**Survey Site:** Roof, ... Street, Norwalk, CT 06854



## Introduction:

360°RF was been retained to perform an RF survey related to the transmission of RF signals from cellular antennas located on the rooftop of the building located in Norwalk, CT. Multiple cellular carrier transmission facilities were found at this location, including AT&T and T-Mobile.

The building's ownership wanted the RF signal levels measured at various locations on the roof to determine levels with respect to RF safety exposure standards. 360°RF cannot claim whether any signal levels are "safe" or not, only state the levels as measured, and where practicable, those levels relationship to FCC and/or OSHA documentation. FCC and/or OSHA resources may be consulted for further detailed exposure related information.

## Equipment and Measurement

360°RF utilized a calibrated Rohde & Schwarz FSH6 portable spectrum analyzer with built-in RF preamplifier in order to measure the absolute (dBm) RF signal strengths in the various cellular bands. Appropriate custom directional antennas (log-periodic) were employed for each cellular frequency range in question.

The FSH6 spectrum analyzer was set to "MAX HOLD" mode, in order to capture the maximum RF signal levels that were present in the relevant frequency ranges during the measurement period. Moreover, the directional antennas were directed to multiple positions in the vertical plane, including pointing directly at the cellular antennas, in order to measure the highest signal levels experienced by personnel on the roof.

Measurements were taken in all four quadrants of the roof area: North, East, South, and West, in that order, and signals were collected for a minimum of six minutes. In each quadrant, the receiving antenna was located as close to the transmitting cellular antenna as possible (worst-case scenario), assuming a location where a person walking on the roof could be. The receiving antenna was approximately five feet above the roof.

Each quadrant of the roof is represented by its associated photo in figures 1-4.



Figure 1: North Quadrant



Figure 2: East Quadrant



Figure 3: South Quadrant



Figure 4: West Quadrant

## Results

The three possible cellular bands used in this area are 700-900 MHz, 1700-1900 MHz, and 2400-2700 MHz. (The 2400 MHz range can also be used by Wireless/WiFi services as employed in many offices.)

### 700-900 MHz band:

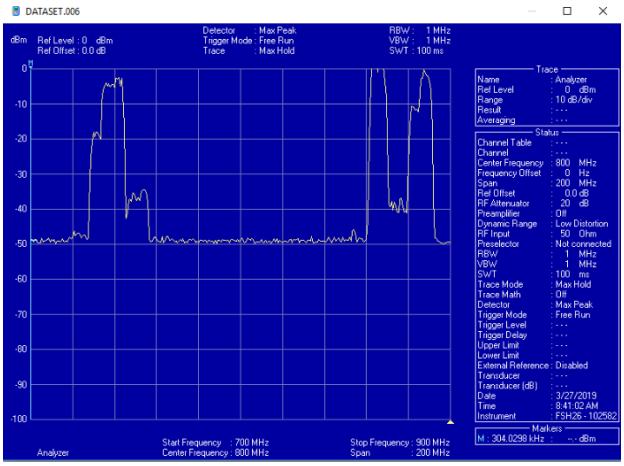



Figure 5: North Quadrant

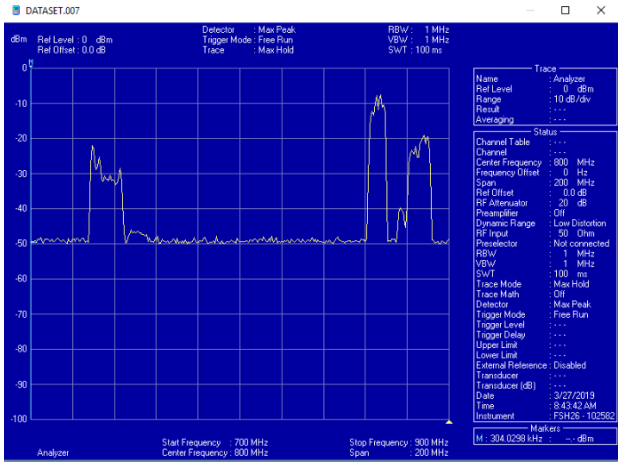



Figure 6: East Quadrant

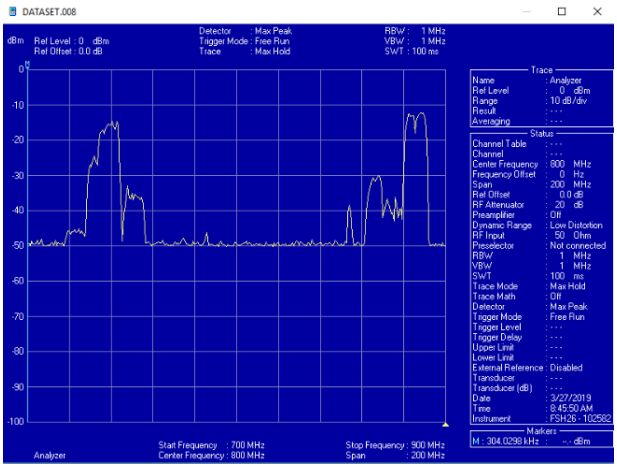



Figure 7: South Quadrant

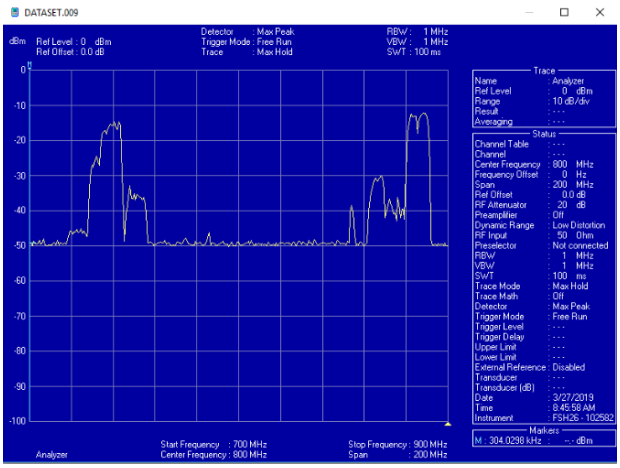



Figure 8: West Quadrant

The highest level of measured signal anywhere on the roof was **+5 dBm** at 863 MHz. Two smaller peaks occur at 888 and 741 MHz (see figure 5.) These maxima were located on the North quadrant of the roof within close proximity to the cellular antenna array…standing right under the antennas. This is where the highest level of RF exposure to personnel on the roof would occur.

The corresponding RF field strength is calculated as:

+5 dBm + 46.9897(50&) = 51.9897 dBmV

51.9897 dBmV +60 = 111.9897 dBµV

The antenna factor (AF) of the antenna employed is 22.3 per the manufacturer's specifications.

111.9897 dBµV + 22.3 dB/m = 134.2897 dBµV/m
134.2897 dBµV/m = 5.182 million µV/m = **5.182 V/m**

[*FCC OET Bulletin 65 "Federal Evaluating Compliance with FCC Guidelines for Human Exposure to radio frequency Electromagnetic Fields", Limits for General Population/Uncontrolled Exposure, states the following limit for the frequency range of 300-1500 MHz:* ***f/1500 mW/cm2****. This is in units of power density.*]

Converting from the typical (US) field strength units of µV/m to RF power density, which the FCC uses for this frequency range, yields:

Capture area of the antenna is 22.3 dB down from a square meter (related to antenna factor). The capture area is about .005 square meter [.005 x (100 x 100) = .005 x 10,000 = 50 sq cm]. Power density = 3/50 or **.06 milliwatts per cm sq.**

The FCC formula f/1500= 863/1500 = .57 mW/cm² = limit of RF exposure.

**.06 mW/cm² is approximately one tenth of the FCC specified limit.**

## 1700-1900 MHz band:

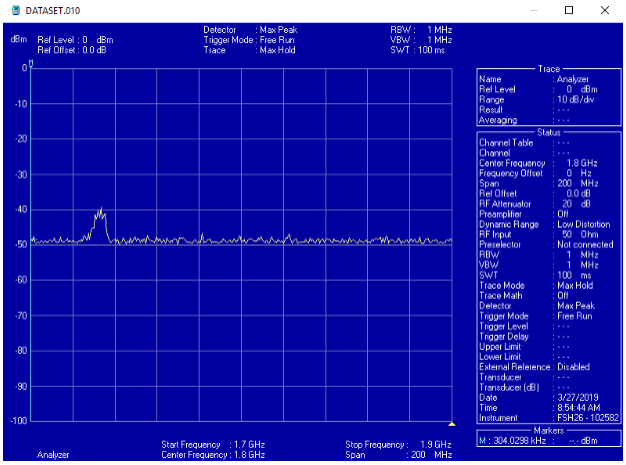



Figure 9: North Quadrant

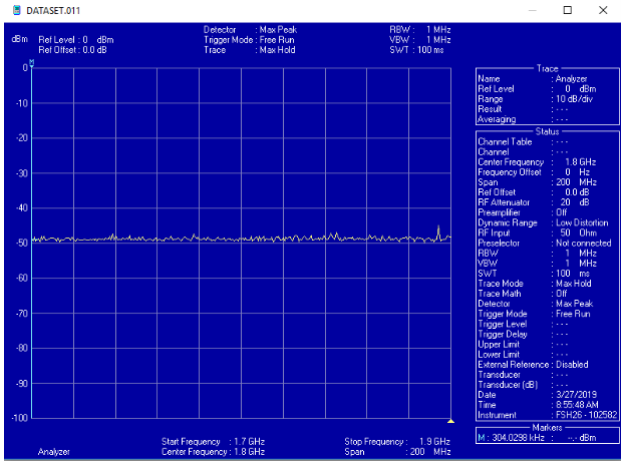



Figure 10: East Quadrant

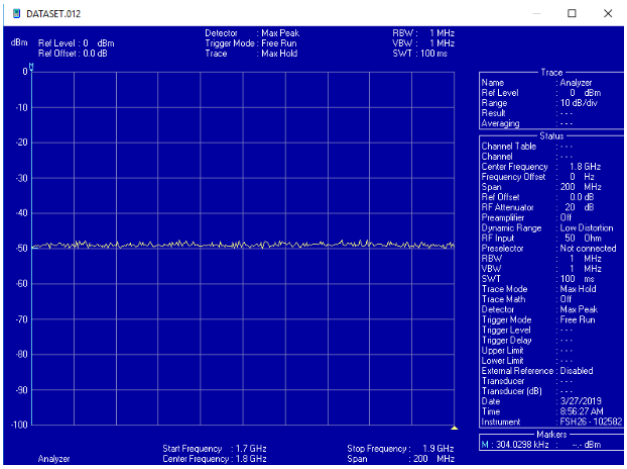



Figure 11: South Quadrant

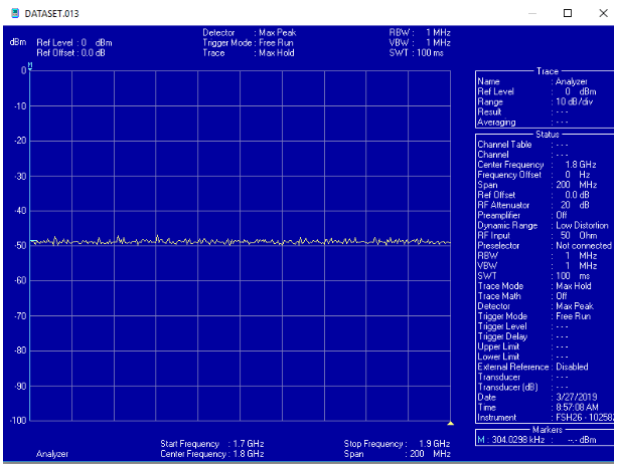



Figure 13: West Quadrant

***There was almost no RF energy detected in this cellular frequency band, indicating that the antennas on the roof at this location are not transmitting in this frequency range.-***

## 2400-2700 MHz band:

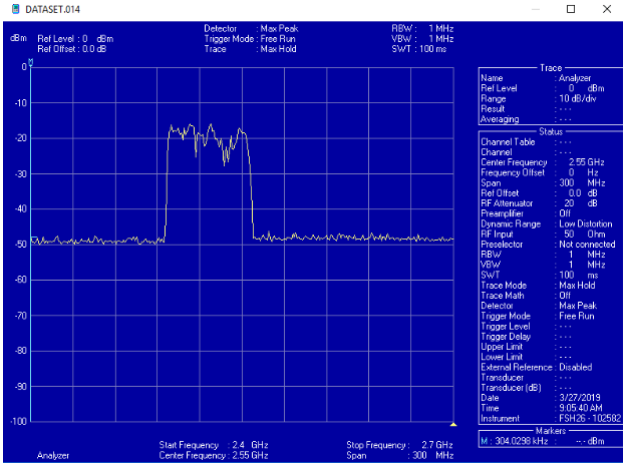



**Figure 14: North Quadrant**

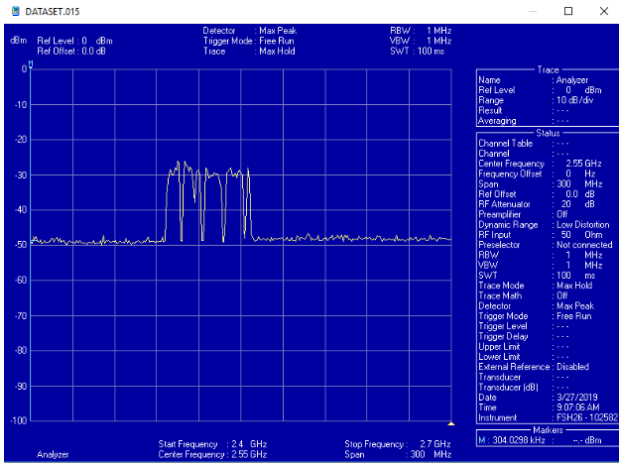



**Figure 15: East Quadrant**

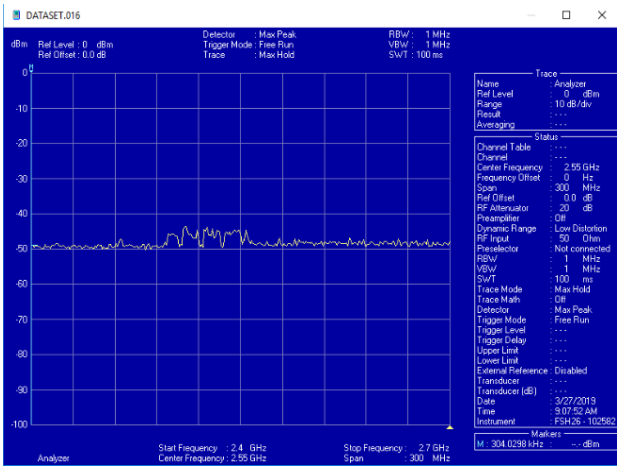



**Figure 16: South Quadrant**

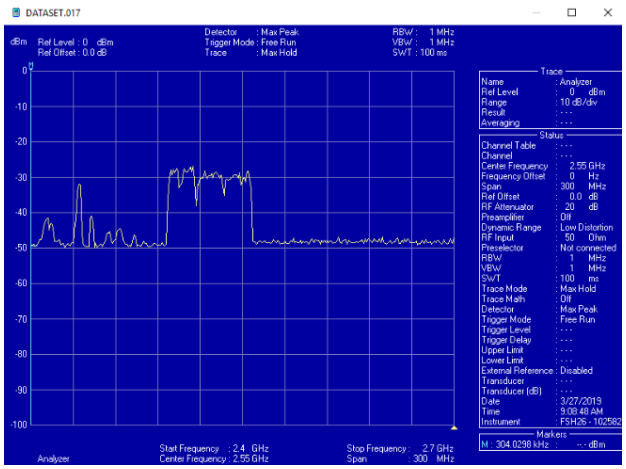



**Figure 17: West Quadrant**

Measurements in this frequency range indicated signals from about 2.5-2.56 GHz (figures 14-17), and were strongest in the North quadrant. These are not cellular signals, but lie within the MMDS “B41” band of 2.5-2.7 GHz, possibly associated with alternative cable TV distribution. The **maximum** signal level in this band was -16 dBm.

In the West quadrant, signals in the WiFi band were detected (2.4 GHz range.)

The corresponding RF field strength is calculated in this band as:

-16 dBm + 46.9897(50&) = 30.9897 dBmV

30.9897 dBmV +60 = 90.9897 dBµV

The antenna factor (AF) of the antenna employed is 32.3 per the manufacturer’s specifications.

90.9897 dBµV + 32.3 dB/m = 123.2897 dBµV/m

123.2897 dBµV/m = 1.46 million µV/m = **1.46 V/m**

Again, converting from the typical (US) field strength units of µV/m to RF power density, which the FCC uses for this frequency range, yields:

Capture area of the antenna is 32.3 dB down from a square meter (related to antenna factor.)
The capture area is about .0005 square meter (.0005 x (100 x 100) = .0005 x 10,000 = 5 sq cm.)
Power density = .025/5 or **.005 milliwatts per cm sq.**

The FCC limit of RF exposure here is a constant of 1.0 mW/cm².
**.005 mW/cm² is only 5-thousandths of the FCC specified limit.**

## Conclusion

Measured signals in all four quadrants of the roof, with the worst-case (personnel located only a few feet from each of the cellular antenna arrays, and as close as possible for personnel walking on the roof) indicated RF levels below the FCC recommended maxima for each of the frequency ranges.

Of course, RF levels farther away from the close proximity of the antenna arrays would be even lower and even farther below the FCC maxima.

It should be noted that the power output of cellular transmitters can vary, depending upon the call load and distance from the transmitters to the cell phones.