



T-Mobile Towers Co-Location Construction Standards

Dated: June 2009

The T-Mobile Towers Co-Location Construction Standards are intended to govern any “on site” Construction activities by all tenants and their contractors and subcontractors, on all T-Mobile Tower owned sites.

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1. APPROVALS AND GENERAL PROCESS

A. Preliminary Approval

1. Upon preliminary approval of application, a preliminary site walk shall be preformed with T-Mobile and tenant to identify location of tenant's equipment.
2. All Architectural, Engineering, Structural, Site Equipment Layout, Electrical, Mechanical and Zoning blue prints must be reviewed and approved by a T-Mobile Tower Project Manager (PM) prior to permitting and pre-construction activities.

B. Pre Construction

1. Upon execution of a lease document, a pre-construction site walk shall be preformed with T-Mobile PM, the tenant, and the General Contractor (GC) performing the work.
2. Tenant should supply a copy of approved stamped building permit drawings and permit card.
3. Tenant shall provide all Notice to Proceed (NTP) checklist items, including a detailed schedule outlining each construction activity, including the projected construction start and completion dates.
4. GC shall be a T-Mobile approved vendor or approved through the T-Mobile Tower PM and/or proper market representative in writing.

C. Construction

1. No Construction will begin without a signed and valid T-Mobile Towers NTP. In order to receive an NTP, the following items must be completed at a minimum:
 - a. Preconstruction walk with the T-Mobile Towers PM, on site. The GC performing the work must be present on this walk. The Carrier Representative should also be available for this walk.
 - b. T-Mobile Towers' approval of building permitted Construction Drawings.
 - c. T-Mobile Towers' receipt of all NTP checklist items.
 - d. Signed and executed lease document between T-Mobile and Tenant.
2. T-Mobile's PM must be notified 48 hours prior to construction start.
3. The T-Mobile Regional Network Operations Center (NOC) must be notified 24 hours prior to construction start, and on each day construction activity is taking place until completion.

D. Post Construction Requirements

1. The T-Mobile Tower PM will be notified when construction is complete, defined as:
 - a. All ground equipment installation complete; the T-Mobile lease area has been restored to previous physical condition: all gravel, blacktop, concrete, etc, has been restored or replaced to match.
 - b. All tower work complete: antennas, lines, TMA's, etc. have been installed per the Approved Structural Analysis and T-Mobile Tower PM.
 - c. All electrical and Telco construction work is complete.
2. T-Mobile Towers will conduct a post construction walk to identify any "punch list" items. Any discrepancies in construction must be remedied within 7 days of punch list receipt. Photo documentation of completed punch list items will be submitted for approval by T-Mobile Tower PM. Once the T-Mobile Tower PM deems all punch list items corrected and complete, the site is ready for final acceptance.
3. Tenant is required to provide the following Close Out Documents within 10 days of construction complete:

INITIAL APPLICATIONS:

 - a. Redline Construction Drawings (CDs) or As-builts
 - b. Final Inspection Reports (electrical, building, and/or zoning)
 - c. Notice of Construction Complete
 - d. Site Photos
 - e. Tape Drop / Height Verification

MODIFICATION APPLICATIONS:

 - a. Notice of Construction Complete
 - b. Final Inspection Reports (electrical, building, and/or zoning)
 - c. Site Photos

2. SAFETY AND COMPLIANCE REQUIREMENTS

A. Protection Of Persons And Property

1. The Tenant including their GC and subcontractors shall be responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with all work on T-Mobile Tower sites, and will comply with all applicable state and federal laws, ordinances, rules, and regulations, including OSHA.
2. The Tenant, their GC and subcontractors shall ensure that no unauthorized personnel (i.e., children, animals, etc.) shall be on the site and shall take all reasonable precautions for safety of, and provide reasonable protection to, and shall prevent damage, injury or loss to:
 - a. Employees on the Work Site
 - b. Other persons who may be affected thereby
 - c. Material and equipment to be incorporated therein
 - d. Other property at the Work Site or adjacent thereto
3. The Tenant, their GC and subcontractors shall be responsible for (at a minimum):
 - a. Implementation of Work Site specific fall protection plan
 - b. Implementation of a Radio Frequency safety program
 - c. Daily Work Site safety meetings
4. The Tenant, their GC and subcontractors shall have safety program in place addressing all applicable safety concerns and be able to furnish a copy to T-Mobile upon request.

B. Environmental

1. The Tenant, their GC and subcontractors shall comply with all applicable federal, state, and local environmental laws including, but not limited to:
 - a. The Resource Conservation and Recovery Act
 - b. The Clean Air Act
 - c. The Federal Water Pollution Act
 - d. The Toxic Substance Control Act
 - e. And the Federal Migratory Bird Treaty Act
2. The Tenant, their GC and subcontractors shall cooperate fully with T-Mobile Towers to promptly respond to, report, and remedying any threat of potential harm to the environment.

3. GENERAL CONSTRUCTION STANDARDS

A. Materials

1. All materials and products provided by general contractors and/or tenants will be new and of standard commercial quality.
2. All material utilized for coaxial cable and antenna support shall be hot dip galvanized or stainless steel and of a gauge that conforms to the telecommunications industry's standards of practice. These materials include:
 - a. Cable bridges and cable ladders
 - b. Cable sleepers
 - c. Antenna mounts (**note: chain mounts are not acceptable**). When possible, use mounts from tower manufacturer. Specification (Spec) sheets will be required.
 - d. Protective covers as dictated by T-Mobile Tower PM
 - e. All steel associated with any tower modification
3. All material necessary for Tenant's installation must be ready for installation and correctly identified prior to the commencement of construction. Upon request, tenant shall provide proof that all materials are 'on hand' prior to construction start.

B. Concrete

1. Proportions of concrete materials for any new pads shall be suitable for the installation method utilized and shall result in durable concrete resistance to the local anticipated aggressive actions. Concrete shall develop a minimum compressive strength of 3000 PSI at 28 days, or greater as local jurisdictions require.
2. Maximum Aggregate size shall not exceed $\frac{3}{4}$ inch. Slump is to be 2" to 5".
3. General Contractor shall take care when forming to prevent blow out.
4. General Contractor wash out shall not take place in the T-Mobile compound or on T-Mobile LL property.

C. Pads (Equipment/Generator/Transformer)

1. Pad steel or rebar will be deformed and conform to the requirements of ASTM A615 Grade 60, except ties which will be Grade 40.
2. Steel mesh shall conform to ASTM A185.
3. All pads will be located at least 36 inches away from existing tower foundation, and will not interfere with the existing ground ring, unless written authorization by T-Mobile Tower PM.
4. All pads will be located at least 4 feet away from any existing equipment, to include other tenant's equipment, transformers, or farther if required by code. If not required by code, the T-Mobile Tower PM can give exceptions for distance in writing.
5. All pads will be crowned to prevent standing water and will have a clean finish.

D. Compound Enclosure (Fences, block walls, etc)

1. All added fencing, block wall enclosure or gate will be built to match existing material, unless otherwise dictated by local jurisdiction and zoning requirements.
2. Any gates must be a minimum of 4 foot wide unless otherwise approved by T-Mobile Towers PM.
3. All new gates must have a secure latching mechanism and be affixed with a combination padlock.
4. If Tenant is installing their own lock, the lock must be interlocked or "daisy chained" into a separate chain link with the use of a hot dipped galvanized chain. The tenant's lock combination must be provided to T-Mobile at the Pre Construction walk.



E. Electrical/Telco

1. All electrical work shall meet BOCA, UBC, NEC, and all applicable local and state codes. All electrical materials shall be UL approved.
2. Materials will meet with approval of division of industrial safety and all governing bodies having jurisdiction.
3. Outdoor exposed conduit will be GRC or schedule 80 PVC with UV protected, unless noted otherwise.
4. Underground conduit will be schedule 40 PVC and buried as required by local code or utility companies.
5. Warning tape will be placed in utility trench 1 foot above conduit after inspection and before back filling. Photo documentation is required.
6. Any exterior outlets must be GFI protected.
7. Tenant's meter will be clearly and legibly labeled with the tenant's name, with a metal or plastic placard. **Marker, tape, or any other adhesive that will be prone to deterioration due to weather is not acceptable.**
8. T-Mobile Towers does **not allow permanent** power or Telco sharing, unless a written agreement is in place. Temporary power will be considered on a site by site basis, and upon approval of a temp power share agreement.

F. Excavation

1. Locates shall be called and marked prior to any construction or excavation starting on the site.
2. Pad site shall be cleared, grubbed, and stripped of organic laden topsoil to a minimum of 3 inches.
3. Hand digging will take place when the following conditions exist:
 - a. Within 3 feet of any other carrier's equipment
 - b. Within 3 feet of the tower base
 - c. Within 3 feet of known underground utilities
4. In the event existing utilities are damaged, **immediate** notification to the T-Mobile Towers PM and the respective utility is required. Tenant is responsible for the cost of all repairs as well as cost associated with loss to existing carriers if the damage is deemed service effecting. Tenant is also responsible for all costs associated with any temporary fixes such as Temp power, microwave shot, etc.
5. Loose material shall be removed from bottoms of excavation prior to concrete placement.
6. GC shall provide adequate shoring and bracing in accordance with all applicable safety ordinances, and as required to protect existing site equipment.
7. During the excavation process, all access must be kept clear. This includes access to existing equipment, tower, access roads, meter boards, transformers, etc.
8. It is **unacceptable** to leave any trenches open and unattended. Unattended trenches must be covered, in a safe manner at all times and per local code.
9. Any soil that is excavated and not used must be removed from site to a designated or prearranged area. No materials, soil, etc. will be stored on or moved to the T-Mobile Landlord's property without prior coordination with the property owner through the T-Mobile Towers PM unless Tenant has a separate ground lease.
10. Proper drainage in to and out of the T-Mobile compound must be maintained. No water will be diverted to existing equipment or cause rills inside or outside the T-Mobile compound. If this occurs, the tenant will be required to repair both the situation and any damage to the compound, existing equipment, tower foundation, etc.

G. Backfill and Restoration

1. Backfill shall be engineered materials and compacted to a 95 percent relative density in lifts not exceeding 8 inches with a moisture content of 2 percent above optimum.
2. Rock under foundations shall conform to BOCA requirements.
3. Site gravel shall match the existing inside the T-Mobile compound.
4. The T-Mobile compound and surrounding area will be restored to substantially the same condition as the site existed prior to construction. This includes inside the compound, around the compound and the access road and/ or any easements.
5. Filter Fabric will be positioned prior to placement of any finish site rock installation for roads, walkways or site compound areas.
6. Any LL or jurisdictional property improvements required or agreed upon by the tenant and the landlord or local jurisdictions will be finished and installed. The tenant is responsible for any maintenance to property improvements for the life of their lease.

4. TOWER MOUNTED EQUIPMENT

A. RF Antenna Separation

1. The **minimum** separation between T-Mobile and Tenant, tip to toe is 4 feet.
2. Intermod studies may be required.

B. Antennas/Microwave Equipment, LNAs etc

1. Installation of antennas, microwave equipment, LNA/TMAs, and associated mounting hardware shall be per manufacturers recommended standards of practice.
2. Only leased equipment will be installed on the tower, at the correct RAD center, on the approved mount, and per the approved T-Mobile structural analysis.
3. If it is discovered that the leased RAD center is obstructed, contact the T-Mobile Towers PM immediately in order to rectify the situation. In no circumstances should existing equipment be removed or new equipment installed at a different RAD center than listed in the lease unless T-Mobile Tower's written permission has been obtained.

C. Cable

1. When installing coax, existing tenant's antennas and coax will not be damaged. If damage or alteration of installation occurs, the T-Mobile Towers PM will be contacted **immediately**.
2. When coax is being installed on the outside of a monopole per the approved T-Mobile structural analysis, it must be distributed on the tower as defined in said analysis and banded every 4' with stainless steel banding and hangars.
3. On monopoles: coax inside will be dressed neatly inside the pole. **No new ports will be cut into the pole unless calculated into an approved SA.**
4. Coax will not interfere with:
 - a. Climbing pegs
 - b. Safety climb
 - c. Existing mounts, antennas, LNAs/TMAs, etc
 - d. Lighting
5. On self support towers (SSTs): coax will be clipped, banded or secured by the method outlined in the approved T-Mobile structural analysis and on designated face. All coax will be attached to the tower a minimum of every 4 feet.

D. Mounting

1. All mounting apparatus will be obtained from the original tower manufacturer when possible. Specification (Spec) sheets shall be provided to the T-Mobile Towers PM.
2. Mounts will be placed in such a manner not to impede safety climbs or climbing pegs.
3. The tower, existing coax and appurtenances should not be damaged by the placement of any new hardware. Any scratches or chips to the tower's paint or galvanizing will be repaired immediately.
4. All mounts will be hot dipped galvanized or stainless steel, and of a gauge that conforms to the current telecommunications industry's standards of practice.
5. If any damage to any appurtenance on the tower occurs, the T-Mobile Towers PM will be contacted **immediately**.
6. **Chain mounts are not acceptable in any situation on any T-Mobile Tower.**

5. COAX ROUTING THROUGH T-MOBILE COMPOUND OR LEASED AREA

A. Ice Bridges

1. The minimum clearance under the ice bridge, including coax, will be a minimum of 8 feet.
2. A clear and unobstructed access between ice bridge posts will be maintained, with a minimum of 4 feet of separation between posts and a maximum of 10 feet.
3. No ice bridge posts are to be placed:
 - a. In another tenant's lease area
 - b. In or on the tower foundation (without written consent from T-Mobile Towers PM)
 - c. In a place where it would impede access to shelters, cabinets, door swings or gates

B. Sleepers

1. All sleepers must be covered with a minimum of 16 gage galvanized sheet metal, or diamond plate if called out.
2. Yellow reflective tape shall be placed on the sides of sleepers to prevent tripping or injury.
3. If a sleeper is placed in an area where it is obstructing access to an existing tenant's equipment, a ramp access will be added were required by the T-Mobile Towers PM.

C. Underground Coax

1. Locates shall be completed to ensure there are no underground obstructions. The T-Mobile Towers PM will be notified immediately if an obstruction is encountered.
2. Any damage to existing underground coax or conduit will be the collocating tenant's responsibility to repair or replace.
3. All underground conduit shall be a minimum schedule 40 PVC and will be sealed on each end with either a cap, insulating foam or other acceptable method.

D. Wall Mounting

Note: Wall mounts in this section are referring to walls built and owned by T-Mobile ONLY.

1. All wall mounted coax should be inside a cable tray, or covered to protect from damage.
2. Attachments should be made every 4 feet to the compound enclosure walls.
3. Wall mountings are to be clear of any existing equipment, and will not impede any access.

6. GROUNDING (Refer to Section 13 for Complete Details)

A. Bonding Preparation and Finish

1. All surfaces require preparation prior to bonding of either exothermic welding or mechanical fasteners. Galvanized surfaces shall be ground or sanded to the point of exposing the steel surface below, prior to bonding the ground conductor. For other surfaces including copper buss bars all paint, rust, tarnish and grease shall be removed prior to bonding the ground conductor.
2. Exothermic type bond (except buss bars) shall be finished with the application of cold galvanization and when applicable, finish paint with an appropriate color as required. Mechanical type bonds on buss bars shall be finished with the application of Noalox or other approved conductive medium material.

7. TESTING

A. Reports

1. Tenant will provide copies of any special inspections required by jurisdiction.
2. Tenant will provide copies of third party test or certifications for:
 - a. Concrete break test
 - b. Rebar certifications
 - c. Welding inspections
 - d. Sweep test if T-Mobile antennas or lines have been modified
 - e. Ground Tests: Resistivity test to meet 5 ohms or less using Fall of Potential Method

8. NEW COAX PORTS

A. Requirements

1. Any new coax ports which need to be added to a tower must be approved by the T-Mobile Towers PM, and included in all structural analysis run by T-Mobile.
2. The new ports should be ordered from the tower manufacturer or equivalent and be engineered ports.
3. New ports shall be installed to the design specifications provided with the port, and added at the height designated on the T-Mobile approved structural analysis.
4. Holes for ports must be cut or ground- **never torched**.
5. Port installation to be completed per welding specifications, extra care to be taken to re-galvanize both the interior and exterior of the pole.
6. Steps must be taken during all phases of installation of the new ports to protect the existing coax in the pole, the pole itself, and the surrounding area. This protection can be provided by utilizing coax blankets, fire watches, etc.
7. New ports will not be installed within five (5) feet of a slip joint per engineers' specifications. If there are any issues regarding this, the T-Mobile Towers PM needs to be consulted for engineer of record re-design.
8. All new port sleeves must be galvanized. If necessary painted to match the tower.
9. Pictures of the final port installation shall be provided to the T-Mobile Towers PM.

9. POWER UPGRADES

A. Requirements

1. The T-Mobile Towers PM must be notified at least 7 business days prior to any and all power outages.
2. A generator must be provided for T-Mobile at Tenants expense.
3. Any existing carriers must also be notified of the power outage, and if necessary, a generator shall be provided at Tenants expense.
4. The T-Mobile NOC and the T-Mobile Towers PM will be notified 24 hours prior to power upgrade, and upon completion.
5. Any new meter racks shall be installed per all local codes and located where approved by T-Mobile Towers PM and/or local utility contact. If located outside of T-Mobile's lease space area Tenant must produce Landlord's (LL) authorization documentation.
6. All conduit etc, shall adhere to the guidelines outlined in this document.

10. CONSTRUCTION RELATED ISSUES

A. Miscellaneous

1. The T-Mobile compound will be secured while the contractor is not on site.
2. Any fencing removed or damaged during construction will be replaced or repaired at tenant expense.
3. Any damage to any existing facilities at the site or to the landlord's property will be returned to its previous condition at tenant expense.
4. Any damage to the LL's property (parking lot, fencing, landscaping, etc) that existed prior to the beginning of construction should be documented and photographed and provided to the T-Mobile Towers PM prior to any mobilization to the site.
5. Impact to T-Mobile LL's property shall be minimized during construction.
6. T-Mobile access route and times shall be followed unless the tenant has been granted their own access.

B. Material Storage

1. T-Mobile assumes no responsibility for materials left on site during construction.
2. Material must not block access to T-Mobile or any other existing tenant's equipment, or the tower.
3. No material is to be stored on the Landlord's property, unless prior consent has been granted.
4. All items must be removed when construction is complete.
5. Trash must be removed daily from the site, and the site should be left in a neat and orderly fashion.

C. Signage

1. No tenant signage will be placed on gate, fence, compound enclosure or the tower.
2. The tenant signage shall be placed on equipment or shelter, with the name of the carrier, the site number and an emergency contact phone number.

11. TOWER MODIFICATIONS

A. Tower Extensions

1. An Extension Authorization must be issued prior to any tower extension work. A full NTP for the tenant's collocation will only be provided once the extension has been added and approved by the T-Mobile Towers PM.
2. Tower extensions will be ordered from the original tower manufacturer. If the tower manufacturer is no longer in business, the extension will be designed by the T-Mobile Towers Architectural and Engineering firm with applicable shop drawings at the Tenants expense. All fabrication will be conducted by a certified shop with applicable Steel Certification and Welding Certification documentation provided to the T-Mobile Towers PM prior to the extension installation.
3. All extension design and loadings will be approved by the T-Mobile Towers PM.
4. If the extension is larger than 10 feet in length, the extension shall be designed to accommodate additional collocations in both its loading design and with appropriate coax ports.
5. If original pole was designed with a capacity to extend beyond the proposed extension, the extension must be designed with a flange plate at the top for additional future extensions.
6. The safety climbs and climbing pegs will be designed and installed to match the existing, and built to align properly. The existing safety climb shall be replaced with a safety climb that connects to the top of the extended tower.
7. The extension must be installed according to all assembly drawings and instructions provided by the extension designer, i.e. tower manufacturer or PE.
8. Mounts for the new extension are to be ordered from the extension/tower manufacturer. If the extension was designed by the T-Mobile A&E firm, the mounts called out in the drawings must be ordered and installed.
9. Pictures of the extension connection in addition to called out 3rd party inspection reports will be provided to the T-Mobile Towers PM for approval.
10. Once the extension has been approved by the T-Mobile Towers PM, a full NTP for the Tenants installation will be issued upon receipt of all NTP check list items.
11. The tenant's installation shall follow all T-Mobile Towers standards outlined in this document.

B. Tower Upgrades

1. An NTP will be issued for the reinforcement of the tower **only**. A stamped BP and Tower Modification drawing must be provided to T-Mobile before an NTP will be issued.
2. All reinforcement drawings will be provided from the T-Mobile Architecture and Engineering firm, and paid for by the tenant.
3. All reinforcement material is to be ordered per the T-Mobile Towers approved reinforcement drawings.
4. All reinforcements must be installed according to the drawing instructions provided by the design engineer.
5. Welding of reinforced steel should be minimized.
6. Any variations due to on site conditions **must** be approved by the design engineer and the T-Mobile Towers PM.
7. Upon completion of the tower reinforcements, a 3rd party inspection and pictures must be provided to and approved by the T-Mobile Towers PM. Once the inspection has been approved, a full NTP for the tenant's install will be issued upon receipt of all completed NTP checklist items.

12. TOWER REPLACEMENTS

A. Requirements

1. An initial NTP will be issued for new tower installation and existing carrier placement and movement only. After T-Mobile Towers PM approves new tower build, and all carriers have approved their new install, the tenant will receive an NTP for their installation.
2. The proposed new tower must be calculated with all future loading for T-Mobile and any existing tenants leased rights. If there is adequate space for future tenants, the pole must be designed with this in mind.
3. The new tower is to be designed with the appropriate number of access ports for both existing and future tenants.
4. The tower manufacturer and design will be approved by the T-Mobile Towers PM. **No tower shall be ordered until this approval is given.**
5. All movement of existing carriers needs to be outlined and approved by all parties involved.

B. Foundation

1. The foundation for the new tower is to be designed by the tower manufacturer supplying the tower.
2. The foundation is to be installed per the tower manufacturer specifications.
3. The concrete used for the new tower foundation shall meet or exceed specifications in the foundation design.
4. The tower will not be erected before a break test yields minimum design strength. After T-Mobile PM has approved the break tests provided, the tower may be erected.
5. Break tests are to be provided to the T-Mobile Towers PM at 7, 14, and 28 days.
6. Pictures of the tower foundation cage, anchor bolt assemblies, and finished foundation are to be provided to the T-Mobile PM, as well as an engineer's report on site during pour.

C. Tower

1. The tower must be installed according to any assembly drawings or instructions provided by the manufacturer. A complete set of tower design and erection drawings are to be kept on site at all times during tower erection.
2. It is the responsibility of the tenant to provide any photos and /or documents to the tower manufacturer when requested by the manufacturer.
3. The tenant is required to inspect the condition of the new pole prior to unloading it off of the delivery truck. If any issues, ie., dents, missing material, incorrect tower, etc are noticed with the tower, immediately contact the T-Mobile Towers PM and tower manufacture for further instructions.
4. Prior to the delivery driver leaving the site the GC must make sure all materials that are listed on the delivery forms are accounted for. The GC will be responsible for providing, replacing or repairing all missing or damaged materials if they are not noted on the delivery drivers documentation prior to his/her departure from the site.
5. All mounts shall be ordered from the tower manufacturer.
6. Before any carriers are relocated to the new tower, the tower must be inspected and accepted by either the T-Mobile Towers PM or a 3rd party (to be determined by the T-Mobile Towers PM).

D. Existing Carriers-Relocation to New Tower

1. Coordination with all existing carriers prior to being cut over to the new pole must be completed with the T-Mobile Towers PM and a representative for all existing tenants. Plans for the cutover include:
 - a. Placement and delivery of COWS, (The carrier replacing the pole is responsible for any temporary ground leases to accommodate COWS)
 - b. Delivery of all new antennas, connectors, coax, TMAs, jumpers, etc
 - c. Cutover specific dates and times
 - d. Any required testing- sweeps, azimuth checks, etc
 - e. Any other information the T-Mobile Towers PM has requested and deemed necessary
2. All antenna and grounding specifications for existing carriers must be adhered to.
3. Pictures to be provide to the T-Mobile Towers PM:
 - a. Tape drop of all RADs
 - b. Weather proofing
 - c. Azimuth verifications
 - d. Antenna mounting
 - e. Antenna Model numbers at each RAD
 - f. Buss bar connections
 - g. Any other photos required by T-Mobile PM or existing tenants
4. All new installation of existing carriers must be approved by the carrier's representative, and be provided to the T-Mobile Towers PM, for verification of acceptance.
5. Once all installations have been completed and accepted, the old tower must be removed per the following:
 - a. The old tower shall be disposed of as directed by the T-Mobile Towers PM
 - b. The old tower foundation will be chipped down to a minimum of 2 feet below grade, or as dictated by specific lease or jurisdiction requirements
 - c. The area of the old foundation is to be restored to match the existing surrounding conditions
 - d. Pictures of the old tower removed and the foundation covered shall be provided to the T-Mobile Towers PM
6. Once the old tower has been disposed of and the area of the old tower has been accepted by the T-Mobile Towers PM, an NTP for the new carrier installation will be issued.
7. The new tenant installation will follow all of T-Mobile Towers Construction Standards for collocation, as written in this document.

13. GROUNDING - MINIMUM GROUNDING AND BONDING

A. Purpose

To establish minimum standards for grounding Tenants' installation and maintain the grounding integrity of T-Mobile's site.

B. Definitions

AGB	Antenna Ground Buss
AWG	American Wire Gauge
CADWELDING	An exothermic welding process which creates positive contact of grounding conductors
PVC	Poly Vinyl Chloride Conduit
EMT	Electrical Metal Tubing (light gauge metal conduit)
RFI	Radio Frequency Interference
THW	Letter type designation for conductor insulation that is a moisture and heat resistant thermoplastic with a maximum operating temperature of 75 degrees Celsius or 167 degrees Fahrenheit.

C. Background

1. Areas of Concern: When designing the grounding system for a Mobile Radio Facility there are four (4) interrelated areas of concern. The basic objective for each is:
 - a. Lightning Protection. - To maintain all equipment at the same potential during a lightning impulse;
 - b. RFI for Noise Induction Control. - To establish the lowest possible impedance among all equipment;
 - c. Electrostatic Control. - To reduce electrostatic discharge problems;
 - d. Personnel Safety. - To maintain a minimum voltage difference between any two metallic objects which personnel might contact simultaneously.

2. Lightning Considerations

Lightning damage occurs from either induction or from an actual direct or indirect strike to the Tower and/or antennas. Strikes to other nearby objects induce high energy into power or telephone cables entering the equipment. This type of effect historically causes most of the damage to the equipment.

D. Station Grounding System

1. Materials

- a. #2 AWG, bare solid tinned copper cable, for all exterior conductors and ground bar conductors or as otherwise specified.
- b. Exothermic or other approved exothermic welding system for bonding as specified.
- c. Solid copper plates of minimum 3' x 3' x 1/4" size as specified.
- d. Noalox or approved equal conduction medium material shall be used in all mechanical connections.
- e. Mechanical fasteners (i.e., lugs, split bolts, parallel connectors) shall be bronze, brass, copper or stainless steel as depicted on the Construction Drawings.
- f. Bolts, nuts and screws used to fasten mechanical connectors shall be stainless steel with star type stainless steel lock washers.
- g. All lug type fasteners shall provide two holes to allow a double bolt connection.

2. Master Ground Bar (MGB)

The purpose of the Master Ground Bar is to ground the BTS. This is the main grounding point for any other grounds that do not ground directly to the tower ground ring.

3. Antenna Ground Bar (AGB)

The purpose of the AGB is primarily for lightning protection. Coaxial cable is usually the only item grounded to this bar. This ground bar should be attached with insulators and have two exothermic weld leads attached to the tower ground ring.

4. Ground Rod and Ground Ring Placement

The Tenant ground ring shall be placed around the Tenants BTS Support at a minimum distance of two (2) feet from the foundation at a depth of 2'-6" or 6" below the frost line, whichever is deeper. Rods shall be driven to a depth such that the top of the rods is at the level of the ground ring conductor. The rods shall be copper clad steel and eight (8) feet in length. The rods shall be placed minimally along the ring at the following locations:

- a. Ring around the tenants equipment must tie into tower ground ring in a minimum of two (2) places.
- b. As required along the ring perimeter to achieve 5 ohms or less resistance when tested (See Section 4.5).
- c. A minimum of one inspection well shall be installed as indicated on construction drawings.

5. Tower Grounding for Pole Replacements

All monopoles shall have a minimum three (3) ground rods. Exothermic welds shall bond the conductors to only structural base plates or lugs or ears IF provided by the manufacturer. No exothermic connections shall be made to the vertical walls of the structure.

6. Antenna Coax and BTS Grounding

COAX:

- a. Coaxial cable grounding shall typically be placed at the top (near bend to antenna), in the middle on vertical runs over 200 feet, at the bottom of the tower (near bend to ice bridge), and at the Antenna ground buss (AGB) outside the BTS or building at a minimum.
- b. The ground kit leads to the buss bars are to be straight with excess trimmed off prior to attachment.
- c. All ground leads are to be attached with two hole lugs and no corrosive goop (Noalox).

EQUIPMENT:

- a. Tenant shall install a ground ring around their own equipment and tie grounds to the existing ground system in a minimum of two (2) locations.
- b. Tenant shall not disturb existing grounding (except as noted above).

Each antenna coaxial cable shall be grounded at three points using a coaxial cable kit from the manufacturer of the antenna cable (4 points if tower is over 200' and/or lamped).

In all cases, the ground kits will be attached to the cable on straight runs (not within bends) and be weatherproofed per the manufacturer's specifications.

7. Generator, Receptacle and Fuel Tank Grounding

The Generator fuel tank shall be connected in at least one (1) place to the main exterior ground ring. Exothermic weld connections shall be made between the nearest exterior ground ring ground rod and one support leg of the fuel tank using #2 AWG bare solid copper wire.

One ground rod located adjacent to the standby generator, and if separated by more than ten (10)', one located adjacent to the fuel tank.

The generator receptacle (Appleton Plug) shall be grounded through the electrical system. No ground rod or down lead is required at this location.

8. A/C Commercial Power Grounding Connections

At the on Work Site riser pole location or underground service entrance location, the A/C service shall be mechanically bonded to the A/C service entrance ground as specified by the National Electrical Code, Article 250, and/or appropriate local codes. A separate ground rod shall be provided at this point, and shall not be connected to the exterior grounding ring. A separate A/C service ground and neutral shall then be routed to and connected to the main disconnect inside the building.

9. Coax Bridge Grounding

Tenant to exothermically ground each ice bridge post individually and will be connected to either ground ring.

10. Chemical Grounds

Chemical ground rods shall not be installed on typical ground ring installations. Chemical ground rods shall be installed only for special design applications that require single point grounding due to specific Work Site conditions and only after T-Mobile Towers PM approval.

11. Limits of Bend Radius

It is important that the grounding conductor connecting the inside and outside ground systems be as straight as possible, with no turn or bend shorter than a one (1) foot radius with a three (3) foot radius preferred. No right angle or sharp bends shall be allowed.

12. Testing

All ground systems installed shall be tested. The resistance to ground shall be measured using the Fall of Potential Method. Testing shall be performed by an independent testing laboratory or authorized T-Mobile approved vendor representative from which a written report shall be produced for review by the T-Mobile Towers PM.

The outside ground ring shall be tested after installation but prior to backfilling the ground ring trench as more specifically described in the Construction Drawings. The ground field resistance shall measure 5 ohms or less to ground. Any difficulty in achieving this level of resistance must be brought to the attention of the T-Mobile Towers Project Manager.

13. Special Conditions

When soil conditions exist (i.e., non-compactable rock, gravel, shale, etc.) that prevent the installation of the standard grounding system and procedures, consult with the T-Mobile Towers PM.