Optimising the Site Layout of Radio Transmitter Stations

Although laboratory tests of radio transmitter system performance are routinely conducted into loads that accurately represent the antenna's input impedance, on-site measurements into a real antenna often produce quite different results. In the field, both the transmitter and the test equipment can be affected by the electromagnetic field of the antenna. Two effects are involved. The first is direct pick-up of the radiated signal by conductors in the transmitter and the test equipment. This effect is more pronounced when the transmitter building is located close to the antenna. The second effect is related to the path followed by the antenna's ground return current. Both effects can negatively impact the transmitter performance and the accuracy of the measured test results.

Direct Pick-up from the Antenna's Electromagnetic Field

Figure 1 shows the magnitude of the electric field in volts/meter measured at a height of 3m surrounding a 30m top loaded monopole fed from a 250 watt transmitter at 300 kHz. It can be seen that the field reduces rapidly as the distance is increased. This shows for example, that a voltage of 200 volts would be induced in a one meter vertical conductor at a distance of 15m from the antenna. Unless adequate shielding is provided, this can interfere with low level radio frequency signals in equipment located close to the antenna.

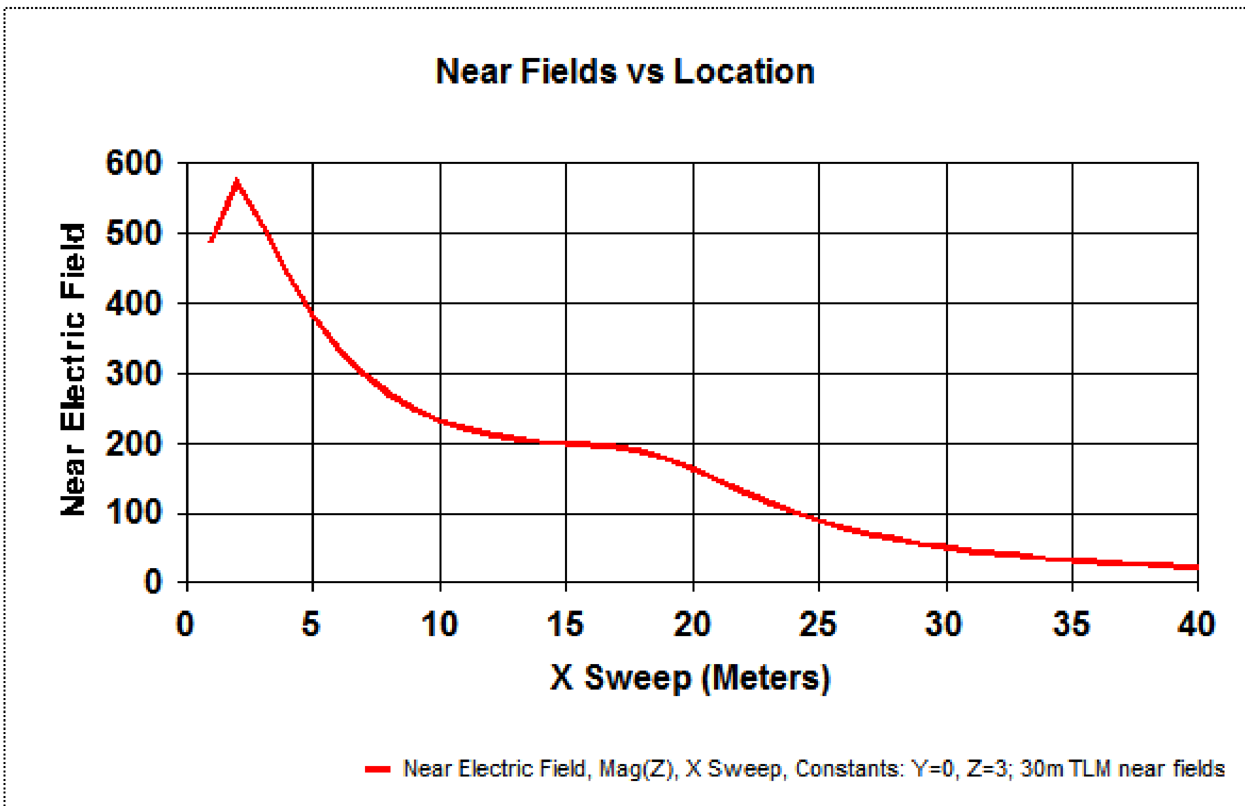

Figure 1 – Near field in V/m vs. distance from a 30 meter top loaded monopole.

Antenna Current Return Path

A typical site layout for a vertical mast radiator is illustrated in Figure 2. An arrangement of ground radials buried just below the ground surface is connected via a circular conductor to the ground terminal of the antenna tuning/matching unit. This provides a return path for the current fed into the base of the antenna mast. Ideally, each ground radial would carry approximately the same current and the sum would be equal to the total antenna input current. A clip–on RF ammeter is a very useful tool to investigate the actual path of these currents. Broken radials can be easily identified by uncovering the ring conductor and clipping on to each radial in turn. At a typical site, the sum of the currents measured in each ground radial will often be much less than the total antenna current. Why is this? It is due to the fact that longer radials tend to carry more current than shorter ones.

As seen in Figure 2, the transmitter's ac line supply, through the transmitter then on to the ATU via the shield of coaxial feeder cable, nearly always represents the longest radial. This path often carries a significant portion of the total antenna current, interfering with low level signals in the transmitter building.

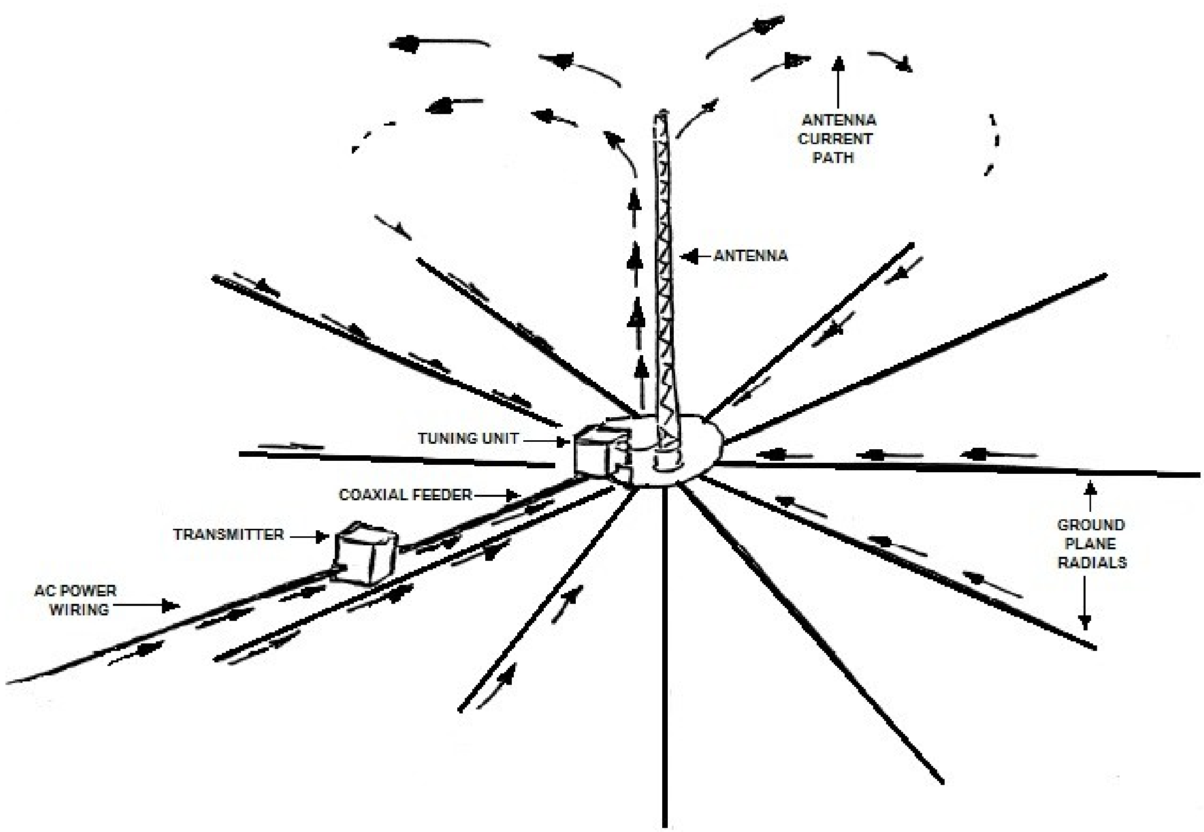

Figure 2 – Site layout showing the return path of the radiated antenna current.

Detrimental Effect of Undesired Antenna Current Paths

The elimination of antenna current from the transmitter building has clear advantages. Its path is somewhat unpredictable and may include low level circuits hence impacting the transmitter system performance. At some sites, unfortunate phase relationships between the interfering antenna current and signal currents can actually result in system instability. Test equipment can also be affected. Many instruments utilize sensitive detectors with selectable front-end attenuators to control their operating range. Antenna currents flowing through these instruments via their ac line cord can bypass these attenuators giving incorrect readings or apparent signal distortion.

Figure 3 shows a typical transmitter building layout. It is quite common to route the ac power source and the coaxial feeder connection to the antenna on opposite walls of the building such that some of the antenna return current flows directly through the transmitter cabinet.

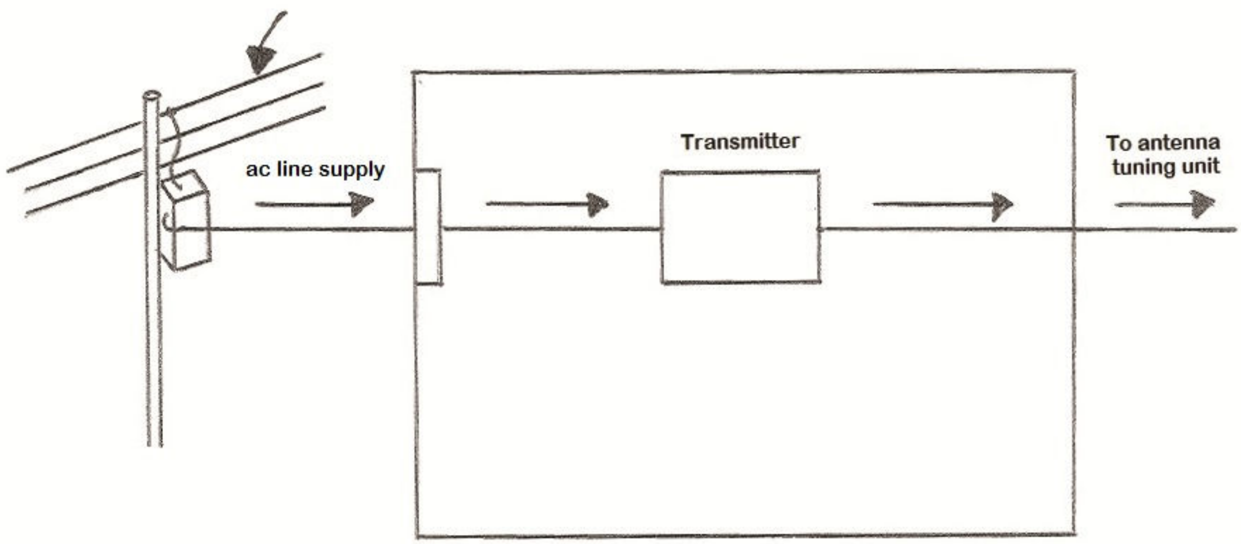

Figure 3 – Typical transmitter building layout.

An improved Site Configuration

Direct pick-up of the radiated signal can be reduced by increasing the distance between the transmitter building and the antenna but this is seldom an option at existing sites. Figure 4 shows a more practical solution. Conductors of the antenna ground plane are routed over the transmitter building effectively placing it below the ground plane, providing some reduction of the direct pick-up.

All electrical conductors that enter the building are brought in close proximity to each other at a point defined as the building Station Reference Ground. Surge arresters and appropriate de-coupling capacitors are installed at this point effectively providing a path for antenna return current that bypasses the interior of the building. In addition, toroidal ferrite chokes are threaded over the ac line supply, the coaxial feeder and any other cables that enter the transmitter building. The overall result is to greatly reduce the current in the ac line supply and the shield of the coaxial cable. Any residual current in this path bypasses the transmitter building. When correctly installed, these chokes are invisible to the systems operating circuits but provide inductance and resistance to the undesired unidirectional antenna current.

This arrangement actually forms part of a site layout technique that provides significant lightning protection for equipment and personnel inside the building. More detail is provided in a Nautel technical paper entitled “Improved Lightning Protection for Radio Transmitter Stations”.

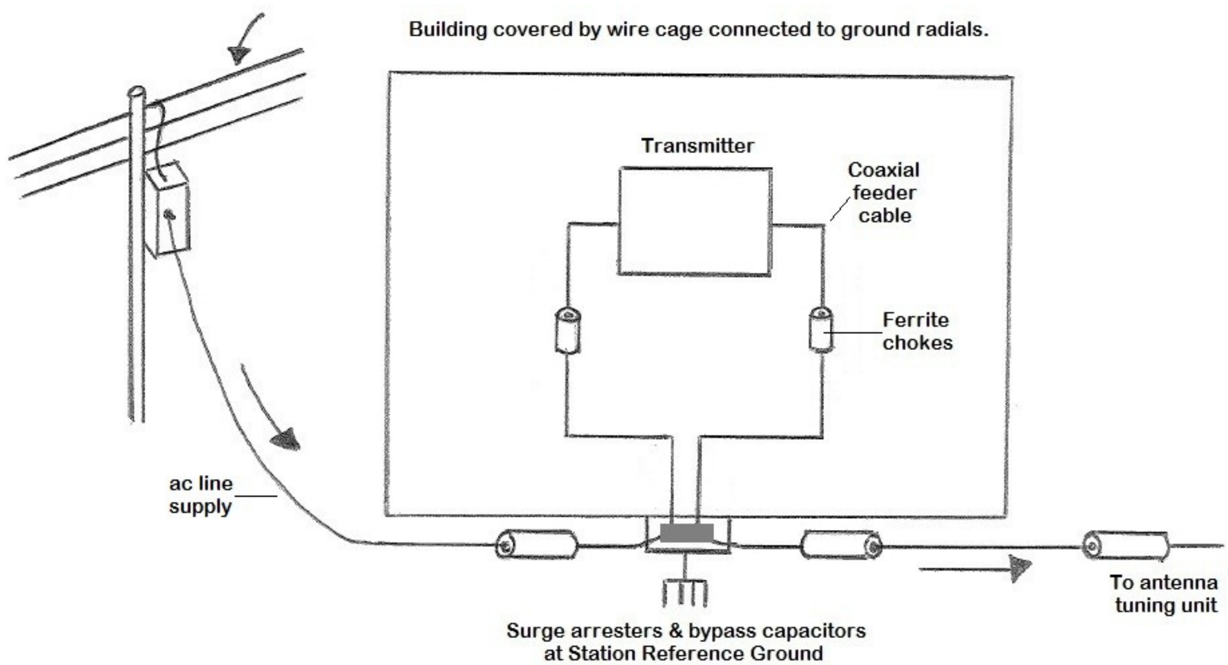

Figure 4 – Improved transmitter building layout.