



Electric Service Requirements

Macro Cell Antenna Installations on SMUD Facilities

Engineering Specifications T012

October 2018

Powering forward.
Together.



 SMUD®	ENGINEERING SPECIFICATION	No. T012 Page 1 of 29	
		REV. 5	DATE: 10/17/2018
CATEGORY ELECTRIC SERVICE REQUIREMENTS			
SUBJECT MACRO CELL ANTENNA INSTALLATIONS ON SMUD FACILITIES			

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1 PURPOSE

This specification provides minimum requirements of the Sacramento Municipal Utility District (SMUD) for the design, approval, and installation of second party cellular communication antennas (a.k.a., macro cell) on SMUD power facilities. Compliance with this specification is necessary to install any macro cell antenna on a SMUD's power facility.

2 SCOPE

This specification outlines the necessary actions, and design, construction and operational requirements and considerations for a communications service provider to install a macro cell antenna on a SMUD power facility in the transmission system, at a substation, or elsewhere on the distribution facilities as defined below. It applies to macro cell antennas to be installed on transmission towers and poles, at substation sites, and on distribution poles and structures.

Exception: Macro cell antennas shall not be allowed at the pole top positions on poles carrying 69kV circuits.

This document is not a design or construction specification but provides minimum requirements and typical design details.

This specification does not cover installation at SMUD's campus, i.e. office buildings, warehouses, garages, parking areas, gardens, etc. It does not cover small cell antenna installations on SMUD distribution poles (refer to ESR T016).

Also, proposed macro cell antenna installations on SMUD operated antenna structures will be considered by SMUD on a case-by-case basis and is not covered in the scope of this specification.

3 REFERENCES

- 3. 1** General Order 95 (GO95), Latest Revision
- 3. 2** California Electric Code (CEC), Latest Revision
- 3. 3** California Code of Regulations, Title 8 – Industrial Relations, Subchapter 5 – Electrical Safety Orders
- 3. 4** National Electric Safety Code IEEE C2, Latest Revision
- 3. 5** US Department of Labor Occupational Safety and Health Administration, Regulations (Standard – 29 CFR) Electric power Generation, Transmission, and Distribution. – 1910.269, and Telecommunications – 1910.268
- 3. 6** California Building Code – CBC, Latest Revision
- 3. 7** ANSI/Telecommunications/Electronic Industry Standards for Steel Antenna Towers and Supporting Structures, ANSI/TIA/EIA-222-G
- 3. 8** SMUD Specification SS6001 – Chain Link Fence
- 3. 9** SMUD Specification C917– Electrical Grounding
- 3. 10** SMUD Specification SS0204 – Tubular Steel Poles
- 3. 11** FAA Advisory Circular AC 70/7460-1k Obstruction Marking and Lighting
- 3. 12** SMUD Specification T004 – Commercial and Industrial Service Requirements

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3. 13 NFPA 70 – NEC, Latest Revision

3. 14 Northern California Joint Pole Manual Antenna Operation Procedures, Section 19.11

4 DEFINITIONS

4. 1 Applicant

Applicant is an entity, typically a communications service provider, requesting to install an antenna on SMUD facilities, or a contractor acting on behalf of such an entity.

4. 2 SMUD Facility Identification (SFI)

SFI is SMUD's assigned identification for a facility. It may consist of:

4.2.1 An Identification number for a pole or structure.

4.2.2 Identification of power lines on the structure, each identified by line voltage and both terminals of the line (terminals may be designated by three place alphanumeric abbreviations).

4.2.3 Access road(s).

4.2.4 Substation Name.

4. 3 Distribution Facility

A pole, or other structure, supporting distribution lines typically rated 69 kV or less. These facilities include attached circuits and devices, such as: secondary electrical circuits, electrical apparatus, risers, lights, communications circuits, and associated equipment. The associated SMUD properties, Right-of-Ways, and/or easements combine to form the Distribution Facility.

4. 4 Macro Cell

A macro cell is a cell in a mobile phone network that provides radio coverage served by a high-power cell site (tower, antenna or mast). Its main purpose is to provide coverage over a large (macro) area. The antennas for macro cells are mounted on ground-based masts, rooftops and other existing structures, at a height that provides a clear view over the surrounding buildings and terrain.

4. 5 Program Manager (PM)

A SMUD employee designated to oversee the process of application, authorization, and installation of communication antennas on SMUD facilities.

4. 6 Master License Agreement (MLA)

An agreement, in principle, to allow a communications company to locate antennas on SMUD's facilities when all requirements are met. The MLA prescribes the basis for SMUD to allow an Applicant to install antennas on SMUD's facilities, but does not provide a specific design nor constitute authorization to install. SMUD prepares the MLA for a fee when solicited by an Applicant and both the Applicant and SMUD execute the agreement. The MLA may define and address the: Site Application Form, Site License Agreement, Modification/Reconfiguration Application, Insurance Requirements, Processing and Inspection Fees, Scope of Work, Project Costs, Bill of Sale, Use Fees and Payments, Termination Agreement, Utility Access, Taxes, Maintenance, Safety, Surrender of Premises, Default, Disclaimers, Indemnification, Third Party Co-Location, Laws, and other general requirements.

4. 7 Modification / Reconfiguration Application (MRA)

This form describes applicants proposed modification to an existing site.

4. 8 Qualified Communication Line Worker

An employee certified annually by the employer to demonstrate the skills required to work safely in the communication space per OSHA Regulations (Standards – 29 CFR) Telecommunications. – 1910.268.

4. 9 Qualified SMUD Inspector

An employee, representing SMUD's interests, qualified to assess the safety and quality of procedures and work performed on SMUD facilities. The inspector will permit construction where safe, will ensure the quality of work and work procedures, and will obtain required clearances from SMUD's Power System Operator (PSO) or Distribution System Operator (DSO) in order to permit Applicant to proceed with work at a SMUD facility. The inspector is authorized on behalf of SMUD to start, stop, and shutdown work on its facilities.

4. 10 Qualified Electric Line Worker

An employee certified annually by the employer to demonstrate the skills required to work safely in the supply space per OSHA Regulations (Standards – 29 CFR) Electric Power Generation, Transmission, and Distribution – 1910.269.

4. 11 Site Application Form (SAF)

A form completed by an Applicant to provide the necessary information for SMUD to consider permitting antenna(s) to be installed on a specific facility.

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4. 12 Site License Agreement (SLA)

The SLA is a separate agreement allowing antennas to be located at a specific location, in accordance with the terms and conditions of the Master License Agreement. The Site License Agreement identifies terms and conditions unique to a specific installation. This license is prepared for a fee by SMUD and executed by the Applicant and SMUD.

4. 13 Substation Facility

A SMUD property containing electrical substation equipment including, but not limited to: power transformers, switchgear, power lines, metering, ground grids, and all associated improvements.

4. 14 Transmission Facility

A pole or tower structure supporting transmission lines, typically 115 kV or 230 kV, and all associated SMUD properties including Right-of-Ways and/or easements.

5 GENERAL REQUIREMENTS AND INFORMATION

5. 1 These service requirements shall be consistent with General Order 95, "Rules for Overhead Electric Line Construction," of the California Public Utilities Commission, and all applicable State of California and Federal orders, codes, rules, and regulations; which have been established in the interest of safety to the public and utility workers. SMUD will not allow the construction or modification of power facilities in any way that does not meet these minimum requirements.

5. 2 The Applicant shall comply with applicable ordinances and provisions of City, County, State and/or other jurisdictions that are not provided as a part of this document. All materials used and all work performed as part of the Applicant's antenna installation or modification/reconfiguration must conform to the requirements of local inspection authorities, these specifications, and SMUD's Rates, Rules, and Regulations.

5. 3 The Applicant shall carefully review all materials supplied herein: text, drawings and drawing notes.

5. 4 It must be the intent of the Applicant to provide communication services at, or within, the proposed SMUD facilities, and the Federal Communication Commission (FCC) must have licensed the Applicant to transmit and receive on the frequencies to be used at the site.

5. 5 **SMUD may disconnect service to antenna installations or otherwise deactivate the antenna, without notice, when performing operational activities that require SMUD personnel to work above ground level in the vicinity of the antenna.**

5. 6 **Where an antenna will be installed on a jointly owned pole, the Applicant shall comply with all requirements of the Northern California Joint Pole Association Manual Section 19.11, and all subsections.**

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Failure to comply with the above requirements could cause unnecessary delays for the Applicant and/or cancellation of agreements allowing the installation or requiring the removal of antenna facilities.

6 MASTER LICENSE AGREEMENT

A TELECOMMUNICATIONS MASTER LICENSE AGREEMENT (MLA) shall be drafted, signed by both SMUD and Applicant, and formally executed, before SMUD will address any specific request. Applicant will complete a Master License Request form supplying all necessary information to SMUD's Real Estate Services Department. The Master License Request forms may be obtained at:

SMUD Real Estate Services
Realestate@smud.org
Fax: (916) 732-6008
6201 S Street, Mail Stop K222, Sacramento, CA 95817
P.O. Box 15830, Sacramento, CA 95852-0830

7 REQUEST TO INSTALL OR MODIFY ANTENNA(S)

All proposals and submittals pertaining to antenna installations on SMUD facilities, or residing within SMUD's rights-of way or property, shall be submitted to SMUD's Program Manager where they shall be reviewed for completeness.

SMUD will not consider any proposal or submittal for installation or modification of antennas unless SMUD and the Applicant have formally executed a Master License Agreement (See Section 6, above).

Maintenance of antennas installed on SMUD facilities within the electric utility space may only proceed after receiving approval from SMUD of the planned work and schedule. All maintenance of antennas installed within SMUD's supply space shall only take place in the presence of a SMUD inspector.

7.1 SITE LICENSE AGREEMENT

7.1.1 The Applicant shall request SMUD to consider a potential facility, or site, for antenna installation by submitting a Site Application Form (SAF) to SMUD's Program Manager. The SAF must be complete in its entirety including digital photos of the location and existing SMUD facility before SMUD will consider the request. SMUD's Program Manager will ensure that all necessary information has been provided and verify that a MLA is in effect.

- 7.1.2** Once the initial screening process has been completed, a SMUD notification (job) number will be assigned and all information will be forwarded to the appropriate staff to process the request. SMUD may reject a proposed site because of conflicts with projects or plans; conflicts with facility operating agreements; conflicts with stipulations of the Right-of-Way, easement or property; community agreements or concerns; facility availability; operating or reliability concerns; exceptions to SMUD construction, maintenance or operating practices; engineering, construction or operational constraints; electric service supply problems; and other considerations specific to a site.
- 7.1.3** SMUD Staff will notify the Applicant if the SAF is initially accepted or rejected. If the SAF is rejected SMUD will identify the reason(s) for the rejection. In some cases, the Applicant may negotiate acceptable mitigation to SMUD's concerns, and the application may then receive approval. NOTE: Approval of the SAF and all associated materials allows the applicant to proceed with the facility design, but does not constitute SMUD authorization to install the antenna or any associated communication facilities.
- 7.1.4** After SAF approval, SMUD may forward certain SMUD information to the Applicant, such as: SMUD's existing facility design and construction drawings; available fault current at the existing site for the purpose of telecommunications design; Right-of-Way information; requirements for electric service; etc.
- 7.1.5** The Applicant shall develop and submit a proposed design for SMUD approval in accordance with Section 8 of this specification. During construction, deviation from the approved design will be cause to halt construction. The Applicant should inform SMUD inspector immediately of design/construction deviations from that which was approved. When applicable, SMUD staff will work with the Applicant to review and approve changes.
- 7.1.6** Following design approval, SMUD will develop a Site License Agreement (SLA) to be executed with the applicant.

7.2 WORK PLANNING, SCHEDULING AND CONSTRUCTION

Work scheduling and construction of antenna installations/modifications will be performed under the review of a Qualified SMUD Inspector. Before scheduling any work, the Applicant and/or its contractor must request a pre-construction meeting with SMUD Inspector. The Applicant will review the agreements and approved design, and supply a work plan to the inspector with additional information as follows:

- The identification of the facility at which the work is to be performed
- The reason for the work and type of work to be performed

- The applicant's primary contact including: name, company, phone number, and e-mail address.
- A proposed schedule showing the requested start dates, breaks, and end dates for:
 - Installation of the site's base station infrastructure, i.e. grounding, foundations, fencing, poles, etc., that does not require access to SMUD structures or substations.
 - Installation requiring access to SMUD structures, or substations, for construction.
- Names of the qualified line workers and/or qualified communication workers proposed to perform the work (with qualifications noted).
- Name of Applicant's field foreman directing work
- A complete set of SMUD approved design drawings and documents showing the proposed work with statement and seal per paragraph 8.1.2.
- Agreed upon conditions of service, construction, or maintenance that are specific to the site.

After reviewing the complete work plan submittal, SMUD Inspector will notify the Applicant if the proposed work plan is approved or not approved. The work plan will be approved if the submitted information is sufficient, the work can be safely performed, and the work has no unacceptable adverse effects on SMUD's electric system operations, and clearances can be obtained. If not approved, discussions between SMUD and the Applicant may take place to resolve any issues, including schedule changes.

SMUD Inspector will oversee the Applicant's installation work and coordinate schedules and clearances with SMUD Operating organizations. Regardless of work schedules and plans, SMUD may cancel work due to factors such as severe weather conditions or power system emergencies.

***** Please Note** – system conditions may prohibit the granting of electrical clearances required to perform the installation, or maintenance, of antennas. Summer load conditions may prohibit the granting of electrical clearances on key facilities for upwards of three months. *******

SMUD Inspector is authorized to order the Applicant to stop work and/or correct any work practices or construction which: endanger the safety of the work force, the public, or SMUD crews; that impact the reliability of the facility and/or power supply system; or is inconsistent with the approved design.

- 7.2.1** Only qualified communication line workers or qualified electrical workers are permitted to install, connect, maintain, and work on antennas installed on power supply poles, towers, and structures, located below the electric supply lines and in the telecommunication space, as defined per GO95.

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- 7.2.2** Only qualified electric line workers are permitted to install, connect, maintain, and work on antennas and associated equipment and apparatus installed on the power supply poles, towers, and structures located in SMUD's supply space, as defined per GO95.

7.3 BILLING AND PAYMENTS

7.3.1 License Fee

This is a monthly fee for the right to operate a particular site. The MLA and SLA further define this fee. SMUD will periodically bill the Applicant this fee with instruction on payment.

7.3.2 Other Fees

These fees are defined in the MLA to cover the cost of processing an Applicant's request. Typically these fees are for: Site License Agreement, Site License Extension, Process & Installation, Modification/Reconfiguration Application, Modification Structural Analysis, etc. The Applicant shall submit a check upon invoice, payable to the Sacramento Municipal Utility District. Note the process (MLA, SAF, MRA, etc.) and specify the SFI on the check.

7.3.3 Cost Reimbursements

SMUD will invoice the Applicant for Cost Reimbursements, as provided in the MLA, with instructions on payment.

7.4 FACILITY TITLE TRANSFER TO SMUD OWNERSHIP

When the installation of an antenna on a SMUD facility requires replacement of the SMUD facility with a facility more appropriate for the installation of the communication antenna, the Applicant shall register title of the new facility through a bill of sale in the name of the Sacramento Municipal Utility District before the antenna is put into service.

8 DESIGN REQUIREMENTS

8.1 GENERAL REQUIREMENTS

8.1.1 Professional Engineers Responsibility

The Applicant's design documents, drawings and pertinent calculations shall be approved, signed, dated, and sealed by a State of California registered professional engineer(s) in their respective field of expertise for the electrical, civil, or structural designs. The engineer(s) shall incorporate applicable Codes, Standards, and accepted sound engineering practices in the design.

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8.1.2 Code Requirements

Designs shown in drawings and calculations shall conform to the requirements of the latest editions of the California General Order 95 (GO95), the California Electric Code, and the National Electric Safety Code IEEE C2 (NESC). All design documents shall be annotated with the following affirmation of the Professional Engineer responsible for the design "I Name of PE affirm that the design presented in this document meets the requirements of the latest editions of GO95, the California Electric Code, the NESC and NEC".

The NESC latest edition addresses the installation of antennas on electric utility facilities. All pertinent areas of the NESC shall apply with special attention directed to paragraphs 224, 235C, 235F, 238, 239G, 239H, sections 22, 41, and 44. Conflicting requirements may exist between GO95 and the NESC. The Applicant's design shall resolve all conflicts by meeting the more stringent code requirements, with recognition that SMUD facilities are built following the California requirements of G.O. 95. All conflicts shall be brought to the attention of SMUD's Program Manager with the Applicant's proposed resolution in writing.

8.1.3 SMUD Facility Identification

SMUD's Facility Identification shall be clearly shown on every drawing and document.

8.1.4 Guidelines for Selecting a Distribution Pole for Antenna Installation

Items to consider during the selection of a distribution pole location for installing an antenna:

- 8.1.4.1 Maintain minimum pole height to accomplish antenna function while minimizing visual impact. If a wood pole is selected for antenna location, it shall be replaced by a steel pole designed to accommodate all existing conductors and attachments as well as all proposed antennas and appurtenances.
- 8.1.4.2 When possible, select a pole supporting only secondary voltage and communications conductors.
- 8.1.4.3 When a pole that supports primary voltage (12 kV or 21 kV) will be selected, consider poles carrying small diameter wires built in tangent configuration (i.e. no dead-ends, guy wires, or corner poles), and a single cross-arm. The pole should not support other power distribution equipment, such as fused cutouts, switches, capacitors, transformers, risers, etc.

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8.1.4.4 Installation on poles where SMUD primary voltage exceeds 21 kV should be avoided for several reasons: 1. The risk exposure to communication equipment and workers increases with voltage. 2. Design clearance requirements are more stringent, making installation more costly. 3. SMUD operational clearance availability may be limited, or seasonally dependent.

8.1.4.5 Ease of access to the proposed antenna location is highly desirable to allow for the maintenance and repair of equipment. Locations along streets or alleys are best. Back yards should be avoided if at all possible, as well as locations adjacent to fences, landscaping, or other obstructions.

8.2 DESIGN REVIEW BY SMUD

8.2.1 Submittals

Transmittal letters shall accompany all design document and drawing submittals, and shall include the following information:

8.2.1.1 Company name, date mailed, and responsible contact person together with contact's phone, e-mail, and postal mailing address.

8.2.1.2 SMUD's Facility Identification

8.2.1.3 Purpose of document transmittal, e.g. for approval, to record as built documents, etc.

8.2.1.4 **Listing of Documents transmitted containing the following information for each document:**

- ID number for Drawing or Document
- Title for Drawing or Document
- Revision for Drawing or Document

8.2.2 Design Criteria

The approvals of the design drawings, calculations and specifications shall include at least the following information, where applicable:

8.2.2.1 Structural calculations of the structure on which the antenna is to be installed.

8.2.2.2 Structure layout showing antenna, antenna cable installation, and all related equipment on the structure. Show these structural additions and modifications as an integral part of the existing structural layout and detail drawings.

8.2.2.3 Base station plan and elevation equipment layout.

8.2.2.4 Description of vertical cable and cableway passing through the supply space, including the maximum possible operating voltage to ground.

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- 8.2.2.5 Site plan and topography.
- 8.2.2.6 Fencing and gate layout and details.
- 8.2.2.7 Meter and accessory panel layout and installation details.
- 8.2.2.8 Lighting details (where applicable).
- 8.2.2.9 Power service one line and schematic drawings.
- 8.2.2.10 Grounding calculations, plan, and details.
- 8.2.2.11 Service design details.
- 8.2.2.12 Lists of all RF transmit frequencies.
- 8.2.2.13 In case of increase in pole/tower height, FAA compliance must be provided, including a copy of FAA Form 7460-1.
- 8.2.2.14 **A fully dimensioned plan and elevation views of the RF radiation patterns at the proposed site showing the FCC MPE guideline limits for Specific Absorption Rate (SAR). A single three-dimensional view, with dimensions, would be acceptable.**

8.2.3 Electronic Submittals

Drawings and other submittals should be provided in electronic format. This will facilitate a timely review by SMUD. Transmittal by e-mail will expedite the processing between the Applicant and SMUD as well as within SMUD. All drawings shall be in Adobe® (.pdf) formats. Documents shall be in Word® (.docx), Excel® (.xlsx), or Adobe® (.pdf) formats. Digital photographs should be (.jpg) format. The drawings, documents and photographs may be zip compressed for e-mail transmittal.

8.2.4 Approval Process

- 8.2.4.1 SMUD's technical staff will review submittals. The applicant will be notified by e-mail of required changes for submittals that are not approved.
- 8.2.4.2 Submittals meeting SMUD's requirements will be signed as approved. SMUD approvals shall be considered valid for a period of one year.
- 8.2.4.3 The Applicant may revise design submittals that are not approved. The Applicant shall incorporate all **SMUD** requirements in all documents of the revised submittal package. The Applicant shall resubmit the whole revised package as described above.

8.3 STRUCTURAL DESIGN

8.3.1 Design and Analysis

A Civil Engineer, licensed in the State of California and acting on behalf of the Applicant, shall perform Structural design and analysis on each SMUD

tower, pole, or structure designated for the attachment or addition of antennas and/or antenna mounts. All drawings and calculations shall be “sealed” by the engineer performing the design and analysis. The design and analysis shall conform to the rules and provisions of ASCE 10-latest edition “Design Latticed Steel Transmission Structures” for Latticed Towers; ASCE 48-latest edition “Design of Steel Transmission Pole Structures” for steel poles; California General Order 95 (GO95) and NESC pertaining to strength, working and electrical clearances, load factors, and safety factors for poles and towers. Loads applied to poles and towers due to antennas and antenna supports shall be in accordance with ANSI/TIA/EIA-222, latest revision. Loads applied to the poles and towers from wind, conductor and cable shall be in accordance with GO95 and NESC. The applicant may design to more stringent criteria to ensure the reliability, operability and/or protection of the antenna and associated equipment.

Refer to SMUD specification SS0204 – Tubular Steel Poles for additional detailed requirements.

8.4 CLEARANCES

8.4.1 Physical Clearances

Antenna, antenna cables, cableways, and all associated hardware shall be installed to maintain clear and safe clearances, climbing space, and working space. The installation shall enable SMUD crews to easily remove, install, and maintain the aerial wires, cables, and insulators and other apparatus installed on power delivery poles, towers, and/or structures. The requirements for all joint pole partners or leased attachment must also be accommodated.

8.4.1.1 Working Space

SMUD crews may be required to perform work to change, maintain, and modify supply wires and cables, insulators and other equipment located on facilities. SMUD crews may climb a tower, pole, or structure to access this equipment. Lift buckets may also be used to access equipment located on the towers or metal poles. The Applicant shall not place any antenna, or associated equipment such as antenna cable ladder(s), cableway(s), or any other antenna associated hardware so as to encumber this access. Drawings shall show sufficient detail so that SMUD is able to confirm that this requirement is met. GO95 climbing and working space shall be maintained.

8.4.1.2 Whip Antenna Danger

Whip antenna wire tips shall be made easily visible and the tips covered.

8.4.1.3 Antenna RF Radiation Danger and Service Disconnect

Radiation from the antenna must be within the limits defined in US OSHA regulations 1910.97 paragraph (a) (2) (ii). If not, the antenna shall be moved a distance from the supply line and shield wire area so that acceptable limits are obtained on the tower at a distance of ten feet above these lines and wires. The Applicant shall install an appropriate RF caution sign (refer to US OSHA regulations 1910.97 paragraph (a) (3) (iii)) at the base of the pole where these limits can be exceeded. See Section 8.7.4 for RF Caution sign specification.

SMUD may disconnect service to antenna installations, without notice, when performing operational or maintenance activities that require SMUD personnel to work above ground level in the vicinity of the antenna. If the service cannot be easily disconnected at the antenna site, e.g. the service is at a remote location, or will not immediately de-activate the antenna, the applicant shall provide an appropriate visible disconnect means (switch) that shall be clearly identified and accessible to SMUD personnel. Provisions shall be made to install a SMUD padlock on the switch to prevent public access but ensure SMUD accessibility. In no case shall the applicant apply a lock to prevent SMUD access.

8.4.1.4 Antenna Electric Touch Potential Danger

If any exposed antenna part is operated at a potential that might cause a muscular reaction when touched, the Applicant shall install a warning sign reading "HAZARDOUS ANTENNA VOLTAGE." This sign shall be installed at the base of the pole where the danger exists. See Section 8.7.3 for Hazardous Antenna Voltage specification.

8.4.1.5 Clearances from Power Conductors

i Antennas Placed Below Supply Conductors

Any equipment installed below the supply conductors shall follow the minimum clearance requirements per G.O. 95 Sections 92.1-F2 and 94.4-A, which shall be 6 feet (72 inches) from the supply conductors for 21kV and below. For 115kV and 230 kV supply conductors, the minimum clearance requirements shall be 10 feet (120 inches) or per NESC Table 238-1, whichever is greater.

- ii **Antennas Placed Above Supply Conductors**
 Minimum distance from the line conductor to the antenna, or its connecting cables, shall meet the requirements of GO95 Table 2, Case 21 and the appropriate column.
- iii **0 - 21 kV Clearance**
 See Section 9.6 DISTRIBUTION STEEL POLE
 TYPICAL ANTENNA REQUIREMENTS
- iv **115 kV Clearance to line conductor**
 120 inches
- v **230 kV Clearance to line conductors**
 120 inches

8.5 GROUNDING

Grounding design for antenna installations shall be consistent with this specification, including the attached drawings as appropriate. These requirements provide for safety at the location of antenna equipment in the case that power supply conductors discharge to ground (ground fault) through the transmission, substation, or distribution facilities, antenna structures or associated equipment. Without such grounding provisions, a ground fault could result in dangerously elevated ground potential voltage gradients.

Grounding requirements for transmission and substation facilities are based on Substation Grounding Standard IEEE 80, and case studies of ground grid performance. The Applicant shall apply grounding requirements from IEEE 80 standard and GO95. For a sample calculation, see Section 9.9 SAMPLE GROUNDING CALCULATIONS.

Industrial and communication grounding practices (refer to CEC and IEEE Green Book Std. 142), as well as the requirements of inspection authorities, compliment these specific grounding requirements.

Grounding designs for transmission and substation facilities have been successfully analyzed while varying the parameters of earth resistivity and available fault current in the following cases:

PARAMETER	UNITS	CASE 1	CASE 2	CASE 3
Earth Resistivity	Ohms/M	≥ 100	≥ 40	≥ 25
Max available S.C. Symmetrical Current	kA	≤ 5	≤ 15	≤ 25

In all cases asphalt resistivity is assumed greater than 100,000 ohms / Meter.

At antenna sites where these parameters vary significantly from those in the case studies, the grounding design will require further analysis by SMUD to establish requirements.

At antenna sites within SMUD substation facilities, applicant shall conduct, at applicant's cost, an assessment of and, if required, provide recommended modification of the existing substation ground grid. SMUD will evaluate and, if approved, perform the recommended modification of substation ground grid at applicant's cost.

8. 6 FENCING AND GATES

Where installation of an antenna and base station contributes to making a tower or pole climbable by non-utility workers, refer to NESC article 217A2, the Applicant shall install a fence and gate around the tower or pole and the associated base station.

Where the antenna will be installed in a SMUD substation, the Applicant shall install chain link fence to isolate its leased area from all SMUD operated equipment. The Applicant shall install exterior access gates to permit its personnel to enter its leased area without entering the area for SMUD operated equipment.

Chain link fence and gate installations shall meet the requirements of the, SMUD's Engineering Specification SS6001 – CHAIN LINK FENCE. Walls may be installed to accomplish the functions provided by exterior chain link fence. The applicant may request SMUD to provide typical wall designs acceptable to SMUD All wall and fence designs are subject to SMUD approval.

A chain used together with SMUD and Applicants pad-locks shall lock the gates accessing the Applicant leased area. SMUD and Applicants pad-locks shall be connected in tandem so that unlocking either lock will allow the gate to be opened.

8. 7 SIGNAGE

The Applicant shall provide all signs in accordance to the requirements of ANSI standards Z535-1, 2, 3, 4, and 5. Signs shall be installed in locations that do not obstruct climbing. Sign locations shall be shown in drawing submittals.

8.7.1 Keep Out Gate Sign

Install a KEEP OUT sign on the gate facing outward. The sign shall read and be constructed per Section 9.1 KEEP OUT!! GATE SIGN.

8.7.2 Antenna Workers Notice Sign

Fasten an ANTENNA WORKERS NOTICE sign to the inside side of the fence at a point easily visible and near the pole or tower. If no fence is required at the antenna installation, install the sign on the pole or tower. The sign shall read and be constructed per Section 9.2 ANTENNA WORKERS NOTICE SIGN, with the specific location specified.

8.7.3 HAZARDOUS ANTENNA VOLTAGE SIGN

When required by Section 8.4.1.4, fasten a HAZARDOUS ANTENNA VOLTAGE sign to the inside of the fence at a point easily visible and near the pole or tower. If no fence is required at the antenna installation, install the sign on the pole or tower. The sign shall read and be constructed per Section 9.3 HAZARDOUS ANTENNA VOLTAGE SIGN.

8.7.4 RF CAUTION SIGN

When required by Section 8.4.1.3, fasten a RF CAUTION sign on the inside of the fence at a point easily visible and near the pole or tower. If no fence is required at the antenna installation, install the sign on the pole or tower. The sign shall read and be constructed per Section 9.4 RF CAUTION SIGN.

8.7.5 RF GUIDELINE NOTICE

Fasten an RF GUIDELINE NOTICE sign to the inside of the fence at a point easily visible from the pole or tower. If no fence is required at the antenna installation, install the sign on the pole or tower. The sign shall read and be constructed per Section 9.5 RF GUIDELINE NOTICE.

8.8 ELECTRIC SERVICE

The electric service for the antenna installation shall meet the minimum requirements set forth in SMUD's Rules and Regulations. In addition to these requirements, the area three feet around power cabinets and telephone cabinets shall be surfaced with a three-inch thick asphalt cover. SMUD shall not be liable for damage to Applicant's equipment or communications issues that may result from fault current, ground potential rise, or other physical or electrical events that may occur in proximity to its power delivery facilities.

8.8.1 SERVICE TO ANTENNAS LOCATED ON HIGH VOLTAGE TRANSMISSION LINE STRUCTURES (115kV and Higher Voltage)**General Information**

Special design precautions must be taken when providing 120/240 V or 277/480 V electric service to cellular antennas that are located on high voltage transmission towers and poles. The antenna base station is typically located on a concrete pad located directly under, or adjacent to, the high voltage structure. There is a direct metallic path from the antenna to the base station equipment ground bus, which is also connected to the utility service neutral and ground. Should a fault occur on the transmission structure, fault current and voltage can transfer to the service panel and the service conductors. Normal construction practices for service installations may not adequately protect personnel that are standing on the ground in contact with the service panel. During fault conditions these personnel could be exposed to "touch voltages" in excess of allowable safe limits. The following design practices shall be employed to improve the safety of the service design for workers and the public:

1. Determine the worst-case ground potential rise (GPR) based upon the available fault current to be quoted by SMUD and the local earth resistivity. The worst-case GPR value shall be submitted to SMUD, with the site-specific grounding design.

2. If the primary distribution system from which the cell site will be served is not solidly multi-grounded, and the predicted GPR is above 12 kV symmetrical, then one of the following design options shall be implemented. Also, SMUD may require one service design or the other, depending upon local conditions or constraints.

A. Dedicated Transformer - To ensure that no other customers share the service neutral connection with these cell sites, a dedicated service transformer shall be installed. The meter must be located on the base station equipment pad with enough clearance around the meter to ensure that personnel who can touch any part of the metering enclosure shall be standing on the equipment pad.

B. Isolation Transformer - If the SMUD service transformer will serve multiple customers or more than one cell site, the applicant must install a ground isolation transformer of adequate rating on the base station pad. The service panel shall be isolated from any/all parts of the base station or transmission structure or ground grid, by a minimum of 50 feet.

Exception: Isolation transformers are not available to accommodate GPR greater than 45,000 V. In these cases, a dedicated service transformer is required. Where service cannot be provided in an acceptably safe manner, SMUD will not allow the installation of a cell antenna at the site.

3. If the GPR is less than 12 kV symmetrical, or if the primary distribution system from which the cell site will be served is a solidly grounded, the site is treated as a SMUD Rule 16 service, except that the service pedestal is required to be placed on the equipment pad of the base station or on a separate pad, electrically connected to the ground grid of the base station, and large enough to ensure that personnel will be standing on the equipment pad when they touch the panel.

4. SMUD Rule 2 special facility charges shall apply to SMUD expenses required to serve the antenna with a dedicated transformer, including the cost to extend primary service to provide power to the antenna location.

5. If multiple cell antennas occupy a single transmission structure, they can share a common ground grid and service facilities. If cell antennas are installed on two adjacent transmission structures, supporting the same transmission circuits, they can share a common ground grid and service facilities.

6. Cell antennas installed on transmission structures that support different transmission circuits shall not share the same service or base station ground grid.

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7. Isolation transformers must have BIL ratings in excess of the predicted GPR for the quoted transmission fault. The high side bushings of the transformer shall not be connected to the case or ground in any manner. Secondary cables and neutrals shall be isolated from ground and run in Schedule 40 PVC conduit to the meter location. There shall be no ground connection between the cell equipment and the electric meter service pedestal.

8. Any deviation from these guidelines shall require SMUD approval. A specific design and associated engineering analysis shall be submitted to confirm touch and step protection to personnel working in the vicinity of the meter panel or cell site equipment.

9 WARNING SIGNS & DRAWINGS

- 9.1** KEEP OUT!! GATE SIGN
- 9.2** ANTENNA WORKERS NOTICE SIGN
- 9.3** HAZARDOUS ANTENNA VOLTAGE SIGN
- 9.4** RF CAUTION SIGN
- 9.5** RF GUIDELINE NOTICE
- 9.6** DISTRIBUTION POLE TYPICAL ANTENNA REQUIREMENTS
- 9.7** TYPICAL TOWER GROUNDING DETAIL
- 9.8** TYPICAL SUBSTATION ANTENNA REQUIREMENTS
- 9.9** TYPICAL GROUNDING CALCULATIONS



9.1 KEEP OUT!! GATE SIGN

Make sign from 18 gauge steel with Porcelain Enamel finish, Red "Danger" header with all other copy and symbols black on white background, size 8.5" x 14", 4 holes with 1/2" I.D. brass grommets, located 1/2" in from each corner, (Standard Sign Blank). Electromark part No. SMD051-W-ZD-AN2 or approved equal.

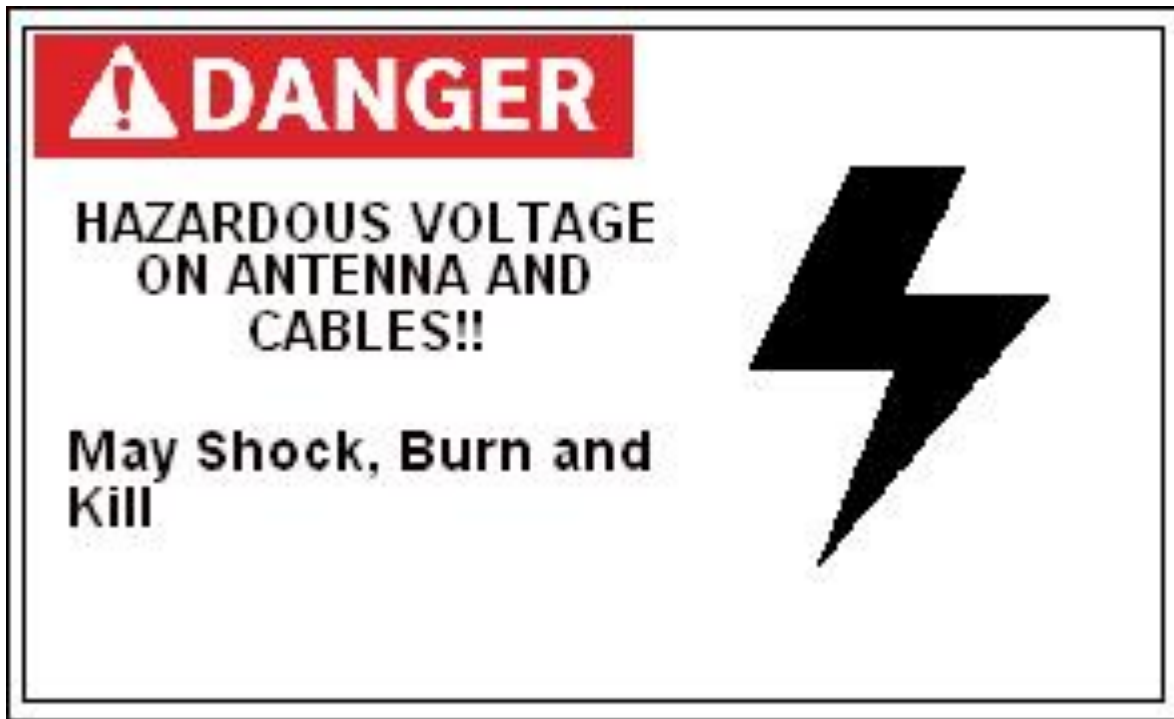


9.2 ANTENNA WORKERS NOTICE SIGN

The Applicant shall complete LOCATION letter placeholder with numbers provided by SMUD. Make sign from 18 gauge steel with Porcelain Enamel finish, Blue "Notice" header with all other copy and symbols black on white background, size 8.5" x 14", 4 holes with 1/2" I.D. brass grommets, located 1/2" in from each corner, (Standard Sign Blank). Electromark part or approved equal.

VARIATIONS:

Substitute the word pole for tower as appropriate.
At distribution poles do not include information after WWWW



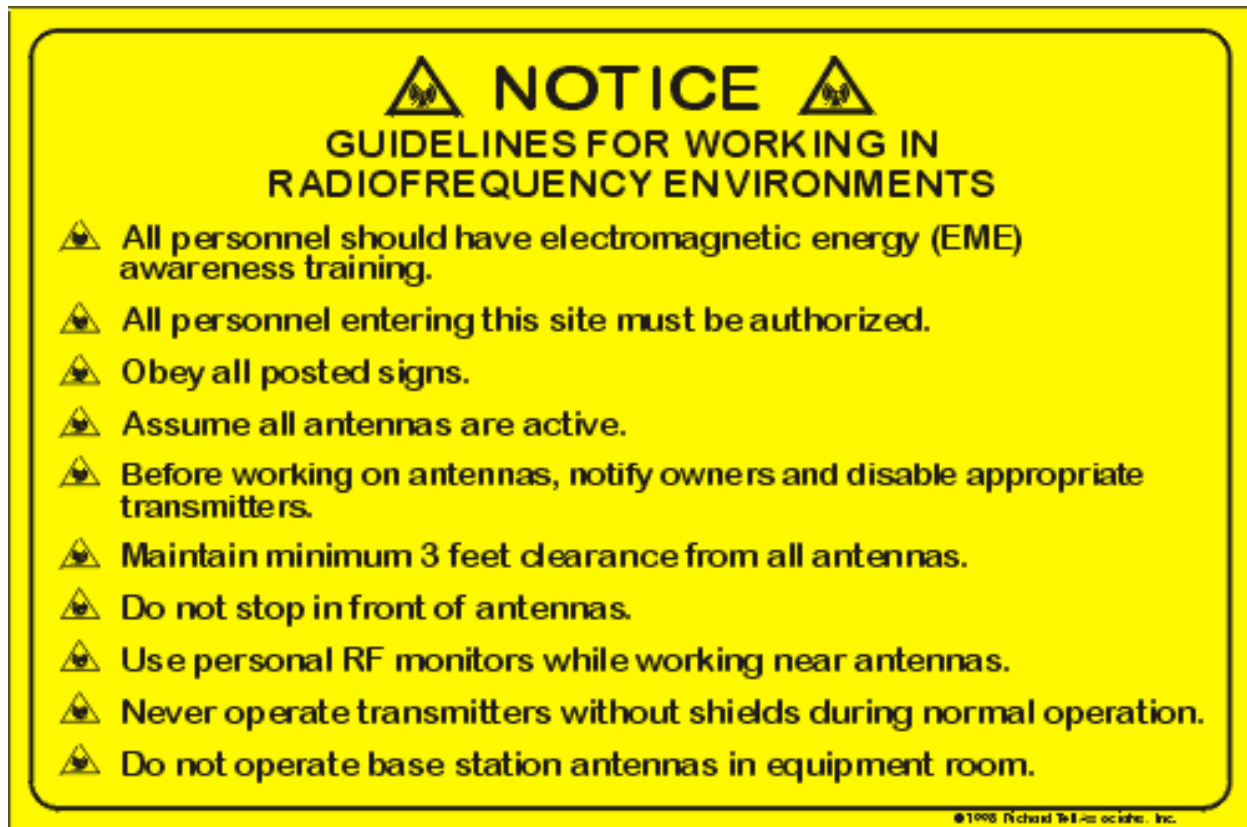
9.3 HAZARDOUS ANTENNA VOLTAGE SIGN

Make sign from 18 gauge steel with Porcelain Enamel finish, Red "Danger" header with all other copy and symbols black on white background, size 8.5" x 14", 4 holes with 1/2" I.D. brass grommets, located 1/2" in from each corner, (Standard Sign Blank). Electromark part No. SMD049-W-ZD-AN2 or approved equal.



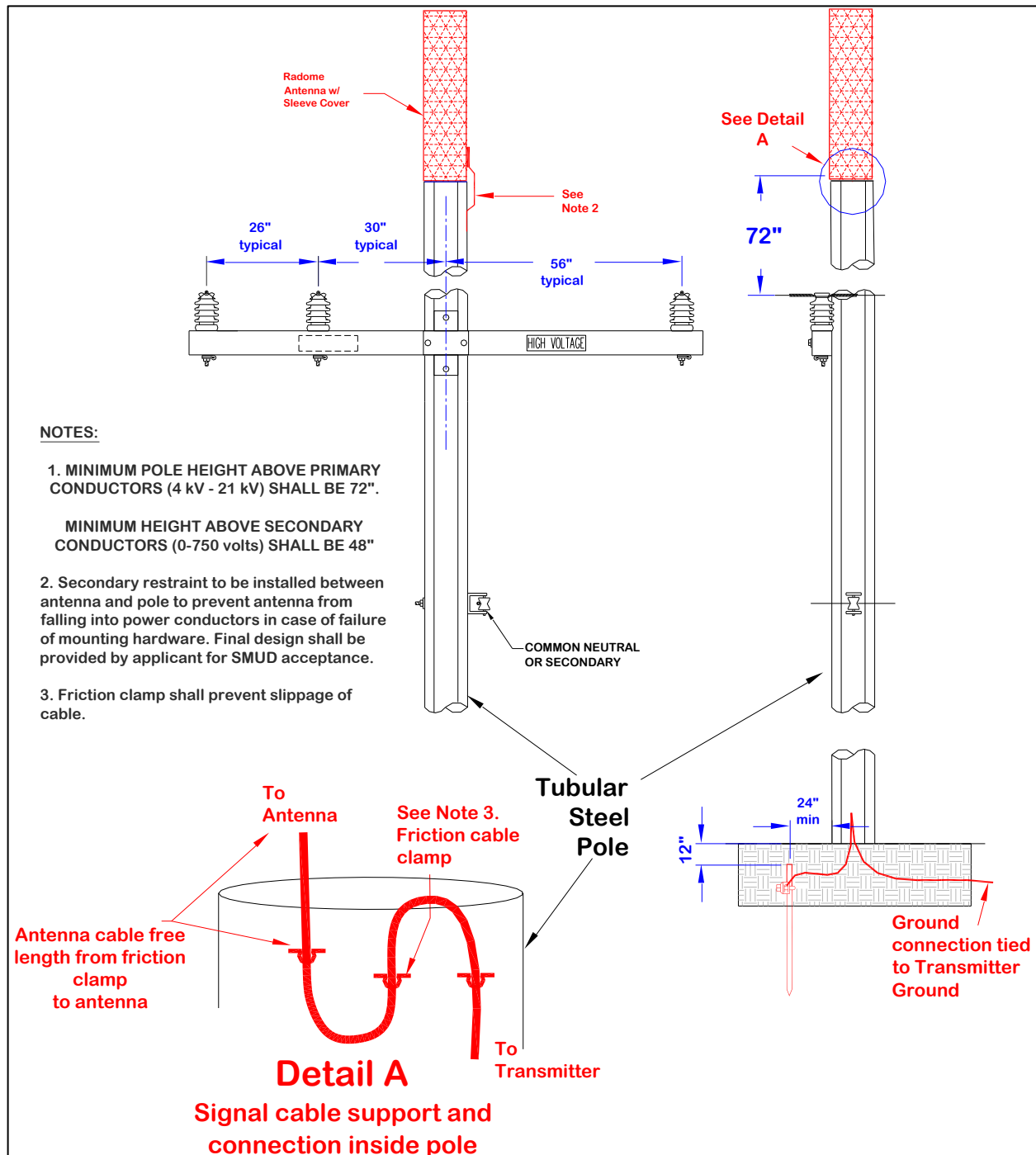
9.4 RF CAUTION SIGN

Sign 12"X18" aluminum panel with rounded corners and holes located near each of the four corners for convenience in mounting. Manufacture the sign with a special UV resisting coat applied to the surface to increase longevity in outdoor environments. TESSCO part No. 43875 or approved equal.

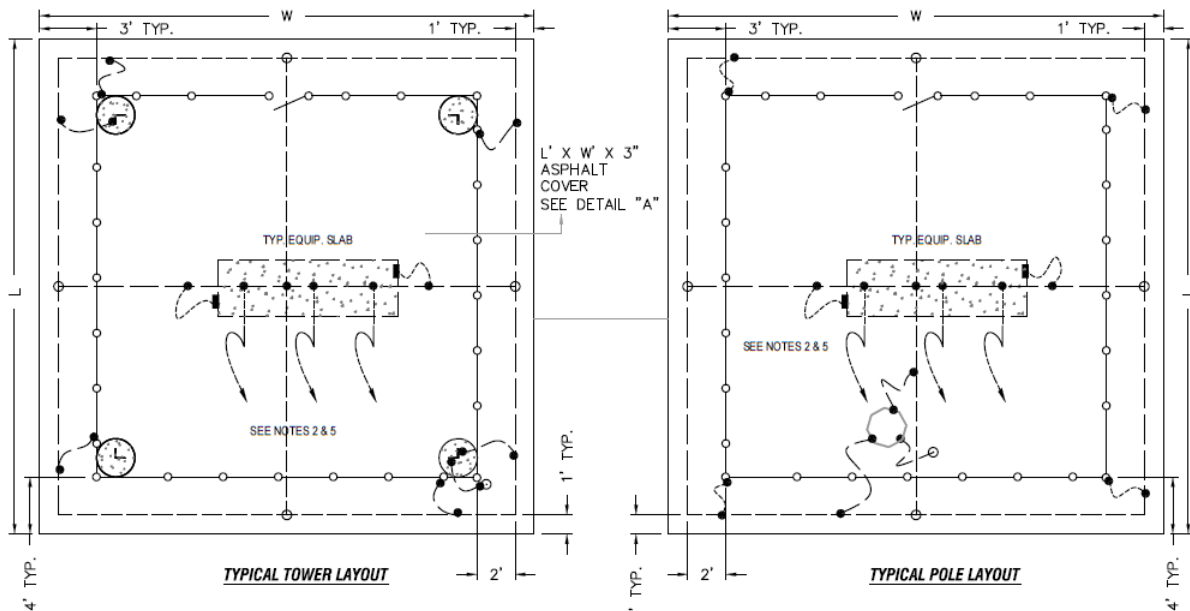


9.5 RF GUIDELINE NOTICE

Sign 12"X18" aluminum panel with rounded corners and holes located near each of the four corners for convenience in mounting. Manufactured the sign with a special UV resisting coat applied to the surface to increase longevity in outdoor environments. TESSCO part No. 68796 or approved equal.

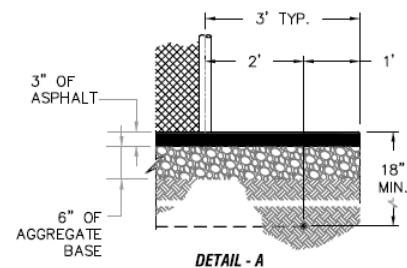


9.6 DISTRIBUTION STEEL POLE TYPICAL ANTENNA REQUIREMENTS



NOTES:

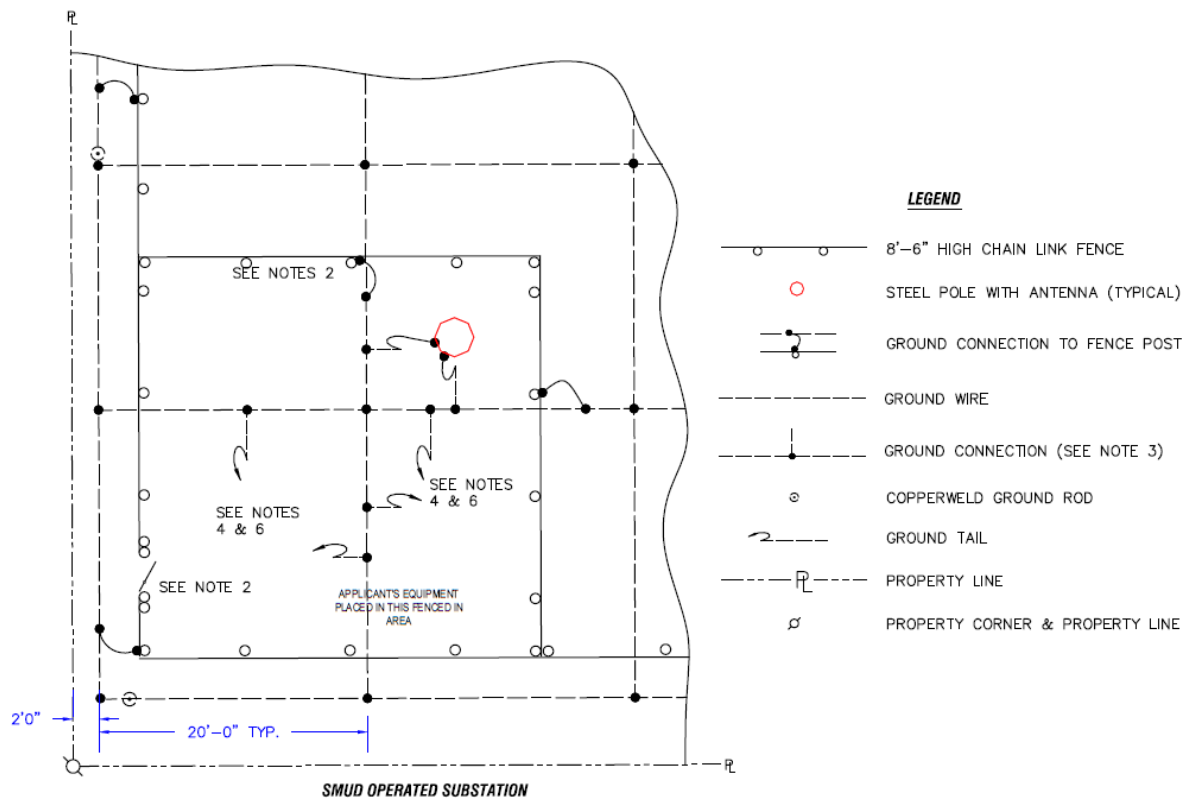
- 1) Three inches of asphalt base to be placed over 6" aggregate base (see Detail A). Asphalt material and placement shall be in accordance with section 39 of the State of California, Department of Transportation CALTRAN Standard Specifications. Aggregate gradation shall be 3/4" maximum. Abut asphalt cover to concrete pad provided for applicants equipment.
- 2) Applicant's concrete pads shall contain #4 minimum rebar with a 1'-0" maximum grid spacing. All rebar intersections must be securely tied together. Connect concrete pads to ground grid at at least two points.
- 3) Ground conductors to be buried at least 18 inches in compacted earth..
- 4) Applicant to provide easement rights and / or lease for property to install all required facilities.
- 5) Applicant to connect ground conductors to antenna and base station equipment per Industrial and communication grounding practices (refer to NEC, IEEE Green Book STD.142, EIA and TIA standards).
- 6) Eight foot 5/8" Diameter copper clad ground rods shall be driven from base of ground conductors trench.
- 7) Ground tails to attach to lower legs above ground at two (2) locations.



LEGEND

- ASPHALT EXTREME
- CHAIN LINK FENCE
- 4/0 CU. GROUND CONDUCTOR
- GROUND ROD
- ⊙ TOWER LEG WITH CONCRETE FOUNDATION
- BASE STAT. EQUIP. AREA
- EQUIPMENT PAD
- GROUND TAIL FOR ATTACHING REBAR OR EQUIPMENT.
- GROUND ATTACHMENT WITH CONNECTOR
- STEEL POLE WITH ANTENNA (TYPICAL)

9.7 TYPICAL ANTENNA REQUIREMENTS AT A TOWER



NOTES

- 1) Antenna should be located so as not to block removal, installation, or maintenance of equipment in SMUD operated substation area.
- 2) Applicant shall install chain link fence between SMUD operated substation and antenna facilities. Applicant to install gate in exterior fence to give access to antenna and base station area.
- 3) Ground connector for substations with highest voltage of 69 kV or less are compression type (use SMUD Standard C917 - ELECTRICAL GROUNDING). Substations that operate at voltages greater than 69 kV shall utilize thermal weld type connectors (use connector manufacturer's instructions and latest IEEE 80).
- 4) Applicant to connect ground grid to his antenna and base station equipment per industrial and communication grounding practices (refer to CEC, IEEE Green Book Std. 143, EIA and TIA standards).
- 5) Applicant to consult with SMUD regarding location and variations from typical details as shown here.
- 6) Concrete pads for equipment shall contain #4 minimum rebar with a 1'-0" maximum grid spacing. All rebar intersections must be securely tied together. Connect concrete pad rebar to ground grid at least two points.
- 7) Ground grid cable shall be minimum #4/0 Cu buried at least 18 inches in compacted earth.
- 8) Existing ground cover in substation to be continued in leased area.
- 9) Applicant shall conduct an assessment of and, if required, provide recommended modification of the existing substation ground grid at applicant's cost.
- 10) SMUD will evaluate and, if approved, perform the recommended modification of substation ground grid at applicant's cost.

9.8 TYPICAL ANTENNA REQUIREMENTS AT A SUBSTATION

GROUNDING SPECIFICATION:

Maximum Grid Voltage Rise: 5000 V

Maximum Resistance: 5 Ω

Maximum Step Potential: $E_s = (165 + \rho)/t^{0.5}$

Maximum Touch Potential: $E_T = (165 + \rho/4)/t^{0.5}$

$$E_s = (165 + \rho)/t^{0.5} = (165 + 345)/3^{0.5} = 295 \text{ V (allowed for 3 sec.)}$$

$$E_T = (165 + \rho/4)/t^{0.5} = (165 + 345/4)/3^{0.5} = 145 \text{ V (allowed for 3 sec.)}$$

$$I_L = 34,800 \text{ d.L}/(\rho t)^{0.5} = [34,800(0.475/12)(1)]/[345(3.28)(3)]^{0.5}$$

$$I_L = 23.64 \text{ A-Ft. (max per linear foot of #4/0 \& } \rho \text{ of 13 } \Omega\text{-meter)}$$

$$I_F \text{ Max} = 20,000 \text{ A (provided by SMUD)}$$

$$L = I_F \text{ Max} / I_L = 20,000 \text{ A} / 23.64 \text{ A-ft.} = 846 \text{ ft.} = 258 \text{ m}$$

$$R = [\rho/4\pi L] (\ln 4L/a + \ln 4L/s - 2)$$

$$R = [345/4 \cdot \pi \cdot 258] \{ \ln [(4)(258)/(0.006)] + \ln [(4)(258)/(0.46)] - 2 \}$$

$$R = 1.89 \Omega$$

9.9 SAMPLE GROUNDING CALCULATIONS