

II. CORS/RTN Monument Construction Guidelines

The installation of CORS stations as part of a Real-Time Network (RTN) has significantly increased over the last few years. Likewise, many different types of installation techniques have been employed. The National Geodetic Survey has produced a set of guidelines that addresses the basic requirements for most mounting types http://www.ngs.noaa.gov/PUBS_LIB/CORS_guidelines.pdf, however more often than not; the installers of these sites are left to their own imagination when it comes to the design of a particular type of monument based on their specific site characteristics. This document provides some specific recommendations and examples for various types of CORS mounts.

A. General Provisions

1. Electrical Supply

- Receivers should be supplied with continuous power via a reliable source. NGS suggests that a dedicated circuit be supplied for the receiver and its associated equipment. The dedicated circuit should be located within 6 feet or less of the receiver to eliminate the need for extension cords or power strips as these are likely to become unplugged or switched off unintentionally.
- Sharing of a circuit with other uses should be avoided if possible. Circuits that serve welders or other intermittent high current draw loads are subject to voltage swings that may affect the receiver.
- In the event that voltage swings exist throughout an entire building's electrical service, some form of voltage regulating equipment should be considered. The use of an Uninterrupted Power Supply (UPS) is highly recommended.
- Each year, GNSS receivers are destroyed by lightning. The use of lightning arresters and antenna grounding systems are highly recommended. Though the antenna will still likely still be damaged by a lightning strike, the use of lightning arresters will protect the receiver and attached communications.

2. Receiver Mounting

- The receiver should be mounted in such a way that it will be accessible for maintenance activities.
- The receiver should be mounted in such a location as to prevent accidental damage caused by persons moving nearby.
- Physical disturbances, such as earthquakes, high winds, or flooding should be anticipated and mitigated.

3. Security

- The CORS system serves as a trusted source of data for many uses. Good security starts with prevention. The receiver and antenna should be located and secured to discourage tampering or theft.

B. Monument Types

Most CORS installations can generally be categorized into two groups, building mounts and ground mounts. Within these two categories, there are a number of different sub-types that have been designed to address specific site characteristics.

As is pointed out in the existing CORS Site Guidelines, stability of the mount and the mounting structure is of the utmost importance. However, economics certainly plays a role in the design and installation of a CORS station.

1. Building Mounts

Building mounts are often the most appealing installation for a number of reasons:

- Accessibility of power and communications
- Site security
- Increased elevation to help overcome local obstructions
- Receiver environmental factors (temperature, humidity)
- Existing structure (implied long-term stability)
- Often reduced installation cost due to reasons listed above

Though building mounts are often the most economical and convenient, they often pose the greatest challenge relative to the mount design since every building has its own characteristics. Additionally, there are challenges that relate to the relationship of where the receiver is to reside within the building to the desired location of the antenna. Most standard antenna cables are 30 meters in length (LMR400), which means that the separation between the antenna and receiver locations is no more than 30 meters. It is not uncommon that the best antenna location is more than 30 meters away from the ideal location of the receiver. In this case, there are a number of options:

- Purchase a longer, low impedance antenna cable, LMR600 for example
 - Creates a longer run but the cable is thicker and stiffer, making the installation more difficult.
- Purchase and install an in-line amplifier and add another length of standard cable.
 - Creates a longer run but also creates another potential point of failure

- Change the location of the antenna to be closer to the final location of the receiver
 - Reduces the cable run but alternate suitable locations not always available
- Change the location of the receiver to be closer to the final location of the antenna.
 - Often the best solution but not always practical. Additional security (locked cabinet) may be necessary if receiver is in a remote, non secure location within the building.

As indicated above, the building characteristics often present a significant challenge, usually related to the type of roof and the amount of overhang. There are three general types of building mounts that can be used and adapted to most situations.

a) Flush Mount

A flush mount can be used if the roof overhang (eave) is small. This is the most desired type of building mount as it provides the best stability. See figure 1.



Figure 1 - Flush Mount used on buildings with small roof overhang

b) Outrigger and Corner Mount

In cases where the roof overhang is large or there is a decorative cornice, two types of mounts are commonly used. These are the Outrigger Mount and the Corner Mount. See figures 2 and 3.



Figure 2 - Outrigger Mount



Figure 3 - Corner Mount

The following link is a collection of various building mount designs. www.ngs.noaa.gov/realtime/buildingmounts (whatever the actual link would be)

When attaching mounts to a building, it is most desirable that the mount be attached with through bolts whenever possible. This may not always be possible if the through-bolt would be visually exposed in the finished space of a building; however, the top bolts will often be above a suspended ceiling where they can be hidden. When through-bolting, a steel backing plate should be used to distribute the compressive force. This is especially true when attaching to block walls. See figure 4.

Careful site reconnaissance and planning will go a long way to making any building mount installation a success. Here are some important points to consider when generating your installation plan.

- Select the best location for antenna first, and then determine a suitable location for the receiver.
- Determine where the power for the receiver will come from. It is also a good idea to have the receiver on a dedicated circuit if possible so determine the location of the nearest electrical breaker box to determine if a dedicated circuit can be run.
- If the receiver is not to be located in a room that has internet access, determine where the nearest access is and plan the route for the internet cable.

- Once the mount location and type is determined, determine where the antenna cable will enter the building and make a list of materials and tools that will be needed for the installation.
- Determine what will be needed (inside and outside) to access the installation site.
 - Ladders or mechanical lifts
 - Ropes
 - Fall protection
 - Is there access to the roof by means other than a ladder or lift?



Figure 4 – Through-bolts with backing plates

C. Ground Mounts

Though ground mounts will generally be more expensive due to the cost of excavation, concrete, installation, and cabling, they do offer some advantages as they can be installed in almost any location that provides a good view to the sky. Ground mounts are well suited to locations that have (or can have) all required infrastructure (power, communications, etc...) but lack a building or the proper building type to facilitate a building mount. Ground mounts generally fall into three categories: Braced, Pillar, and Tower. One disadvantage to ground mounts is a lack of security since the antenna could be accessed from the ground or a short ladder. Also since the monument is on the ground, it is in potential danger of being disturbed (hit) by motor vehicles or maintenance equipment. Other things to consider when choosing a location for ground monuments are:

- Future use of the area, i.e., construction of new buildings or improvements and installation of underground utilities
- Multi-path from nearby objects
- Soil type
- Access to power and communications

1. Braced Mount

A braced mount, typical of stations installed by the Plate Boundary Observatory (PBO) are the most stable of the ground mounts. See http://www.unavco.org/facility/project_support/permanent/monumentation/deepdrilled.html and http://www.unavco.org/facility/project_support/permanent/monumentation/sdbm.html

2. Pillar Mount

A pillar mount generally consists of a concrete monument that extends at least 1.5 meters (2 – 2.5 meters is recommended) above ground and is poured to a depth of 4 meters or poured to a depth of less than 4 meters and pinned to bedrock. These mounts have been used in a number of states that have co-located their CORS stations with their Road Weather Information Systems (RWIS). In this case, the RWIS site contains the required power and communications that will support the CORS and a pillar is constructed near the site.

The general construction guidelines that are contained within the links below describe the process well. One item that should be cautioned against though is the use of Delrin tubes in the monument as well as the placement of electrical conduit (for the antenna cable) in the monument. Some who have manufactured these monuments have experienced cracking of the monument when a large Delrin tube was inserted to attach the antenna and when the conduit was installed inside the monument. It is unknown what the exact cause of the cracking is, but it is suggested that those constructing these monuments err on the side of caution and refrain from these practices. See figure 5.



Figure 5 – view of pillar monument (note the crack that has developed near conduit location)

The following is a link to the resource page for pillar monuments that shows photos and schematics for a number of different pillar designs.
www.ngs.noaa.gov/real-time/pillar

3. Tower Mounts

The last type of ground monument is the Tower Mount. A Tower Mount can be used in locations with conditions that are similar to those for a pillar, but have some local obstructions that require elevating the antenna more than would be accomplished with a pillar. See figures 6 and 7.



Figure 6
Figure 7
Examples of a Tower Mount

If constructing a Tower Mount, the foundation should be poured to the same depth as that of a Pillar Mount. Also depending on the height of the tower, a system of guy wires may be needed to ensure stability against wind loading. The following is the link to the Tower Mount resource page
www.ngs.noaa.gov/realtime/tower.html