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USACE / NAVFAC / AFCEA UFGS-16790A (March 1989)  
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Preparing Activity: USACE Replacing without revision  
CEGS of same number and date

## UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 22 December 2004

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#### SECTION 16790A

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03/89

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### SECTION 16790A

#### STAND-ALONE ONE-WAY RADIO CONTROL SYSTEM 03/89

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NOTE: This guide specification covers the requirements for stand-alone 1-way FM radio control systems. The control scheme consists of one-way control of equipment (i.e., there is no feedback to the control panel).

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

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## PART 1 GENERAL

### 1.1 REFERENCES

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NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest guide specification. Use of SpecsIntact automated reference checking is recommended for projects based on older guide specifications.

\*\*\*\*\*

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI X3.154 (1988; R 1994) Office Machines and  
Supplies - Alphanumeric Machines-Key-board  
Arrangement

IEEE C62.41 (1991) IEEE Recommended Practice on Surge  
Voltages in Low-Voltage AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (2003) Enclosures for Electrical Equipment  
(1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 780 (2000) Installation of Lightning  
Protection Systems

U.S. DEPARTMENT OF AGRICULTURE (USDA)

RUS 345-50 (1979) Trunk Carrier Systems, PE-60

RUS Bull 345-83 (1979; Rev Oct 1982) Gas Tube Surge  
Arrestors (PE-80)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15 Radio Frequency Devices

1.2 SYSTEM DESCRIPTION

1.2.1 General

A 1-way FM radio control system for controlling equipment shall be provided. The system shall consist of status display and control panel, command generator, transmitter, communication links between the antenna and transmitter, communication link between command generator and transmitter, antenna system, radio switches, communication links surge and overvoltage protection, and power line surge protection. Computing devices, as defined in 47 CFR 15, shall be certified to comply with the requirements for Class A computing devices and labeled as set forth in 47 CFR 15.

1.2.2 Environmental Requirements

Equipment to be utilized indoors shall be rated for continuous operation under ambient environmental conditions of 1.7 to 48.9 degrees C 35 to 120 degrees F dry bulb and 10 to 95 percent relative humidity, noncondensing. All other equipment shall be rated for continuous operation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered for the installed location.

1.2.3 Electrical Requirements

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**NOTE: Designer must show electrical details for  
power sources.**  
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The equipment shall operate from a voltage source as shown, plus or minus 10 percent, and 60 Hz, plus or minus 2 percent.

#### 1.2.4 Power Line Surge Protection

Equipment connected to ac circuits shall be protected from power line surges. Equipment shall meet the requirements of IEEE C62.41. Fuses shall not be used for surge protection.

#### 1.2.5 Communications Links Surge Protection

Communications equipment shall be protected against surges induced on any communications link. Cables and conductors which serve as communications links shall have surge protection circuits installed at each end that meet RUS 345-50 requirements. Additional triple electrode gas surge protectors meeting the requirements of RUS Bull 345-83 shall be provided on each pair of conductors within 900 mm 3 feet of the building cable entrance.

#### 1.2.6 Communications Links Overvoltage Protection

Communications equipment shall be protected against overvoltage on all communications links. Cables and conductors which serve as communications links shall have overvoltage protection for voltage up to 480 Vac rms, 60 Hz installed. Instrument fuses or fusible resistors are acceptable for this application.

### 1.3 DELIVERY OF TECHNICAL DATA

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NOTE: The acquisition of all technical data, data bases and computer software items that are identified herein will be accomplished strictly in accordance with the Federal Acquisition Regulation (FAR) and the Department of Defense Acquisition Regulation Supplement (DFARS). Those regulations as well as the Army and Corps of Engineers implementations thereof should also be consulted to ensure that a delivery of critical items of technical data is not inadvertently lost. Specifically, the Rights in Technical Data and Computer Software Clause, DFARS 52.227-7013, and the Data Requirements Clause, DFARS 52.227-7031, as well as any requisite software licensing agreements will be made a part of the CONTRACT CLAUSES or SPECIAL CONTRACT REQUIREMENTS of the contract. In addition, the appropriate DD Form 1423 Contract Data Requirements List, will be filled out for each distinct deliverable data item and made a part of the contract. Where necessary, a DD Form 1664, Data Item Description, shall be used to explain and more fully identify the data items listed on the DD Form 1423. It is to be noted that all of these clauses and forms are required to assure the delivery of the data in question and that such data is obtained with the requisite rights to use by the Government. Include with the request for proposals a completed DD Form 1423, Contract Data Requirements Lists. This form is essential to obtain delivery of all documentation. Each deliverable will be clearly

specified, both description and quantity being required. Include a payment schedule in the SPECIAL CONTRACT REQUIREMENTS with the request for proposals. This payment schedule will define payment milestones and percentages at specific times during the contract period.

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Items of technical data which are specifically identified in this specification shall be delivered in accordance with the CONTRACT CLAUSES, SPECIAL CONTRACT REQUIREMENTS, and the Contract Data Requirements List, DD Form 1423, which is attached to and made a part of this contract. Technical data submitted shall be coordinated with the requirements of Section [\_\_\_\_]. All data delivered shall be identified by reference to the particular specification paragraph against which it is furnished.

#### 1.3.1 Group I Technical Data Package

##### 1.3.1.1 System Drawing

The data package shall include the following:

- a. Data transmission system block diagram.
- b. Radio system installation, block diagrams, and wiring diagrams.
- c. Radio system physical layout and schematics.
- d. Details of connections to power sources, including grounding.
- e. Details of surge protection device installations.
- f. Details of cable splicing and connector installation.

##### 1.3.1.2 Equipment Data

A complete data package shall be delivered for all materials, including field and system equipment.

##### 1.3.1.3 Data Transmission System Descriptions and Analyses

The data package shall include complete system descriptions, analyses, and calculations used in sizing equipment required. Descriptions and calculations shall show how the equipment will operate as a system to meet the performance specified.

##### 1.3.1.4 System Overall Reliability Calculation

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**NOTE: Insert section number and title for the UMCS specification.**

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The data package shall include all manufacturers' reliability data and calculation required to show compliance with the reliability specified in Section [\_\_\_\_]. The calculation shall be prepared using Section [\_\_\_\_] as a guide. The calculations shall be based on the configuration specified in Section [\_\_\_\_].

#### 1.3.1.5 Certifications

All specified manufacturer's certifications shall be included with the data package.

#### 1.3.2 Group II Technical Data Package

The Group II technical data package is specified in Section [\_\_\_\_].

#### 1.3.3 Group III Technical Data Package

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**NOTE: Insert section number and title for the specification.**  
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The Group III technical data package shall consist of factory testing data. The Contractor shall prepare a test plan and test procedures in accordance with Section [\_\_\_\_] for the factory test. The test plan shall describe the applicable tests to be performed, and other pertinent information such as specialized test equipment required, length of factory test, and location of the factory test. The procedures shall explain in detail, step-by-step, actions and expected results to demonstrate compliance with the requirements of this specification, and the methods for simulating the necessary conditions of operation to demonstrate performance of the system. The Contractor shall deliver the test plan for the factory test to the Government. After receipt by the Contractor of written approval of the test plan, the Contractor shall deliver the factory test procedures to the Government for approval. After receipt by the Contractor of written approval of the factory test procedures, the Contractor may schedule the factory test.

#### 1.3.4 Group IV Technical Data Package

##### 1.3.4.1 Performance Verification and Endurance Testing Data

\*\*\*\*\*  
**NOTE: Insert section number and title for the specification.**  
\*\*\*\*\*

The Contractor shall prepare a test plan and test procedures in accordance with Section [\_\_\_\_] for the performance verification test and endurance test. The test plan shall describe the applicable tests to be performed, and other pertinent information such as specialized test equipment required, and length of performance verification test. The test procedures shall explain in detail, step-by-step actions and expected results to demonstrate compliance with the requirement of this specification. The Contractor shall deliver test plans for the performance verification test and endurance test to the Government. After receipt by the Contractor of written approval of the test plans, the Contractor shall deliver the performance verification test and endurance test procedures for approval. Written approval by the Government of the performance verification test procedures shall be one of the prerequisites for commencing the performance verification test as specified.

##### 1.3.4.2 Operation and Maintenance Data

A draft copy of the operation and maintenance data, in manual format, as

specified for the Group V technical data package, shall be delivered to the Government prior to beginning the performance verification test for use during site testing.

#### 1.3.4.3 Training Data

Lesson plans and training data, in manual format, for the training phases, including type of training to be provided, with a list of reference material, shall be delivered for approval.

#### 1.3.5 Group V Technical Data Package

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**NOTE: Unless the installation has a specific requirement, specify two copies of all manuals, except for the Operator's Manual, which should be specified to be six copies.**  
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The Group V technical data package consists of the operation and maintenance data, in manual format. Final copies of the manuals, bound in hardback, loose-leaf binders, shall be delivered to the Government within 30 days after completing the endurance test. The draft copy used during site testing shall be updated with any changes required prior to final delivery of the manuals. Each manual's contents shall be identified on the cover. The manuals shall include the names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and of the nearest service representative for each item of equipment and each system. The manuals shall have a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies delivered after completion of the endurance test shall include all modifications made during installation, checkout, and acceptance. Manuals delivered shall include:

- a. Functional Design Manual: [two] [\_\_\_\_] copies.
- b. Hardware Manual: [two] [\_\_\_\_] copies.
- c. Operator's Manual: [six] [\_\_\_\_] copies.
- d. Maintenance Manual: [two] [\_\_\_\_] copies.

##### 1.3.5.1 Functional Design Manual

The functional design manual shall identify the operational requirements for the data transmission system and explain the theory of operation, design philosophy, and specific functions. A description of hardware functions, interfaces, and requirements shall be included for all system operating modes.

##### 1.3.5.2 Hardware Manual

A manual describing all equipment furnished, including:

- a. General description and specifications.
- b. Installation and checkout procedures.
- c. Equipment electrical schematics and layout drawings.



- d. Data transmission system schematics.
- e. Alignment and calibration procedures.
- f. Manufacturer's repair parts list indicating sources of supply.
- g. Interface definition.

#### 1.3.5.3 Operator's Manual

The operator's manual shall fully explain all procedures and instructions for operation of the system.

#### 1.3.5.4 Maintenance Manual

The maintenance manual shall include descriptions of maintenance for all equipment including inspection, calibration, periodic preventative maintenance, fault diagnosis, and repair or replacement of defective components.

### PART 2 PRODUCTS

#### 2.1 RADIO FREQUENCY COMMUNICATION EQUIPMENT (RFCE)

##### 2.1.1 Government-Furnished

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**NOTE: Designer must identify Government furnished RFCE.**  
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The Government will provide RFCE as indicated. All Government-furnished RFCE shall be tested by the Contractor to assure that the equipment is in calibration and functioning correctly. Modifications to the Contractor's system shall be made to be compatible with the Government-furnished RFCE.

##### 2.1.2 Contractor Furnished

All RFCE not shown as Government-furnished shall be furnished and installed by the Contractor.

#### 2.2 STATUS DISPLAY AND CONTROL PANEL

The control panel shall be a programmable microprocessor based controller. The controller may be an external host computer. A minimum of 5 separate control groups shall be implemented. Each group shall be scheduled as a function of time-of-day, day-of-week, holiday, external sensing (e.g., demand meter), and manual control. A video monitor and keyboard shall be provided for changing program configuration. The keyboard shall include a 64-character standard ASCII character set in accordance with ANSI X3.154.

#### 2.3 COMMAND GENERATOR

Command generator shall accept commands from the control panel and generate the control signals necessary to operate radio switches over the radio channel. The generator shall contain a digital tone synthesizer, and station control over communication links to the transmitter.

## 2.4 TRANSMITTER

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**NOTE: Director of Information Management  
coordination must be achieved and appropriate  
frequency assignment granted by the installation.**  
\*\*\*\*\*

A continuous duty VHF transmitter shall be provided to transmit at a frequency of [136-174 MHz] [\_\_\_\_]. RF output impedance shall be 50 ohms. The conducted spurious harmonic emissions shall be less than minus 75 dB. Frequency stability shall be a maximum of 0.0005 percent over the operating temperature range. Modulation deviation shall be adjustable to plus or minus 5 KHz. FM hum and noise shall be less than minus 60 dB. The transmitter shall be designed to maintain a minimum field strength of 30 microvolts per meter at any point in the coverage area during transmission. The Contractor has the option of using remote signal repeaters to ensure sufficient field strength to control all radio switches. When multiple transmitters are used to control radio switches of a particular group, circuitry shall be incorporated to compensate for the transmission delay over the communication links to the remote transmitter. A redundant transmitter shall be provided to assume the functions of the primary transmitter in the event of transmitter failure. Circuitry shall be provided to detect transmitter failure and automatically switch over to the redundant transmitter.

## 2.5 ANTENNA SYSTEM

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**NOTE: The designer must show the topography on the  
drawings.**  
\*\*\*\*\*

Antenna system shall utilize vertical polarization antennas, communication links between transmitters and antennas, and matching networks as needed for the proper coverage. Antenna shall be either omni-directional or shaped coverage as determined by the Contractor from the topography. The antennas shall be capable of withstanding the environmental conditions of [201.2] [\_\_\_\_] km per hour [125] [\_\_\_\_] mph wind and [13] [\_\_\_\_] mm [1/2] [\_\_\_\_] inch radial ice without failure. The antenna system shall be selected by the Contractor to meet the requirements as determined from the topography. Lightning protection shall comply with NFPA 780.

### 2.5.1 Grounding Conductor

Antenna grounding conductors shall be minimum 32-strand, No. 17 AWG copper.

### 2.5.2 Ground Rods

Ground rods shall be as specified in Section 16402 INTERIOR DISTRIBUTION SYSTEM.

### 2.5.3 Communication Links

Transmission line between the transmitter and the antenna shall be 50 ohm impedance, foam dielectric rated for the transmitter output power. Minimum requirement shall be RG-8/U foam dielectric. For lengths in excess of 15 m, 50 feet, transmission line shall be of the corrugated copper outer sheath type with either foam or air dielectric.

## 2.6 RADIO SWITCH

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NOTE: Designer must show location of equipment to be controlled.

The designer must show power wiring details, and voltage for each type of radio switch installation. Standard radio switch voltages are 24, 120, and 208-240 volts.

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A microprocessor based radio switch shall be provided to control equipment as shown. Modulation technique shall be direct FM. The coding capacity shall be at least 256 discrete addresses. The radio switch shall incorporate a 15 minute plus or minus 20 percent timer and restore the controlled service when the time out period has elapsed and another signal is not received. The radio switch shall operate on the voltage source as shown. Contact life of the relay shall be at least 100,000 operations at the rated load. The radio switch shall incorporate a narrow band FM, superheterodyne receiver that operates at a frequency of [136-174 MHz] [\_\_\_\_\_]. The sensitivity shall be such that 20 microvolts per meter field strength level shall cause relay operation. The radio switch shall contain an internal antenna. Selectivity shall be at least 50 dB down from carrier reference at plus or minus 25 KHz. Spurious and image rejection shall be at least 40 dB. Frequency stability shall be plus or minus 0.002 percent over the range specified in the paragraph Environmental Requirements.

## 2.7 CONDUIT

Conduit as specified in Section 16402 INTERIOR DISTRIBUTION SYSTEM and Section 16375A ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND and as shown shall be furnished.

## 2.8 ENCLOSURES

Enclosures shall conform to the requirements of NEMA 250 for the types specified. Finish color shall be the manufacturer's standard, unless otherwise indicated. Damaged surfaces shall be repaired and refinished using original type finish. Enclosures installed indoors may be Type 1 when located in a clean dry environment, and shall be Type 12 when installed indoors in other than clean dry environment, or as shown. Enclosures installed outdoors shall be Type 4 unless otherwise shown.

## PART 3 EXECUTION

### 3.1 INSTALLATION

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NOTE: This section must be used in conjunction with Section 16415A ELECTRICAL WORK, INTERIOR; Section 16375A ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND; Section 16370A ELECTRICAL DISTRIBUTION SYSTEM, AERIAL; and any other guide specification sections required by the design.

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All system components and appurtenances shall be installed in accordance

with the manufacturer's instructions and as shown. All necessary interconnections, services, and adjustments required for a complete and operable data transmission system shall be provided.

#### 3.1.1 Antenna

All tubular radiator elements shall be plugged to prevent wind vibration fatigue. All vertical tubular elements shall have drain holes near the bottom. All outside connectors shall be snug and properly taped over with plastic tape suitable for cold weather.

#### 3.1.2 Interior Work

All interior electrical work shall be installed as specified in Section 16402 INTERIOR DISTRIBUTION SYSTEM and as shown.

#### 3.1.3 Exterior Work

##### 3.1.3.1 Underground

Except as otherwise specified, underground electrical work shall be installed as specified in Section 16375A ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND and as shown.

- a. Minimum burial depth for direct burial cable shall be 800 mm, 30 inches, but not less than the depth of the frost line.
- b. Where direct burial cable will pass under sidewalks, roads, or other paved areas, the cable shall be placed in minimum 25 mm 1 inch rigid galvanized steel conduit. Conduit may be installed by jacking or trenching, as approved. When direct burial cable is to be placed in heavy use areas other than paved areas and where the cable may be subject to damage from heavy equipment, the cable shall be placed in minimum 25 mm 1 inch rigid PVC conduit buried a minimum of 1.1 m 42 inches below the surface.
- c. All direct burial cable shall be placed below a minimum 76.2 mm 3 inches wide plastic warning tape buried in the same trench or slot. The tape shall be 300 mm 12 inches above the cable. The warning tape shall be continuously imprinted with the words "WARNING - COMMUNICATION CABLE BELOW" at not more than 1.2 m 48 inch intervals.
- d. Transitions from underground cable to aerial cable shall be as specified for CONNECTIONS BETWEEN MEDIUM-VOLTAGE AERIAL AND UNDERGROUND SYSTEMS in Section 16375A ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND.
- e. Splices shall be installed in cable boxes. Sufficient cable shall be provided in each splicing location to properly rack and splice the cables, and to provide extra cable for additional splices. All cable ends shall be protected at all times with end caps except during actual splicing. During the splicing operations, means shall be provided to protect the unspliced portions of the cable from the intrusion of moisture and other foreign matter.
- f. For cable installed in ducts and conduit, a cable feeder guide shall be used between the cable reel and the face of the duct and conduit to protect the cable and guide it into the duct and

conduit as it is played off the reel. As the cable is played off the reel, it shall be carefully inspected for jacket defects. Precautions shall be taken during installation to prevent the cable from being "kinked" or "crushed." A pulling eye shall be attached to the cable and used to pull the cable through the duct and conduit system. Cable shall be hand fed and guided through each manhole. As the cable is played off the reel into the cable feeder guide, it shall be sufficiently lubricated with a type of lubricant recommended by the cable manufacturer. Where the cable is pulled through a manhole, additional lubricant shall be applied at all intermediate manholes. Dynamometers or load-cell instruments shall be used to ensure that the pulling line tension does not exceed the installation tension value specified by the cable manufacturer. The mechanical stress placed upon a cable during installation shall be such that the cable is not twisted or stretched.

### 3.1.3.2 Aerial

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**NOTE: Aerial cable should be installed on existing poles. Where this is not possible, requirements must be shown on drawings.**  
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Except as otherwise specified, aerial electrical work shall be installed as specified in Section 16370A ELECTRICAL DISTRIBUTION SYSTEM, AERIAL and as shown.

- a. A messenger cable system to support all aerial cable shall be furnished. The messenger system shall be capable of withstanding a minimum of 20 kN 4500 lbf of tension, including all appurtenances, guys, and hardware.
- b. Transitions from aerial cable to underground cable shall be as specified for CONNECTIONS BETWEEN MEDIUM-VOLTAGE AERIAL AND UNDERGROUND SYSTEMS in Section 16370A ELECTRICAL DISTRIBUTION SYSTEM, AERIAL.
- c. All splices in aerial cable shall be within 900 mm 3 feet of a pole and placed inside a watertight enclosure. Drip loops shall be formed at the cable entrance to the enclosure. Lashing clamps shall be placed within 300 mm 12 inches of the enclosure.
- d. Lashing wire shall be wound tightly around both the communication cable and the messenger cable by machine methods. The lashing wire shall have a minimum of 900 mm 3 feet turns per linear meter. linear foot. Lashing clamps shall be placed at all poles and splices.

\*\*\*\*\*  
**NOTE: Designer must coordinate with facility personnel for ground clearance and establish clearances to be shown on drawings.**  
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- e. Loops shall be formed in the aerial cable at all points of connection and at all poles to prevent damage from thermal stress and wind loading. The communication cable shall be protected from

chafing and physical damage with the use of spiral cut tubing and PVC tape, or plastic sleeves. The ground clearance of installed cabling shall be as shown.

#### 3.1.4 Enclosure Penetrations

All enclosure penetrations shall be from the bottom and shall be sealed with rubber silicone sealant to preclude the entry of water.

### 3.2 TESTING

#### 3.2.1 General

The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all testing.

#### 3.2.2 Government Furnished RFCE Test

The Contractor shall test the Government furnished RFCE and certify that the equipment is in calibration and functioning correctly.

#### 3.2.3 Contractor's Field Test

The Contractor shall verify the complete operation of the stand-alone one-way radio control system. The Contractor's Field Test shall include an error rate test. The Contractor shall perform the test by sending 100,000 commands and measuring the error rate. The error rate shall be not greater than 5 out of 100,000. The Contractor shall prepare a report containing results of the field test.

-- End of Section --