SECTION 27 02 40

COMMUNICATIONS-COMPREHENSIVE RADIO COMMUNICATION SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes: A Radio Communication System consisting of the following systems, subsystems, features, and capabilities:

1. WMATA Comprehensive Radio Communication System (CRCS) – below and above ground subsystem.
2. Public Safety Radio System (PSRS) – below ground subsystem.
3. End-Of-Line Terminal Supervisor's Radio.
4. Mobile Radio at:
   a. Rail Yard Tower Stations.
   b. Gate House.
5. Distributed Antenna System (DAS) providing coverage at:
   a. WMATA Stations.
   b. Buildings.
   c. Wayside Structures.
   d. Tunnels.

B. Related Requirements:

1. Section 27 00 60 Communications System Submittals & Services.
2. Section 27 00 70 Communications Systems Quality Assurance & Testing.
3. Section 27 05 14 Communications Electrical Power Distribution.
4. Section 27 05 26 Grounding and Bonding for Communications Grounding Systems.
5. Section 27 06 05 Communications Standard Specifications - Equipment & Material.
6. Section 34 21 08 Uninterruptible Power System.

1.03 REFERENCES

A. Abbreviations and Acronyms:

1. AVL: Automatic Vehicle Location.
2. BDA: Bi-Directional Amplifiers.
3. CBC: Cross-Band Coupler.

4. CRCS: Comprehensive Radio Communication System.
5. DAQ: Delivered Audio Quality.
6. DAS: Distributed Antenna System.
7. HB: High Band.
8. LB: Low Band.
9. LSHF: Low-Smoke, Halogen-Free.
10. MTPD: Metro Transit Police Department.
11. PSRS: Public Safety Radio System.
12. RF: Radio Frequency.
13. SMNT: System Maintenance.
14. T/R: Transmitter/Receiver.

B. Reference Standards:

1. National Electric Code (NEC – latest edition).
2. Federal Communication Commission (FCC part 15).
3. National Fire Protection Association (NFPA 130 / NFPA 101).
4. Underwriters Laboratories (UL).
5. ANSI/TIA Technical Service Bulletin (TSB) – 88.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Pre-installation Conference: Conduct conference at the Jackson Graham Building (JGB) 600 Fifth Street N.W. Washington, D.C.20001.

1.05 SUBMITTALS

A. Product Data: For each type of component, equipment, and product indicated inclusive of coaxial cables, radiating cables, and fixed antennas.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and salient features for all components, equipment, and products.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and all mounting, attachment, and anchoring details with all associated hardware/components.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for RF power, signal strength, and monitoring and control details.

C. Samples:

1. For each component, equipment, and product specified.
2. For Distributed Antenna Systems (DAS) which requires BDA, Cables, Antennas, RF taps, connectors and terminations.

D. Delegated-Design Submittal: For example of a mounting bracket of an antenna.

E. Coordination Drawings: DAS Schematics Drawings, Cable Elevation Drawings, Cable Schedule Drawings, Antenna mounting details, drawn to scale, on which the items are shown and coordinated with each other, using input from the installers of the items involved.

F. Qualification Data: For Installer, Manufacturer, and Testing Agency.

G. Product Certificates: For each component, equipment, and product specified:

1. Bi-Directional Amplifier.
2. RF Antennas.
3. RF Taps.
4. RF connectors.
5. RF cables.
6. RF Terminations.

H. Material Test Reports: For each Passive and Active Electronics by a qualified testing agency.

I. Product Test Reports: For each Passive and Active Electronics for tests performed by manufacturer and witnessed by a qualified testing agency.

J. Evaluation Reports: For Passive and Active electronics.

K. Preconstruction Test Reports: For In building DAS design.

L. Source quality-control reports.

M. Field quality-control reports.

N. Sample Warranty: For manufacturer's warranty.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance (O & M) manuals:

1. Complete printed operating instructions in manual or handbook form, completely and clearly indexed for ready reference during actual operation and for use as text during instruction of personnel.
2. Include descriptions of systems, background information, and complete procedures for adjustment, calibration, replacement, and repair of components in system.
3. Make data contained specific for and exclusive to the systems and equipment for the work of this Contract.
4. Field test data and reports.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.

2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

C. Substantial and Completion Report (SCI) Documentation:
1. Bill of Materials.
2. Design Documentation.
3. Product Datasheets.
4. Installation / Implementation plan.
5. Test Procedure and test reports.
6. Punch list checklist.
7. Final Acceptance Report.
8. Final Test Data.

D. Training:
1. Training Schedule.
2. Training Syllabus.
3. Training Documentation.

1.07 EXTRA MATERIALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Provide spare parts and/or equipment for no less than 10% of new items.

1.08 QUALITY ASSURANCE

A. Manufacturer Qualifications: a company specializing in manufacturing the components, equipment, and products specified in this section with minimum Five (5) Years documented experience.

B. Installer Qualifications: a company specializing in the installation of components, equipment, and products specified in this section with minimum Five (5) Years documented experience.

C. Testing Agency Qualifications: Member Company of TIA.

D. Mockups: Build mockups to set quality standards for installation and execution**.**
1. Build mockup of typical DAS as shown on Drawings.

1.09 QUALITY CONTROL

A. Preconstruction Testing: Performed by a qualified testing agency on manufacturer's standard assemblies:
1. Antenna Coverage.
2. BDA power output.

3. Cable Insertion Loss.
4. Covers frequency range.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Deliver all components, devices, equipment, and products in their original sealed containers and packaging.
2. Refer to Section 01 61 00 Basic Product Requirements for additional information.

B. Storage and Handling Requirements:

1. Protect, store, and handle as per manufacturer's written instructions and as per WMATA's project requirements.
2. Storage off ground in dry, well ventilated spaces.
3. Storage methods shall be such as will facilitate inspection and testing before and during use.

1.11 WARRANTY

A. Manufacturer and Installer agree to repair or replace all products and equipment installed/specified, and components of all active electronics that fail(s) in materials or workmanship within specified warranty period.

1. Warranty Period: Two (*2)* year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. The WMATA Rail End-Of-Line Terminal Supervisor's Radio Subsystem facility is completely independent and provides two-way voice communications between the Terminal Supervisor's Office and WMATA personnel (usually train operators) within the passenger station interfacing with the existing WMATA Simulcast radio system.

1. An End-Of-Line Terminal Supervisor's mobile radio, antenna and RF coaxial cable shall be designed, furnished, and installed in the end-of-line passenger station (Station).

B. The WMATA Mobile Radio at Rail Yard Tower Stations and Gate House provides two-way voice communications between the Rail Yard Tower towers, Gate House and WMATA personnel (train operators, maintenance personnel within the yard facility interfacing with the existing WMATA Simulcast radio system).

1. The Rail Yard Tower and Gate House mobile radio, antenna and RF coaxial cable shall be designed, furnished, and installed at those locations.

C. The WMATA Distributed Antenna System (DAS) shall provide mobile radio coverage in poor radio coverage areas by repeating existing above-ground simulcast radio signal communications in areas of metro rail facilities having deficient radio coverage. The Off-The-Air Radio Repeater System shall be designed to support rail operations and maintenance, transit police, and support the Integration of the Public Safety Radio System (PSRS).

1. The contractor shall use the installed Radiax Cable provided by WMATA to create a Distributed Antenna System (DAS) for use in the underground sections of WMATA rail system. The DAS shall consist of Below Station Bi-Directional Amplifier (BDA) sites and Tunnel BDA sites. The Contractor shall perform a link budget analysis to determine the placement of BDAs, cabling, and radiating elements. The contractor shall expand the WMATA supplied Radiax system to obtain required coverage. The Contractor shall be responsible for installation of additional radiating cable and or antennas (Omni or panel), in the ancillary spaces, sufficient to achieve stated system requirements for minimum acceptable coverage. All rooms and spaces accessible to personnel within or near the ancillary location shall be provided with minimum acceptable coverage. This includes the entire egress route to the surface (stairs or ladder); if such a personnel egress shaft exists. Ancillary Space DAS components shall meet the following minimum requirements:
   a. Radiating Cable: Same specifications as the existing tunnel “WMATA DAS” radiating cable.
   b. Antennas: Omni or Panel, as required for area covered 490 to 1000 MHz broadband or better.

D. The purpose of the WMATA CRCS Subsystem is to provide two-way voice communications between control consoles to Rail Operations Control Center (RAIL OCC), and portable, vehicular and rail car radios, the Washington Metropolitan Area Transit Police Department (MTPD), Bus, Maintenance departments utilized throughout the WMATA Transit System in tunnels, stations and all areas above ground where the WMATA service extends.

E. The purpose of the Public Safety Radio System (PSRS) Radio Subsystem is to provide two-way voice communications between control center facilities of local Fire Department, Police Department, and Emergency Medical Services (EMS) authorities and their corresponding portable radios, when utilized within the tunnel and underground station areas of the WMATA Transit System.

F. The purpose of the Mobile Radio at Rail Yard Tower station and guard booth is to provide limited communications between the tower, train operators entering and leaving yard buildings and other areas within the facility.

G. The purpose of an End-Of-Line Terminal Supervisor's Radio is to provide limited communications between the End-Of-Line Terminal Supervisor and train operators near or at the station platform.

H. The purpose of the Distributed Antenna System Stations, Buildings, Wayside Structures and Tunnels is to provide adequate radio communications coverage to each room, public and non-public space within these facilities to which MTPD, emergency responders, maintenance or WMATA employees can access using their radios throughout the CRCS coverage area.

I. The WMATA Comprehensive Radio Communication System (CRCS) is a frequency modulated, UHF T-Band, (operating in the 470-512 MHz portions of the frequency band) digital, single-cell simulcast trunked Motorola Smart Zone 3.0z radio system, used for communicating with radio users throughout the entire WMATA service area. The WMATA CRCS consists of several networks: each network operates as a separate system with its individual transmitter/receiver (T/R) equipment, control consoles, portable and vehicular radios.

J. The WMATA CRCS consists of surface and underground Bi-Directional Amplifier (BDA) network located along the WMATA right-of-ways to provide radio coverage for the entire WMATA Transit System. The Surface design composed of 10 remote above ground sites, 15 voice channels, 4 data AVL (bus) channels, one mobile data channel and one paging channel to provide coverage for all surface and aerial portions, while an underground BDA system cover underground passenger stations and tunnel areas of the WMATA Transit System.

K. The underground CRCS is divided up into 26 segments. Each segment consists of several Bi-Directional Amplifiers (BDA) cascaded together. The first Amplifier in the chain is a fiber-fed BDA connected to the main Prime site location at JGB. All BDAs are cascaded along the tunnel segment using a single slotted coaxial cable antenna system installed in underground stations and tunnels.

L. The PSRS Radio Subsystem is a frequency-modulated voice radio system operating in the 850 MHz portions of the frequency band. The Public Safety Radio System (PSRS) is multiplexed into the same radiating cable used by WMATA CRCS using a Cross-Band Coupler (CBC). The PSRS subsystem is similar design utilizing the 850 MHz frequency band and associated components. The PSRS Head-end equipment shall be co-located in the passenger station Communications Equipment rooms and BDAs inside the tunnels. The PSRS radios provide coverage for PSRS portable radios in underground stations and tunnels.

M. The Slotted Coaxial Cable Antenna System shall act as the medium for receiving/transmitting the radio frequency waves to/from the WMATA Comprehensive Radio Communication Subsystem and the Public Safety Radio System (PSRS) Subsystem.

N. The Slotted Coaxial Cables Antenna System shall be installed as required to achieve 95% coverage at a 3.4 DAQ level requirements throughout the Metrorail Project coverage area.

O. A WMATA Rail End-Of-Line Terminal Supervisor's Radio Subsystem facility shall be provided in the Terminal Supervisor's Office in an End-Of-Line passenger station. The WMATA Rail End-Of-Line Terminal Supervisor's Radio Subsystem facility is completely independent and provides two-way voice communications between the Terminal Supervisor's Office and WMATA personnel within the passenger station.

P. Distributed Antenna System shall be designed using any combination of BDAs (fiber-fed, off-air or RF-fed), Optical master units, Antennas (Omni, Yagi, Flat panel), radiating coax and non-radiating coax for providing Coverage at WMATA Stations, Buildings, Wayside Structures and Tunnel Segments.

Q. Vehicular and portable radios shall be provided to interface and operate over the CRCS system built on Motorola Smartzone technology.

R. Each Public Safety Radio System Subsystem network operates as duplex, push-to- talk. A call can be initiated by a portable radio or the control facility by operating the push-to- talk switch and speaking into the microphone. Portable-to-portable radio operation is available for each network within the tunnel and underground passenger station areas. (In addition, communications between portable radios in the tunnel and underground passenger station areas and vehicular and portable radios above ground is available).

2.02 PERFORMANCE REQUIREMENTS

A. Radio:

1. Frequency range: 450-520 MHz.
2. Channel Spacing: 12.5/25 KHz.
3. Maximum Frequency Separation: Full Band split.
4. Rated RF Output Adj: 1 to 5 Watts.
5. Frequency Stability: ±0.0002% of assigned carrier frequency between 30°C and +60°C.
6. Audio Response: Within +1 and -3dB of 6dB per octave pre-emphasis 300-3000Hz referenced to1000 Hz.
7. Emissions (Conducted and Radiated): -70 dBc.
8. Audio Distortion: Less than 3% deviation @ 1000 Hz @ 1 kHz.
9. RF Impedance: 50 ohms.
10. Modulation: 16F3, ± 5 kHz for 100% deviation at 1 kHz.

11. Receive Analog Sensitivity (12 dB SINAD): 0.25µV.
12. Receive Digital Sensitivity (1% BER/ 5% BER)): 0.35µV / 0.25µV.

B. Distributed Antenna System (DAS):

1. Frequency range:
   a. U/L (489.5125 – 490.9625 MHz, 496.3375 – 496.6125MHz).
   b. D/L (492.5125 – 493.9625 MHz, 499.3375 – 499.6125MHz).
2. Channel Spacing: 12.5/25 KHz.
3. Channel Bandwidth:
   a. User selectable, 15 KHz, 30 KHz DSP filters Both either Low.
   b. Selectivity or High Selectivity400 KHz or 1.5 MHz band select filter.
4. Rated RF Output Adj: 1 to 5 Watts per Band.
5. RF Impedance: 50 ohms.
6. Maximum Gain: 80 dB.
7. Gain Adjustment: 0 – 30dB in 1dB steps per channel.
8. Passband Ripple: +/-2dB.

2.03 COMPONENTS

A. End-Of-Line Terminal Supervisor's mobile radio antenna rail yard tower radio antenna and gate house radio antenna:

1. Manufacturers:
   a. Motorola APX4500 (M22SSS9PW1AN) radio R2 with:
      1) Dash mount (G66AW).
      2) Control station desk mic (W382AM).
      3) Control Station Power supply (G91AE).
      4) Trunking Baud Single System (QA01749AB).
      5) Base Station APEXWWM (W665BJ).
      6) Dash mount 02 wwm (G66AW).
      7) APX 02 Control Head (GA00804AB).
   b. Or approved equal.
2. Ratings:
   a. Frequency: 450-520 MHz band.
   b. RF Input impedance: 50-ohms.
   c. Power Input: 120-Vac, 60-Hz. Adaptor.
   d. Equipped with desk microphone and tray.

B. Flexible foam-dielectric ½ - inch coaxial cable for DAS:

1. Manufacturers:
   a. Commscope FXL-540-NHR.
   b. Or approved equal.
2. Ratings:
   a. Impedance: 50 ohms.
   b. Jacket: Non-halogenated, fire retardant polyolefin.
   c. Dielectric Material: Foam PE.
   d. Operating Temperature: -30 °C to +70 °C (-22 °F to +158 °F).
   e. Peak Power: 41.8 kW.
   f. Operating Frequency Band: 100 – 8800 MHz.
   g. Fire Retardancy Test Method:

1) IEC 60332-3-24.
2) UL 1666/CATVR/CMR.

h. Smoke Index Test Method: IEC 61034.
i. Toxicity Index Test Method :
1) IEC 60754-1.
2) IEC 60754-2.

C. Radiax coaxial radiating cable 1-5/8 - inch for DAS:

1. Manufacturers:
a. Commscope RCT7-WBC-2A-RNAM.
b. Or approved equal.

2. Ratings:
a. Impedance: 50 ohms.
b. Jacket: Non-halogenated, fire retardant polyolefin.
c. Tape Barrier: Mica.
d. Dielectric Material: Foam PE.
e. Operating Temperature: -30 °C to +80 °C (-22 °F to +176 °F).
f. Peak Power: 302.0 kW.
g. Operating Frequency Band: 50 – 2700 MHz.
h. Fire Retardancy Test Method:
1) IEC 60332-3-24.
2) IEC 60332-3C-24.
3) NFPA-130-2010.
i. Smoke Index Test Method: IEC 61034.
j. Toxicity Index Test Method:
1) IEC 60754-1.
2) IEC 60754-2.

D. Radio Repeater and Donor Antennas for DAS system:

1. Manufacturers:
a. MARS Antenna and RF system - MA-CQ27-1X (OMNI 490/800 MHz).
b. Sunol Sciences – LP425PCB (Broadband Directional Antenna 490/800 MHz).
c. Sunol Sciences – LP425 (Broadband Directional Antenna 490/800 MHz).
d. Telewave, Inc. – ANT450D (Freq: 406-512 MHz Dipole Antenna / Off- Air).
e. PCTEL - BMOY4705 (470-512 MHz 9dBd 5 Element Yagi Antenna/ Off-Air).
f. Or approved equal.

2. Ratings:
a. Impedance: 50 ohms.
b. Frequency Range: 490 MHz / 800 MHz.

E. Off-The-Air Radio Repeater System Components for DAS:

1. The nature of the Off-The-Air Radio Repeater Systems mandate custom- designed and fabricated components tailored around the required operating frequencies. Detailed specifications shall be provided for each custom-designed component for approval prior to fabrication.
a. Manufacturers:
1) Axell Wireless BDA: 50-206801.
2) Andrew/Commscope BDA: Node A4.
3) Or approved equal.

2. The coaxial cables, radiating cables, and/or fixed antennas selected for use in this system shall be submitted for approval prior to procurement. The cables shall be rated Low-Smoke, Halogen-Free (LSHF).

3. The Off-The-Air Radio Repeater Systems shall be provided with a backup power system that will assure the system will continue to provide service during interruptions of commercial power to the system lasting up to 8-hours.

4. Ratings:
   a. Impedance: 50 ohms.
   b. Frequency:

TDR Channel No.	**Band**	**Tx Channels (MHz)**	**Rx Channels (MHz)**
1	LB	490.8625	493.8625
2	LB	490.7875	493.7875
3	HB	496.4375	499.4375
4	HB	496.5375	499.5375
5	HB	496.6125	499.6125
6	HB	496.5625	499.5625
7	HB	496.4875	499.4875
8	HB	496.3375	499.3375
9	LB	490.9625	493.9625
10	LB	490.9125	493.9125
11	LB	490.8875	493.8875
12	LB	490.8375	493.8375
13	LB	489.5375	492.5375
14	LB	489.5125	492.5125
15	HB	496.5875	499.5875
AVL 1	HB	496.4625	499.4625
AVL 2	LB	489.0875	492.0875
AVL 3	LB	489.1625	492.1625
AVL 4	LB	490.7625	493.7625
MTPD	LB	490.9375	493.9375
SMNT	HB	496.5125	499.5125

2.04 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate the Installed CRCS components.

B. Testing: Test and inspect CRCS components, equipment, and products according to TIA 88.

1. DAQ 3.4 level.

C. CRCS active electronics will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports and submit to WMATA per the project requirements.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine facility's areas and conditions with Installer present for compliance with the project requirements for installation of components, products, equipment, systems, and other conditions affecting performance of the Work.

B. Examine components, products, equipment, and all active CRCS electronics before installation. Reject components, products, equipment, and all active CRCS electronics that are defective, wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit piping installation to verify actual locations of piping connections before products, components, equipment, and systems installation.

D. Examine walls, floors, roofs, ceilings, structures, and tunnel surfaces for suitable conditions where BDAs, Antennas, and Cables will be installed.

E. Prepare written report, endorsed by Installer, listing conditions detrimental to performance and submit to WMATA Engineer for resolution and directives.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. End-Of-Line Terminal Supervisor's Office / Rail Yard Tower Office / Gate House:

1. Install the End-Of-Line Terminal Supervisor's Mobile Radio / Rail Yard Tower Radio and Gate House Radio, as shown on the contract drawings, in a location approved by the Engineer.
2. Install the required power cable, connectors, and associated hardware to provide 120-Vac, 60-Hz power for the Mobile Radio from an available ac receptacle at the different locations.
3. Adjust the transmitter for minimum power output to minimize interference to other WMATA frequencies.

B. The WMATA Distributed Antenna System (DAS):

1. Install the Metrorail CRCS Radio Subsystem, as shown on the contract drawings, in a location approved by the Engineer.
2. Install the required power cable, connectors, and associated hardware to provide 120-Vac, 60-Hz power for the Mobile Radio from an available ac receptacle at the different locations.

3. Adjust the transmitter for minimum power output to minimize interference to other WMATA frequencies.

3.03 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. All End-Of-Line Terminal Supervisor's Radio, Yard Tower Radios and Gate house radios shall be tested for 2-way communication. For measuring the audio quality of the communications during the RF coverage tests, the Delivered Audio Quality (DAQ) levels from ANSI/TIA Technical Service Bulletin (TSB)-88 were used. A DAQ of 3.4 or better is expected.
2. All Distributed Antenna Systems (DAS) installed in stations and other WMATA facilities to provide supplemental coverage shall be tested for 2-way communication and maintain a signal level exceeding -95 dBm for 95% of the time in the entire station and provide Delivered Audio Quality rating of 3.4 (DAQ 3.4) or better in all areas specified in this document . Open areas shall be divided up into 5 feet x 5 feet grids. Radio checks and downlink control channel levels will be measured in each grid. Two or more radio check failures after moving 3 feet in either direction within a grid will be considered a failure. Radio coverage shall also be performed in all station public areas, service rooms and other non-public areas that are part of the station or facility as defined in drawings.
3. Test Requirement for DAQ (3.4 and better) :

DAQ 5.0	Speech easily understood.
DAQ 4.5	Speech easily understood. Infrequent noise/distortion.
DAQ 4.0	Speech easily understood. Occasional noise/distortion.
DAQ 3.4	Speech understandable with repetition only rarely required. Some noise/distortion.

B. Prepare test and inspection reports and submit to WMATA as per the project requirements.

3.04 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Manufacturer's field services:

1. Prepare and start systems under provisions as specified in the contract documents.
2. Supervise final wiring connections and system adjustments.

3.05 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

B. Occupancy Adjustments: When requested within Twenty-Four (24) Months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to Eight (8) visits to the Project Site during other-than-normal occupancy hours for this purpose.

C. A Preventative Maintenance Instructions (PMI) shall be provided followed when any adjustments are made to any CRCS electronic components.

3.06 CLEANING

A. Waste Management:

1. The Contractor shall, during the progress of the work, remove and properly dispose of the resultant dirt and debris daily and keep the premises clean and free from safety hazards.

2. Upon completion of the work, the Contractor shall remove all equipment, salvaged materials and unused materials provided for the work (except any materials that are to remain the property of the WMATA as provided in the specifications) and leave the premises in a neat and clean condition satisfactory to WMATA.

3.07 PROTECTION

A. Remove and replace all components, equipment, and products that are wet, moisture damaged, or mold damaged at no additional expense to WMATA.

B. Protection of components, equipment, and products against damage and deterioration shall be provided during transit to site, unloading, delivering and storing at site, installation or erecting and periods between installation or erection and final acceptance.

3.08 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include Twenty-Four (24) Months' full maintenance by skilled employees of systems and equipment Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, trouble-shooting, inspecting, testing, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacture's authorized replacement parts and supplies.

3.09 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for Two (2) Years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within Two (2) years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least Thirty (30) days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

B. Demonstrate operation and maintenance of Products to WMATA personnel two weeks prior to date of Substantial Completion.

C. Demonstrate Project equipment by a qualified person who is knowledgeable about the Project.

D. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with WMATA personnel in detail to explain all aspects of operation and maintenance.

E. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at equipment location.

F. Demonstrate system operation.

G. Conduct walking tour of Project and briefly describe function, operation, and maintenance of each component.

END OF SECTION