole-mounted antennas and amplifier, and GPS antennas, shall be routed to and connected to a new site.
F. Grounding and lightning protection shall be installed at the point of cable entrance into the existing train control room.
G. RF cable shall be installed in conduit or ladder tray, as depicted in the design drawings.

H. Vertical cable support on the tower shall be as recommended by the tower manufacturer.

I. New conduit and ladder trays shall be grounded per lightning protection and NEC requirements.

J. RF cable shall be routed as depicted in the plans from the new lightning protection to the radio transmitter cabinet number 5 inside the train control room by way of the overhead cable ladder.

K. Cable connectors shall be placed on the end of the cables, but not terminated into the cabinet.

L. Lightning protection installation shall be in accordance with Harris Incorporated Document AE/LZT 123 4618/1, Site Grounding and Lightning Protection.

M. The radio antenna system shall be fully tested, and RF components and systems be fully sweep or PIM tested by the Contractor at the transmitter equipment cabinet connection point through to antennas or radiating equipment in the presence of BART personnel and be certified ready for use.

N. Contractor shall accommodate the Engineer to make the final termination of the new work to the existing radio equipment cabinets for the final performance test.

O. Test data, performance data, and plots shall be submitted to BART as part of the Record Documents.

P. Equipment and systems testing procedures used shall be in accordance with the current RF component and systems best practices used in the LMR and Cellular Communications Industries.

Q. If later additions or changes are made to the antenna systems, then added equipment shall be fully tested in the presence of the Engineer, and systems re-swept and re-certified from the point of transmission to radiating antennas.

3.02 FIELD QUALITY CONTROL

A. Contractor shall test the antenna system prior to final connection to radio equipment cabinets and certify that they are ready for use.

B. Contractor shall perform all tests in the presence of the Engineer and BART personnel.

C. Contractor shall furnish all items used in testing.

D. The Contractor shall give notice 48 hours prior to test.
E. The contractor shall provide the test reports and certificates for the Engineer to review.

F. Final connection to the existing radio equipment cabinets will be performed by designated District representatives.

G. Equipment, lines, and weatherproofing shall be visually inspected in the presence of the BART Radio Engineers representative.

H. The effective performance of the System shall be reviewed annually for the duration of the Contract and warranty.

3.03 FIELD TESTING

A. Work shall be performed to complete the testing set out in the test planning submittals, Contract Drawings, and Specifications.

B. Verify that the radio systems equipment has been installed in accordance with the Contract Specifications, Contract Drawings, and the system performance criteria. This shall include inspection, test and measurements of the DC power, ground tests, RF components sweep tests, the coverage maps, system configuration and attenuation settings on updated power block diagram, Radio Voice Quality DAQ, and BER testing. Record all test measurements. Provide diagrams showing equipment placement and routing for antennas, coaxial cables, and AC power to the District’s Representative prior to acceptance testing. Power and network configuration settings shall be supplied with each test report. Submit an RF compliance certificate for each radio system at the conclusion of the acceptance testing.

3.04 TRAINING, MANUALS, SPARES, AND SUPPORT

A. Full operating manuals and electronic documents shall be provided at each equipment location. Copies shall be provided to BART Engineering and Maintenance Departments.

B. Training shall be conducted by the Original Equipment Manufacturer (OEM) or OEM partner engineering staff at BART premises for both engineering and maintenance engineers and technicians. Sufficient quantity shall be set up to allow staff from all shifts to complete training in small class sizes.

C. Spares shall be available for the Systems for 15 years from purchase, and if any components become unavailable, then OEM or OEM partners shall redesign replacements at their own cost, to keep equipment fully functional for this life-span.

D. OEM and OEM partners shall provide 24-hour support and support centers with knowledgeable tier 1 through 4 support staff available to support the systems for life of the product.
3.05 PREVENTATIVE MAINTENANCE SCHEDULES

A. OEM or OEM partner shall provide full preventative maintenance procedures and schedules for equipment and systems.

END OF SECTION 33 83 03