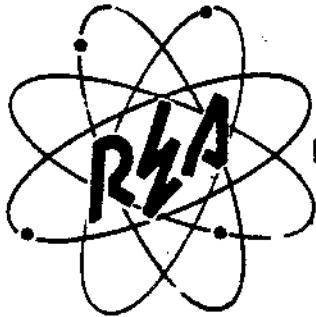


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*Reviewed and Approved for
Reprint - July 1987*



Form 397d June 1970

Design Specifications for

POINT-TO-POINT MICROWAVE RADIO SYSTEMS

REA Project No. _____

Seller _____

1.10 Building plans and general specifications for non-REA buildings to be provided by Seller. This should include foundation details, structural details, size of building, interior and exterior finish details, electrical plan and temperature control plan.

1.11 A project completion schedule. This should include time allocations for the path survey, FCC activity, equipment manufacture, system engineering, construction work, equipment installation, line-up, and testing in order to meet the cutover date.

1.12 Deviations or exceptions (see last paragraph on page 1 of REA Form 397).

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POINT-TO-POINT MICROWAVE RADIO

SYSTEM SPECIFICATIONS

0. SCOPE

0.1 These specifications are for a point-to-point microwave radio system. Part I contains the overall system design specifications and certain auxiliary equipment specifications. Part II contains requirements for installation, alignment, inspection and acceptance tests. Part III contains the Purchaser's equipment requirements and technical data for application engineering. It also contains the Seller's technical data illustrating how it proposes to comply with these specifications.

Note: REA Telephone Engineering and Construction Manual Section 933 is an application guide which contains examples of appropriate responses to Part III of these specifications.

PART I

POINT-TO-POINT MICROWAVE RADIO SYSTEM

DESIGN SPECIFICATIONS

1. SYSTEM PERFORMANCE

1.1 The system shall be designed to permit setting each two-wire trunk, including voice frequency extension when provided, to the appropriate 1000 Hz net loss as follows:

1.11 Via net loss (VNL) for trunks connecting a Class 4 office with adjacent Class 4 offices and for connections to higher ranking offices.

1.12 Via net loss plus 2 dB (VNL + 2) for all terminating trunks including toll connecting trunks between adjacent Class 4 and 5 offices, and EAS trunks between adjacent Class 5 offices.

1.2 The system shall be capable of providing circuits whose voice frequency levels do not vary more than .5 dB over a three month interval.

1.3 The system shall be designed to meet the idle channel noise requirements or objectives in effect in the operating telephone companies of the locality involved. It shall be the responsibility of the Purchaser or its engineer to determine these values including method of testing and specify accordingly in the addenda described in paragraph 1. of Part IIIA. If there are no requirements or objectives already imposed, the system shall be designed to limit idle channel noise in the worst channel to 31 dBrc-0 under normal RF propagation conditions with signaling tones on all channels except the measured channel. Noise shall not exceed 35.5 dBrc-0 in the worst multiplex channel for more than one percent of the busy hour during normal RF propagation conditions. These requirements apply for a single or multihop system.

1.4 The system shall be designed to provide circuits which register no more than a median of 5 counts of impulse noise at a noise threshold of 59 dBrc-0 (VB) during three separate 5-minute testing intervals. (If companders are included, a special testing procedure and a different noise threshold value must be determined for each application).

1.5 Each radio frequency hop shall be designed to provide a received signal which will assure that:

- 1.51 The calculated noise contribution during normal propagation shall not exceed its allocated share of the total system noise permitted in paragraph 1.3.
- 1.52 The calculated noise increase due to failure of one RF channel shall not raise the system noise more than three dB above the limit stated in paragraph 1.3 during normal propagation conditions (this applies to frequency diversity only).
- 1.6 Microwave path engineering shall assume the baseband is loaded with the total number of channels specified in paragraph 1. of Part IIIA as the ultimate requirement, except as limited by necessary bandwidth rules of the Federal Communications Commission.
- 1.7 Radio path fresnel zone clearance shall be provided in accordance with accepted industry practices.
- 1.8 Radio frequencies shall be determined by a recognized frequency coordinating organization.

2. AUXILIARY EQUIPMENT

- 2.1 Antenna systems including antennas, towers, passive repeaters, transmission lines, pressurization and tower lighting specifications are as follows:
- 2.101 Antenna systems which experience 12 dB or more loss due to rain, ice, snow or trash, shall be equipped with radomes or other means of reducing the loss.
- 2.102 Structural design of antennas and antenna supporting structures shall be in accordance with the latest Electronic Industries Association specifications RS-195-A, "Electrical and mechanical characteristics for microwave relay system antennas and passive reflectors," and RS-222-A, "Structural standards for steel antenna towers and antenna supporting structures."
- 2.103 Painting and lighting shall be in accordance with the terms of the FCC construction permit.
- 2.104 Tower lighting systems shall be equipped with an alarm panel which will detect top and side light failures.
- 2.105 The return loss of each antenna and its associated transmission line shall be designed to be greater than 24 dB at F_0 for each RF carrier. Pressurization and/or other accepted methods of maintaining the actual design value shall be provided.

2.106 Electrical grounding of the antenna system shall comply with applicable instructions given in Appendix I.

2.107 Towers and passive repeater foundation designs shall be based on generally known characteristics of local soil conditions. If unanticipated abnormal soil conditions are encountered during construction of tower or passive repeater foundations so as to require foundation design changes to adapt them to the new conditions, the Seller shall be entitled to be reimbursed for the additional costs thereof, if any, in accordance with Article I, Section 3.0 of the Contract Form 397.

Note: Normal soil is that which will support a minimum of 4000 pounds of pressure per square foot acting normal to it. Sand, or rock, or soil which is normally below the ground water table, is abnormal soil.

2.108 Concrete and steel materials shall conform to appropriate specifications of the American Society for Testing Materials (ASTM).

2.109 Structural members and antennas shall be galvanized or made of corrosion resistant materials. All hardware shall be galvanized or made of stainless steel. Galvanizing shall be done in accordance with appropriate ASTM specifications.

2.110 When towers require painting and lighting, climbing steps shall be provided and shall be located so that guys or structural members do not interfere with persons using the steps.

2.2 Voltage regulators shall contain electronic control circuitry rather than mechanical voltage correcting devices. It shall regulate the input voltage range to all equipment connected to the regulator to within the equipment manufacturer's published tolerances (this assumes the input voltage range to the regulator is within the range stated by the regulator manufacturer).

2.3 Prime and standby power may be provided by combinations of commercial ac, batteries, motor generators and inverters. Where devices such as thermoelectric generators or fuel cells are proposed, they will be subject to REA acceptance. The power plant specifications are as follows:

2.301 Prime movers shall be of a size to deliver at least two horsepower for each kilowatt of the generator's full output rating.

2.302 The generator shall have a kW rating of at least one and a half times the calculated load when it is operating at the proposed location altitude.

Note: Transfer of tower lights to the standby power source is not required.

- 2.303 The motor generator speed and voltage regulator shall maintain:
- a. The frequency under full rated load to within three cycles of the frequency under no load.
 - b. The output voltage under full load to within 10 percent of the output voltage under no load.
- 2.304 The prime mover shall be powered from liquified petroleum gas unless otherwise specified in Part III.
- 2.305 Cold start motor generators shall be arranged to:
- a. Delay starting for at least five seconds after a commercial power failure.
 - b. Delay transfer of load to generator until generator frequency has stabilized at its no load value.
 - c. Delay transferring load to commercial power for at least 15 seconds after commercial power has been restored.
 - d. Open the start circuit after the motor fails to start within a preset period of time.
 - e. Automatically cycle at intervals recommended by the manufacturer.
 - f. Prevent feeding voltage back to the commercial line.
- 2.306 Air, fuel and exhaust systems shall be arranged in accordance with the motor generator manufacturer's requirements and local codes.
- 2.307 Motor generator mounting arrangements shall be in accordance with the motor generator manufacturer's instructions and local codes.
- 2.308 Radio frequency interference from the prime mover's ignition system and associated electrical equipment shall not degrade the noise performance of carrier and microwave equipment beyond the limits stated in 1.3.
- 2.309 Batteries shall be lead-antimony, lead-calcium, or nickel-cadmium type.

- 2.310 Battery size in terms of ampere hour rating must provide:
- a. A minimum of 4 hours reserve base on the calculated initial load.
 - b. Sufficient capacitance to permit the charger manufacturer to meet its charger noise specification (usually 4 times charger ampere rating).
- 2.311 Batteries supplied to start the prime mover of cold start motor generators shall be of a size to deliver at least one minute of uninterrupted full current to the starter motor.
- 2.312 An adjustable trickle charge circuit shall be provided to charge the start batteries.
- 2.313 Inverters, converters and chargers shall be arranged so that they will not introduce noise into the battery which will limit the noise performance of the proposed equipment being operated from the battery plant.
- 2.314 Alarm contacts are required to permit detection of all major power plant equipment failures.
- 2.315 Separate main distribution fuses or circuit breakers shall be provided at the power board or main battery bus for:
- a. The microwave equipment.
 - b. The multiplex and its associated voice frequency equipment.
 - c. The alarm system equipment.
- 2.316 Distribution fuse ratings shall be no greater than the nearest higher value of current for which the power distribution wiring is rated. The voltage rating of a distribution fuse shall be at least equal to the voltage applied to the distribution circuit.
- 2.317 Wire sizes and wire insulating materials for power plants shall conform to National Electrical Code ratings for load current, temperature and humidity. Conductor sizes should also be selected to assure less than .5-volt drop between a dc voltage source and its load.
- 2.318 A main control and relay panel shall be provided for each power plant when the calculated load exceeds 20 amperes, and there are more than 3 battery distribution circuits.

2.4 Alarm system specifications are as follows:

- 2.41 The equipment at the alarm center shall be designed to scan continuously so that it can register station status changes as they occur.
- 2.42 Interconnection of the alarm center equipment with the central office alarm system is required.
- 2.43 The remote stations shall be arranged to transmit at least the following alarms:
- a. Commercial power failure.
 - b. Battery charger failure.
 - c. Tower light failure.
 - d. Radio or multiplex common equipment failure.
 - e. Standby generator operation.
 - f. Unauthorized building entry.

2.5 Baseband extensions and wire line entrance link specifications are as follows:

- 2.51 Video pairs, coaxial cables or cable pairs may be used. Cable types must generally be selected from REA Bulletin 344-2. Unlisted cables are subject to REA acceptance.
- 2.52 Protection of the cable against lightning damage shall be provided in accordance with applicable instructions given in Appendix I.
- 2.53 Noise generated in a baseband extension shall be limited by filters or other devices to prevent unacceptable degradation of other portions of the radio baseband.
- 2.54 Where circuits are extended at carrier frequencies, they shall be engineered in accordance with REA Form 397b, "Design Specifications For Wire Line Trunk Carrier Systems."
- 2.55 Terminal equipment included in baseband extensions and wire line entrance links shall be arranged to meet the electrical protection requirements of PE-50, "REA Specification for Trunk Carrier Multiplex Equipment."

3. MISCELLANEOUS

3.1 Factory Test

3.11 Microwave, multiplex, order wire and alarm equipment shall be interconnected and tested at a central location (preferably the prime manufacturer's factory) to assure compatibility and proper functioning of the equipment when it is operated in a system.

3.2 Environmental control devices shall be provided to ensure system performance when the anticipated operating environment of a critical item of equipment will exceed limits set by its manufacturer. Heaters, air conditioners, dehumidifiers, fans and voltage regulators are items which may be supplied to meet this requirement.

3.3 Alarm systems may utilize transmission facilities which they are monitoring, or a separate facility, or a combination of facilities.

3.4 A ground system shall be provided at all new building sites. The ground system shall be designed and installed in accordance with applicable instructions given in Appendix I.

3.5 Other REA Specifications

3.51 Radio frequency equipment shall comply with REA Specification PE-63, "REA Specification for Microwave Radio Equipment."

3.52 Multiplex equipment shall comply with REA Specification PE-60, "REA Specification for Trunk Carrier Multiplex Equipment."

3.53 Buildings shall comply with specifications in REA Form 772, "Specifications for Standard Masonry Type Unattended Telephone Central Office Buildings," or the Purchaser's building specification.

3.6 Prior to submission of the proposal, the Seller may elect to visit the project to make an examination of each site shown on the maps submitted by the Purchaser. At this time the Seller may make preliminary surveys of the proposed RF facilities with respect to the kind and character of the soil and terrain to be encountered and all other matters which may affect the cost and the time of completion of the proposed facilities.

APPENDIX I
REQUIREMENTS FOR
MICROWAVE STATION GROUND AND PROTECTION SYSTEMS

1. MICROWAVE STATIONS

1.1 General - Microwave station installations are generally susceptible to lightning strokes, often directly to antenna towers, and special protection measures are required. Where such stations are located in rural or suburban areas, conditions may be especially unfavorable due to poorer grounding and lack of shielding by tall buildings.

1.2 Protective Grounding

1.21 General - Because of the large currents involved in near or direct lightning hits to the towers and associated structures, the development of hazardous differences of potential between metal parts is a definite possibility. In order to avoid such potential differences it is essential that all metal elements of the building structure, such as steel reinforcing rods in concrete, metal sheathing, metal roof supports and trusses and metal piping and conduit systems be bonded to the station ground. While it is desirable that the station ground have low resistance, it is more important that all metal parts be bonded together and grounded in such a way as to obtain short paths to ground. Multiple paths to the station ground system are desirable.

1.22 Tower Installations - A typical tower ground arrangement is illustrated in Figure 1. Self-supporting towers should have a ground rod driven at the base of each footing and bonded to the tower leg with a #6 or larger copper conductor. Interconnection of the tower and building grounding system is made external to the building. Where wires connecting to ground cross they should be bonded together to avoid arcing. Also, care should be taken in placing grounding conductors to maintain appreciable (6 feet or more) separation from other grounded metal parts which may be hidden within the building structure--such as structural members, steam, gas, or water pipes, etc. Where such members are accessible, numerous bonds to the station grounding conductor are desirable to prevent arcing.

1.221 Where grounding or bonding conductors are likely to be subjected to mechanical injury they may be run in metal conduit. However, in order to avoid arcing, the grounding conductor should be bonded to the conduit at each end of the run.

1.222 Where extremely rocky soil exists or where ground rods cannot be driven for other reasons, a network of wires should be constructed in shallow trenches that will accommodate at least a 12-foot length of conductor. A length of conductor totaling 500 feet may be found necessary. Low resistance of such networks is not as important as distribution of the conductors over the nearby surrounding areas.

1.23 Pole-Mounted Installation - In some cases the antenna may be supported by a wood pole and connected to equipment located in a suitable outdoor cabinet. Similar principles should be followed of common bonding of metal cabinets, conduit, telephone cable strand and shield, if present, to a grounding conductor connected to a made ground system. Where the power system MGN is accessible, the made ground should be interconnected with it using a #6 copper conductor.

1.231 Where antenna supports are attached to a metal building or located on a metal roof, the support, if made of metal, and all guy wires should be bonded together and connected to the metal frame of the building by a #6 or larger copper conductor. Grounded antenna supports or their grounding conductors should have either (1) at least 6-foot separation from other grounded structures or (2) should be bonded to them by a #6 copper conductor.

1.232 In order to minimize the possibility of damage to guy anchors embedded in concrete a ground rod (or rods) should be driven as close to each anchor as possible. All rods at each anchor should be bonded together and to the guy wire with a #6 copper conductor. Where earth resistivity is high, additional benefits will result from bonding the guy grounding system to the station grounding system if feasible.

1.3 Protection of Microwave Equipment

1.31 Mounting of equipment on grounded metal racks ordinarily provides a satisfactory means of common grounding. All such racks should be carefully bonded together and connected to the station ground by a conductor or bus not smaller than a #10 copper wire. Protectors applied to incoming exposed telephone circuits should be grounded to the station ground electrode by a separate #10 copper conductor.

1.32 Bonding of wave guides to the metal framework of the tower structure with #6 or larger copper conductors will provide adequate conductivity for the discharge of lightning currents. Details of the protection to be provided on connecting equipment are given in the following paragraphs.

1.33 Protection of Connecting Facilities

1.331 Built-up Areas - In built-up areas antenna locations and grounding arrangements, such as installations on metal frame buildings, etc., will be such that lightning strokes will be readily conducted to earth and special protection of incoming telephone circuits is not usually required. All incoming cable sheaths or shields should be bonded together and to the station ground as specified in preceding paragraphs.

1.332 Rural or Suburban Areas - The need for additional protection precautions for facilities serving stations located in open country arises due to exposure of the tower to more frequent lightning discharges and to the likelihood of a poorer grounding situation. Also, connecting telephone cable will more likely be small, so that lightning currents carried by the cable shield will develop higher shield-to-conductor potential for a given length due to the higher shield resistance of the smaller cable.

1.333 Where plastic insulated cable, either aerial or buried, is installed between a microwave building and a central office, all pairs, except video pairs, should be terminated on MDF protectors at each location. Video pairs should be terminated at each end of the circuit on video termination panels. The shields of the video pairs should be grounded at one end of the circuit by means of an optional grounding arrangement on the video termination panel. Grounding the video pair shields at both ends of the circuit is not normally recommended because currents in ground loops may cause noise. Protection required by paragraph 2.55, of the specification, for terminal equipment will also serve as protection for the video pairs, so no additional gap type protection is needed. The main cable shield should be grounded at the microwave building to the main station ground, and at the central office end, to the C.O. ground. Typical installation arrangements are shown in Figures 2 and 3.

1.334 If the plastic insulated cable is a composite type which includes pairs and coaxial tubes, the coaxial tubes should not be bonded to the cable shield. The main cable shield, however, shall be bonded to the station grounding bus or grounding conductor. No gap protection is required on the inner conductor of coaxial cables.

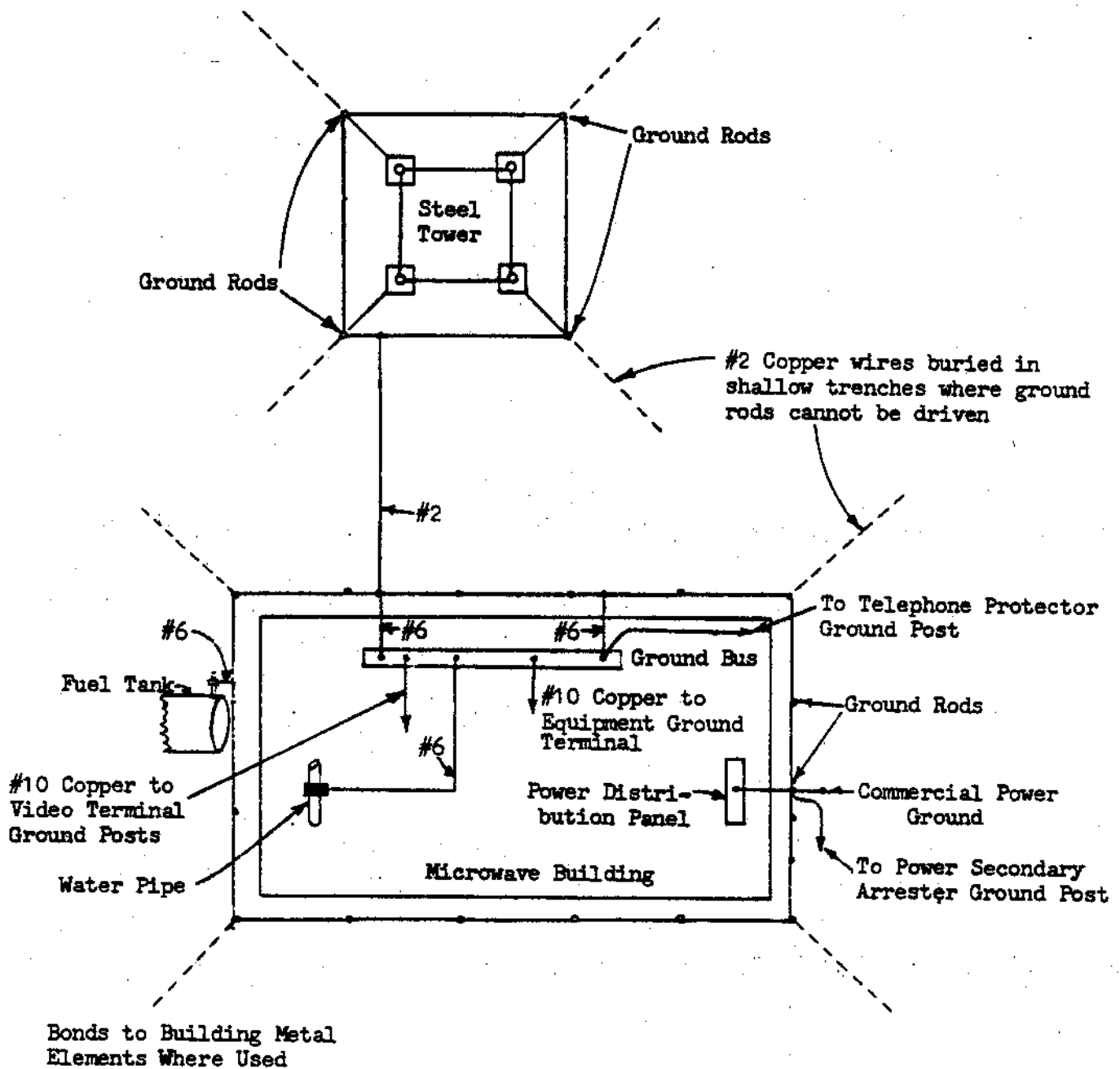
1.335 Power Service Protection - While lightning arresters applied to power distribution primary circuits provide adequate protection against lightning surges insofar as the distribution transformer and meter are concerned, voltages of sufficient magnitude to damage equipment connected to the secondary circuits may be readily developed. It is desirable, therefore, to apply arresters to the secondary power circuits. Such arresters are available having ratings ^{1/} ranging from 175 to 650 volts.

^{1/} These ratings refer to the maximum potential at which the arrester will interrupt power follow-up currents, rather than to sparkover voltages.

Most of the available types have a sparkover rating in excess of 2000 volts. Unless it is known that the power service equipment will withstand in excess of 2000-volt surges, it should be protected as indicated in Figure 4.

1.3351 Both secondary and primary arrester ground conductors should be connected to the same ground electrode unless the power company preference is to operate its system with separate primary and secondary grounds. In such cases the primary and secondary ground conductor should be interconnected through a suitable isolation gap, as determined by discussion with the power company.

1.3352 It is important that all conduit, switchboxes, metal shielded cables, metal sheathed cables, and other noncurrent carrying metal parts be bonded together and connected to the main station ground.



Notes:

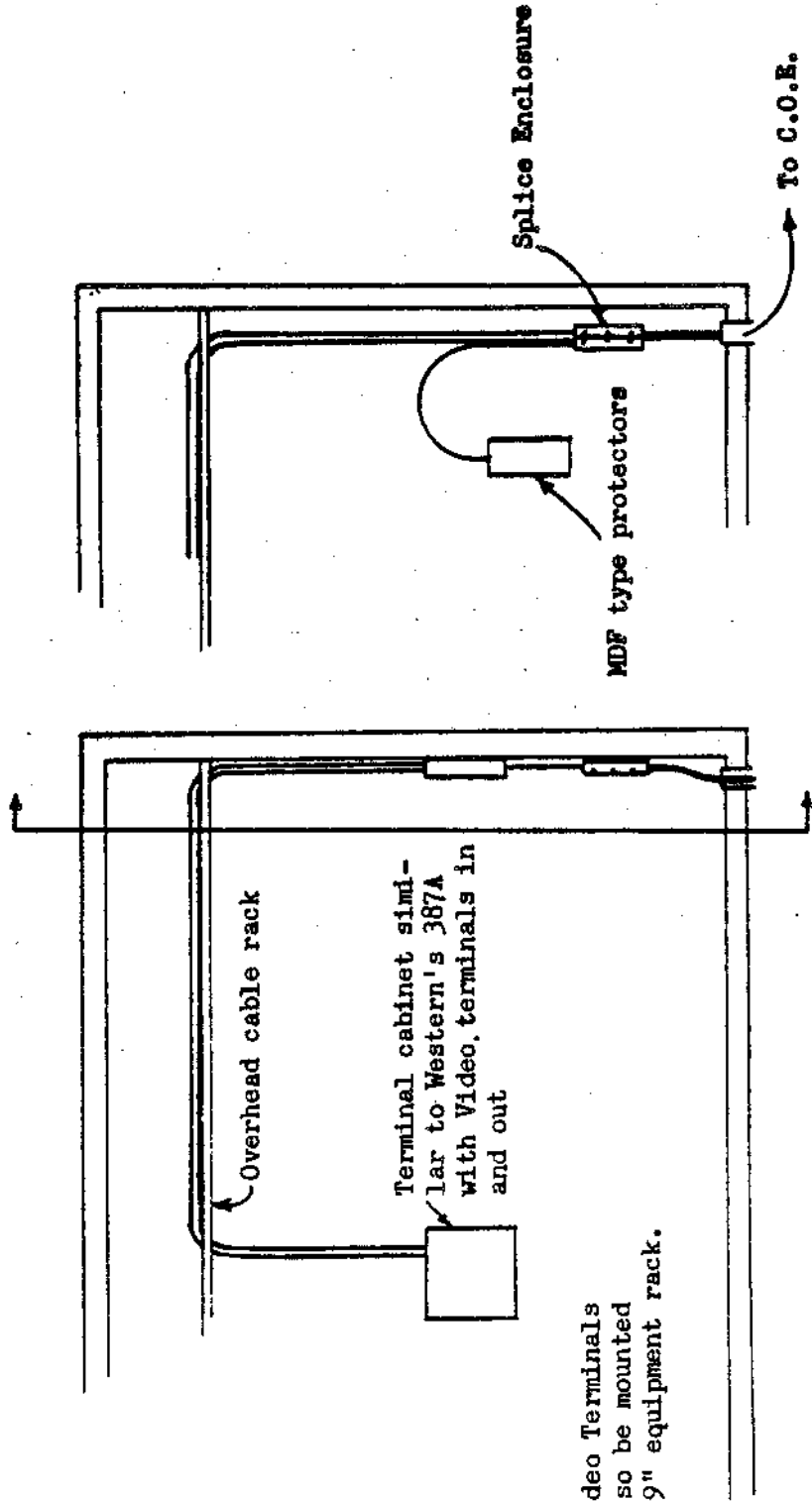
1. Connections from equipment to grounding system to be #10 copper or larger.
2. Bond ground rods with #2 copper

TYPICAL GROUNDING ARRANGEMENT FOR MICROWAVE BUILDING AND TOWER

Figure 1

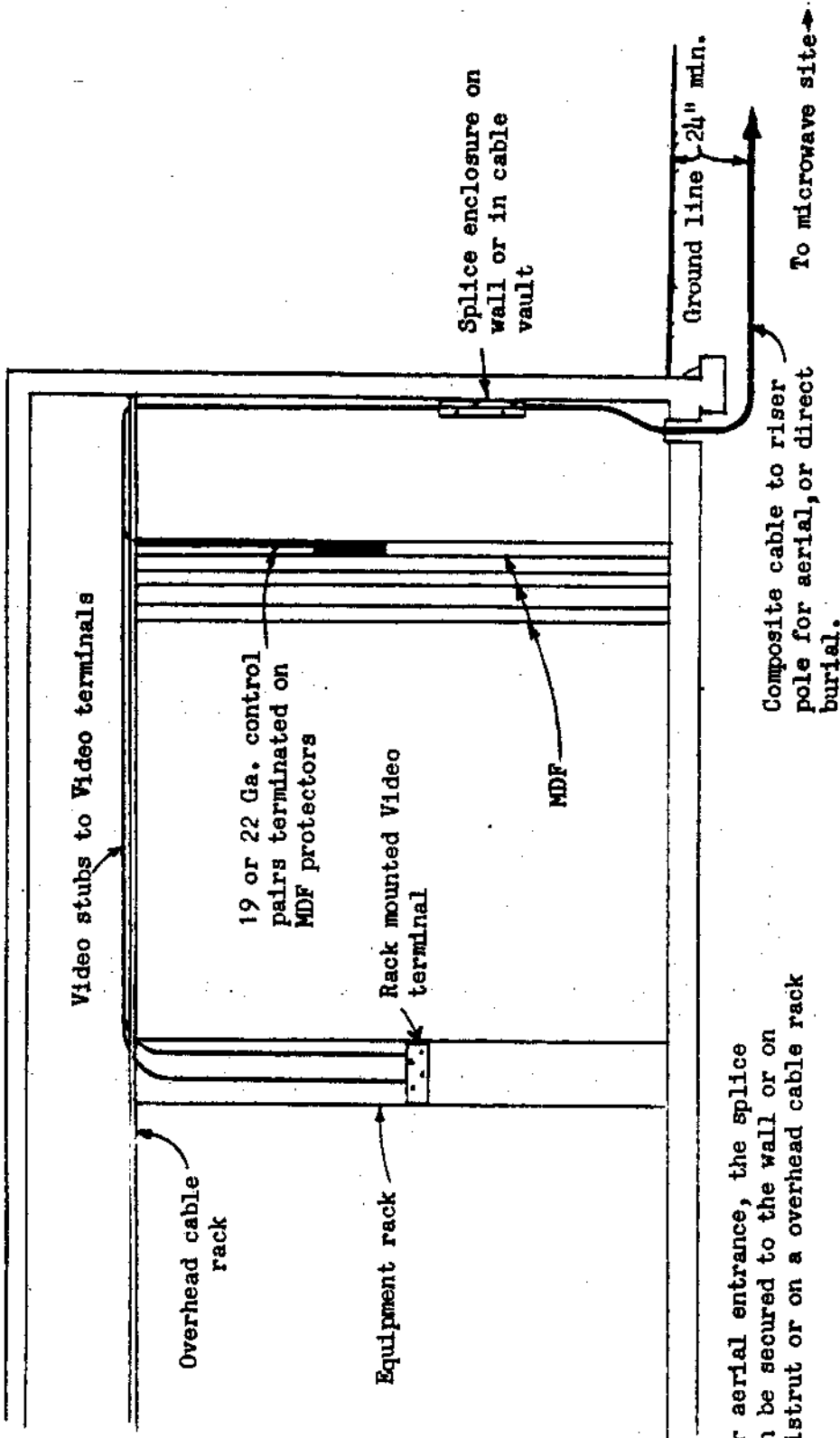
Figure 2

MICROMAVE BUILDING



NOTE: The Video Terminals may also be mounted on a 19" equipment rack.

NOTE: For aerial entrance, the splice may be secured to wall, on unistrut or on an overhead cable rack.



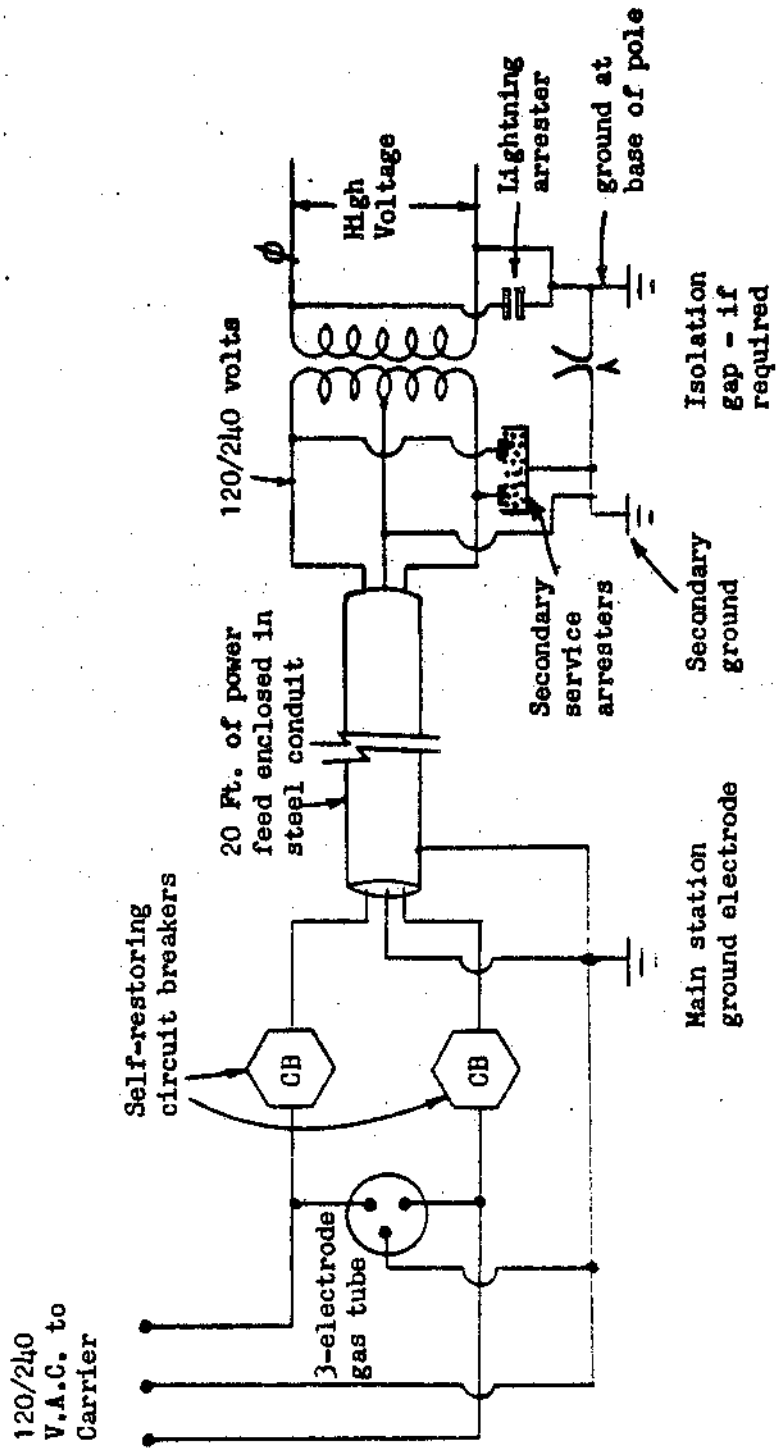
NOTE: For aerial entrance, the splice can be secured to the wall or on unistrut or on an overhead cable rack

CENTRAL OFFICE-TYPICAL TERMINATION OF VIDEO CABLE

Figure 3

Figure 4

POWER SERVICE PROTECTION



PART II

POINT-TO-POINT MICROWAVE RADIO EQUIPMENT

INSTALLATION, ALIGNMENT, INSPECTION AND ACCEPTANCE TESTS

Note: These requirements include installation work performed by the Seller. No work shall be done until the Purchaser approves and signs a copy of building plans, floor plans, plot plans, and power wiring plans. Construction of microwave towers and buildings used exclusively to house microwave equipment shall not be started until the Purchaser has notified the Seller that he has received FCC construction permits and all other necessary permits, leases, titles, easements, authorizations and rights of ingress and egress.

1. INSTALLATION RESPONSIBILITIES

- 1.1 The Purchaser shall be responsible for the following items:
 - 1.101 During the progress of the installation, the Purchaser shall allow the Seller free access to the existing premises and facilities at all hours.
 - 1.102 The Purchaser shall take necessary action to ensure that the existing premises are dry and free from dust and in such condition as not to be hazardous to the installation personnel or the material to be installed.
 - 1.103 The Purchaser shall provide suitable temperature control and lighting in existing rooms in which work is to be performed or materials stored.
 - 1.104 The Purchaser shall provide suitable openings in buildings which it provides to allow equipment to be placed in position.
 - 1.105 In buildings provided by the Purchaser, it shall furnish the necessary conduit and commercial power to the locations shown on the approved floor plan drawings; provide commercial power and a reasonable number of outlets for soldering irons and extension cords necessary for the installation of the equipment; provide suitable openings or channels and ducts for cables and conductors, from floor-to-floor and from room-to-room; and provide an approved grounding system.
 - 1.106 The Purchaser shall make alterations and repairs to existing buildings, when necessary, for proper installation of material, except to repair damage for which the Seller is responsible.

- 1.107 The Purchaser shall test all lines and trunks that will be connected to the multiplex equipment for continuity, leakage, loop resistance, idle circuit terminations (where applicable) and ensure that all lines and trunks shall be suitable for operation with the multiplex equipment specified.
- 1.108 When voice or carrier frequency extensions are provided, the Purchaser shall connect outside cable pairs to the distribution frame and run all line jumpers to the intermediate distributing frame blocks associated with the multiplex equipment.
- 1.109 The Purchaser shall provide and install adequate fire fighting apparatus.
- 1.110 The Purchaser shall provide sufficient land to accommodate buildings and towers including rupture area (foundation excavation area).
- 1.111 The Purchaser shall provide all roads, grading, tree removal and other site improvements before the Seller is scheduled to begin its work.
- 1.112 The Purchaser shall provide staking of all plots to show the exact boundary of the plot and where new buildings and towers will be located. The staking shall be based on a plot plan which shows the tower coordinates and the area required for the tower and building to be furnished by the Seller. This does not relieve the Seller of its responsibility for proper tower construction.
- 1.113 The Purchaser shall provide a suitable access road to each site for trucks used during the proposed construction except where access by air or water is required, in which case the Seller shall be responsible for access facilities.
- 1.114 The Purchaser shall perform all structural modifications, when required, to support roof-mounted antenna structures. The modifications shall be based on roof structural requirements determined by the purchaser's engineer or architect.
- 1.115 The Purchaser shall provide commercial ac power to the terminal box of all new buildings.
- 1.116 The Purchaser shall provide fusing when a dc power source is provided by the Purchaser.
- 1.117 The Purchaser shall secure all permits and pay all fees required by Federal, State and Local ordinances or regulations, including FCC construction permits.

- 1.118 The Purchaser shall arrange for necessary replacement of parts, component repair, rehabilitation, modification, etc., of existing equipment or Purchaser-furnished equipment not under warranty.
- 1.119 The Purchaser shall provide cable runways, superstructures and distributing frames except as stated in Part IIIA.
- 1.120 The Purchaser shall coordinate installation and test schedules when a connecting company is involved.
- 1.2 The Seller shall be responsible for the following items:
- 1.21 The Seller shall obtain the Purchaser's permission before proceeding with any work necessitating cutting into or through girders, beams, concrete or tile floors, partitions or ceilings of buildings provided by the Purchaser. This does not apply to the installation of lag screws, expansion bolts and similar devices used for fastening equipment to floors, columns, walls and ceilings.
- 1.22 The Seller shall repair all damage to the building due to carelessness of its workmen and exercise reasonable care to avoid any damage to the building during occupancy of the quarters.
- 1.23 The Seller shall take necessary steps to ensure that all fire fighting apparatus is accessible at all times. Volatile materials shall be kept in suitable places outside of the building.
- 1.24 When batteries are provided by the Seller, it shall make final battery charger adjustments using the manufacturer's recommended procedure.
- 1.25 The Seller shall furnish the Purchaser with a record of the battery cell voltages and specific gravity readings made at the completion of installation before being placed in service.
- 1.26 The Seller shall provide a #6 gauge (or larger) bare copper groundwire from the carrier multiplex and/or RF equipment bays to the central office ground and properly connect it.
- 1.27 The Seller shall extend voice and signaling wiring from the carrier multiplex equipment to the appropriate blocks on the intermediate distributing frame with separate sheathed cable for signaling leads, four-wire VF transmit, four-wire VF receive, and two-wire VF receive pairs. Separate shielded leads shall be used for carrier frequencies inside the central office. The shields shall be grounded.

1.28 The Seller shall notify the Purchaser at least one week prior to the date on which a transmitter will first be tested in such manner as to produce radiation.

1.29 The Seller shall notify the Purchaser at least one week prior to completion of the installation.

2. INSTALLATION METHODS

2.1 The equipment and materials specified herein shall be installed in conformance with the following specifications:

2.11 Vertical wiring and cabling shall be supported at intervals not exceeding five feet.

2.12 Permanent cabling shall be terminated in accordance with the cable manufacturer's recommendations.

2.13 Connections shall be soldered, wire wrapped, equipped with spade lugs, coaxial connectors or special devices as necessary to provide a good mechanical and electrical connection.

2.14 Frame blocks, fuse panels, jack fields, power, RF multiplex, and VF equipment shall be stencilled or otherwise identified.

2.15 Equipment racks shall be attached to the floor, supported at the top (when top supported racks are furnished) and lined up with existing racks.

2.16 Equipment shelves shall be adjusted so that plug-in cards fit well.

2.17 All shelves and panels shall be aligned with adjacent units.

2.18 All mounting screws shall be in place and tightened.

2.2 Power Apparatus

2.21 Applicable wiring practices of the National Electrical Code shall be used to connect power apparatus.

2.22 Installation of fuel line, exhaust and ventilation system shall be in accordance with the motor generator manufacturer's specifications and local codes.

2.3 Buildings

2.31 Buildings shall be completed in accordance with REA Form 772 or the Purchaser's building specification.

2.4 Antenna Systems

- 2.401 Towers shall be plumbed in accordance with the manufacturer's recommendations.
- 2.402 Guys shall be tensioned, served and safety wired in accordance with the tower manufacturer's specifications.
- 2.403 Bolts shall be tightened in accordance with the tower manufacturer's specifications.
- 2.404 Transmission line bend radii shall be in accordance with the manufacturer's specifications.
- 2.405 Transmission lines shall be sealed so that they will not lose more than two pounds of pressure in one month.
- 2.406 Transmission line horizontal runs shall be supported at intervals of eight feet or less.
- 2.407 All parabolic antennas and tower mounted reflectors shall have "tie back" devices to prevent horizontal movement of antennas.
- 2.408 An ice shield shall be provided for each horizontal transmission line bridge between the tower and building in areas where ice falling from the tower could damage the transmission line.
- 2.409 Tubular tower "weep" holes shall be unobstructed.
- 2.410 Anchors and foundations shall be backfilled 6 inches above average ground level.

2.5 Framing and Cable Rack

- 2.51 Framing and cable rack shall be installed in straight runs. Framing shall be supported by ceiling inserts installed at time of building construction (when standard building is provided).
- 2.52 Cable rack pans are required on all horizontal ladder type cable racks.
- 2.53 Cable support brackets shall be installed at no less than five-foot intervals on horizontal ladder type cable racks.
- 2.54 Cables shall be free of sharp bends or kinks and shall not rest on an abrasive surface where they "break out" of cable racks.

3. ALIGNMENT (ELECTRICAL)

- 3.1 The equipment shall be adjusted and aligned to meet the requirements set forth in Part I and III of these specifications.
- 3.2 Auxiliary equipment controls such as temperature, speed, high and low voltage settings, etc., shall be adjusted in accordance with manufacturers' specifications. Final values are to be determined by the Seller.

4. INSPECTION

- 4.1 Upon completion of the alignment, a joint inspection shall be made by the Seller and the Purchaser, or the Seller and the Purchaser's engineers, to determine that the equipment has been installed in accordance with paragraphs 1. and 2. of this part of the specification.
- 4.2 During each site inspection quantities and types of equipment and materials should be compared with those shown in Part III of this specification. Example: size of building, height of tower, number of channel ends, number and types of spare equipment, etc.

5. ACCEPTANCE TESTS

Note: The intent of these tests is to sample system performance in critical areas and compare sampling tests with factory test or field alignment data. Where sampling reveals nonconformance with requirements of Parts I and III, more detailed tests shall be performed to determine the cause of nonconformance. Tests at more than one location may be required to observe the extent of a problem. Where corrective action is required, it shall be performed in accordance with Article II of the Contract (Form 397). An accurate report of data and test arrangements shall be recorded during these tests. One set of test data shall be forwarded to the REA in accordance with Bulletin 385-3.

- 5.1 Determine voltage regulation and adequacy of wiring at a selected location. The following procedure may be used to perform this test.
 - 5.11 Measure the primary voltage at each new equipment rack and record it.
 - 5.12 Open the power circuit to the new equipment rack which is assumed to draw the most current.
 - 5.13 Record the voltage change at the open circuit and at each of the other new equipment racks.

- 5.14 Before reclosing the circuit, set up the following test conditions (when applicable) to observe:
- a. Multiplex channel noise.
 - b. Microwave transmitter power output.
 - c. The operation of any other equipment which might be affected by this test.
- 5.15 Close the circuit (opened in 5.12) and monitor the test equipment for unusual meter indications. Also observe possible fuse or circuit breaker operation.
- 5.2 The following test is to be performed at a site where a new motor generator has been installed.
- 5.21 Open the main ac circuit breaker to check the operation of all features of the standby power plant. Observe the proper sequence of operations when ac power is restored. Record comments.
- 5.3 The following test is to be performed at a site where environmental control equipment has been installed.
- 5.31 Check all controls for "turn on," "shut down," etc. This includes fans, heaters, air conditioners and automatic ventilators. Record comments.
- 5.4 The following tests are to be performed at a site equipped with a new alarm system.
- 5.41 At remote sites, simulate alarms and verify that the alarm center is receiving them. Record comments.
- 5.42 At the alarm center, verify that alarms appear in their assigned position on the alarm display panel, that the central office audible and visual alarm is activated when an alarm is registered on the display panel and observe that the alarm display can be restored to normal when no alarm conditions are present. Record comments.
- 5.5 The following tests shall be performed at a site where new microwave radio equipment has been installed.
- 5.51 The output power and frequency of each transmitter shall be measured and entered in the station log and in the test data.

5.52 The fade margin shall be measured on a radio path. This test may be performed by inserting an RF attenuator in the receive transmission line and observing the amount of attenuation it takes to raise the noise in a 3 kHz baseband slot to within 30 dB of the normal single channel sideband level at the receiver output. The final RF attenuator setting is a good indication of the fade margin. Record the RF attenuator loss. Example: The normal 1000 Hz single channel sideband level is determined to be -15 dBm (by examining system block and level diagram or by actual measurement). Read total RF attenuation when the slot noise in an unused portion of the baseband rises to -45 dBm at the receiver output.

Note: It is suggested that the transmitter at the distant end be turned off momentarily to observe the local receiver muting action.

5.6 At the two-wire drop of one channel in each group (minimum of three channels per system) the following tests shall be made in both directions of transmission.

5.61 Record circuit net loss at 1000 Hz.

5.62 Record idle circuit noise with C-message weighting and signaling tone removed.

Note: Perform tests described in 5.61-5.64 at a 4-wire point when no terminating sets are provided by Seller.

5.63 Record frequency response between 300 and 3400 Hz.

5.64 Record crosstalk by applying 1000 Hz at -10 dBm0 on either adjacent channel.

5.65 Record signaling distortion.

5.66 Perform a talk test and record comments concerning any circuit hollowness or speech distortion.

5.67 Suitable additional tests may be added to determine that all special service circuits are operating satisfactorily.

PART III

POINT-TO-POINT MICROWAVE RADIO EQUIPMENT

PURCHASER'S EQUIPMENT REQUIREMENTS AND TECHNICAL DATA

FOR APPLICATION ENGINEERING AND SELLER'S TECHNICAL DATA

1. GENERAL

The addenda checked in Part IIIA are supplied by the Purchaser to aid the Seller in quoting on a Point-to-Point Radio (Microwave) system to provide circuits between the central offices listed herein. The Seller shall complete Part IIIB addenda where applicable and submit any additional information it deems necessary to fully describe the system proposed. Examples are included in REA TE&CM Section 933, Issue 2, "Application Guide for Point-to-Point Microwave Radio Specification REA Form 397d."

1.1 Where the connecting company will own a portion of the RF and multiplex equipment which comprises the system covered in this specification, the Purchaser shall provide the Seller with all available technical information by attaching a description to Part IIIA.

1.2 Extensions of multiplex channels over paired telephone cable or open wire circuits shall be treated as trunk carrier and covered in REA Form 397b. All multiplex (carrier) equipment used at the far end of the physical facility shall be listed in Form 397b under the name of the central office in which the channel modem units and four-wire terminations are placed. This equipment need not be specified in Part III of REA Form 397d; however, the terminal equipment which connects into the RF baseband shall be included in REA Form 397d.

PART IIIA

POINT-TO-POINT MICROWAVE RADIO EQUIPMENT

PURCHASER'S EQUIPMENT REQUIREMENTS AND TECHNICAL DATA

FOR APPLICATION ENGINEERING

(See REA TE&CM Section 933)

1. Purchaser's addenda to this specification are:

- 1.01 A narrative description of the proposed system including locations, kinds of trunks to be established, types of equipment existing and to be added, connecting company considerations and the cutover date, if known.
- 1.02 A map showing the geographic location of all central offices and fixed radio sites to be included in this system. It should also include road information, mileages and other landmarks which can be used to locate the sites.
- 1.03 A trunking diagram showing the quantity and type of circuits to be established between each office. It should also include mileages and types of facilities. Geographic relationships between offices must be maintained on this diagram.
- 1.04 A narrative description of existing equipment which Purchaser proposes to include in the new system. This description should contain existing equipment manufacturer's name, model number, location of equipment, existing tower heights, interface levels and any information which may help the Seller to better understand the Purchaser's existing system.
- 1.05 A baseband spectrum allocation chart illustrating existing supergroup, group and channel assignments between existing locations. Proposed frequency allocations may also be shown on this chart.
- 1.06 A statement of connecting company engineering data. This should include the type of connecting facility, quantity and type of trunks to be established, types of signaling, and terminating equipment to be provided by the connecting company and other information which may affect the cost and time of completion of this work.

1.07 A description of the multiplex and associated VF equipment to be provided by the Seller. This should include a statement of operating voltage, the number of channels for which the equipment shall be arranged to expand, multiplex options such as frequency synchronization or supergroup regulation, the number of circuits to be wired, the number of circuits to be equipped, kinds of signaling to be provided, kinds of voice frequency terminating devices to be provided, kinds of jacks, and any other miscellaneous equipment. All equipment should be listed by location and circuit group with which it is to be associated. A statement of required operating net losses by trunk group must be included in this list. The Purchaser must also include a complete description of its central office trunk relay equipment to which the new equipment will be connected. Rack heights must be shown for each location.

1.08 A description of the microwave equipment to be provided by Seller. This may include a statement of operating voltage, kind of configuration (diversity, standby, other), whether terminal or repeater, preferred operating frequency band (2, 4, 6, 11 GHz) and quantities for each location. Rack heights must be shown.

1.09 A description of the order wire and alarm system to be provided by Seller. This should describe the line facilities to be used, the location of the alarm center, the number of alarms and control functions, maximum alarm and control function capability, location of order wire appearances, and central office alarms to which this equipment will be connected at the alarm center. State quantities for each location.

1.10 A description of the antenna systems to be provided by Seller. This should show the kind of towers (guyed or self-supported), desired wind loading, ultimate number of antennas, type of antennas (parabolic, shrouded, horn-reflector), preferred transmission line (type of wave guide or coaxial cable) and tower lighting information, if known.

1.11 A description of power plant equipment to be provided by Seller. This should include Purchaser's battery reserve requirement, a requirement for motor generators (when needed), availability of commercial power, reliability of commercial power, preferred battery voltage, preferred type of battery (lead-calcium, etc.). Quantities must be stated for each location. If Purchaser's power plant is to be used, a statement of existing voltage, capacity, busy hour load and charger capacity shall be made for each location.

- 1.12 A description of special equipment to be provided by Seller. This should include special signaling, terminating or other equipment which has not been described in other addenda to this specification.
- 1.13 A description of the buildings to be provided by Seller. This should include type of construction, size, specifications and location of each building.
- 1.14 REA Forms 772 and 772A for each standard masonry building to be provided by Seller.
- 1.15 Detailed plans showing building modifications to be performed by Seller. Plans should contain enough information to allow Seller to obtain a firm construction bid on the work.
- 1.16 A floor plan of existing buildings showing tentative and existing equipment locations. The plan should be drawn to scale and existing equipment should be identified.
- 1.17 A plot plan sketch of each site where building or tower work is contemplated. This sketch should identify plot boundaries, show existing structures, locate underground and overhead utilities and show proposed location of new construction.
- 1.18 A description of Purchaser's spare parts requirements. This should include the number of spare modules the Purchaser proposes to stock for each active module whose failure can affect service on ten or more circuits, the number of spare passive modules for each passive module whose failure can affect service on 60 or more circuits, and a statement of the number of years supply of fuses and lamps to be stocked by Purchaser.
- 1.19 A description of Purchaser's test equipment requirements. This should include a requirement for a full complement of Seller's card extenders and all special test equipment manufactured by the Seller to service its equipment.
- 1.20 A description of training to be provided by Seller. This should include the number of employees to be trained, the preferred training location (factory or field) and the level of training desired.

REA Project No. _____

Seller _____

PART IIIB

POINT-TO-POINT MICROWAVE RADIO EQUIPMENT

SELLER'S TECHNICAL DATA

(See REA TE&CM Section 933)

1. Seller's addenda to this specification are:

- 1.01 A list of material and services to be provided by Seller for each location. This should include training.
- 1.02 A list of spare parts to be provided by Seller.
- 1.03 A list of test equipment to be provided by Seller. This should include Seller's recommended list of test equipment manufactured by others.
- 1.04 Calculated noise performance for each trunk group. This should include a summation of the noise contribution of all radio links and multiplex terminals in each trunk group.
- 1.05 Calculated maximum power required at each site for equipment provided by Seller.
- 1.06 A functional block diagram of the system showing the voice frequency, multiplex and RF baseband arrangement. This should illustrate the proposed plan at baseband drop and insert locations, and the planned method of extending the baseband where applicable.
- 1.07 A functional block diagram of the order wire and alarm system. This should illustrate bridging arrangements, auxiliary amplifiers, tone frequencies, location of alarm center and location of special filters.
- 1.08 A chart of the baseband spectrum allocations for this system. This should illustrate supergroup, group and channel assignments between all locations. Existing and proposed assignments should be shown.
- 1.09 Preliminary radio frequency engineering data for each microwave path. This should include tentative site locations, path lengths, antenna sizes, transmission line information, calculated fade margin and a propagation reliability estimate.

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- 1.21 A description of documentation to be provided by Seller. This should include path survey data, equipment rack profiles, floor plans, system block and level diagrams and radio log books. Quantities should be stated.
- 1.22 A statement of special considerations. This may include assignment of responsibilities not covered elsewhere, special operating conditions, soil information, etc.
- 1.23 The Seller shall submit information for the following items in Part IIIB: 1.01, _____
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