

# **Radio Frequency Safety Plan Cheyenne Mountain, Colorado**



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Prepared by:

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# Radio Frequency Safety Plan Cheyenne Mountain, Colorado

## Executive Summary

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Exposure to high levels of radio frequency energy can be harmful. Cheyenne Mountain is an antenna site with many high-power transmitters and harmful exposure is possible if precautions are not taken. To help ensure your safety, we have prepared this radio frequency safety plan. Please read the plan in its entirety and follow its recommendations.

Everyone on the site should follow these guidelines:

- All personnel entering the site must be authorized
- Obey all posted signs
- Assume all antennas are active unless proven otherwise
- Before working on an antenna, notify the owner and disable the transmitter
- Use a radio frequency (RF) personal monitor when working near antennas
- Never operate transmitters without shields

Radio frequency power densities at ground level on Cheyenne Mountain are measured regularly and at the time of this writing are well below the FCC limit for occupational exposure. Power densities above ground can be much higher. For this reason, tower climbers should request power reductions from high-power tenants *and* carry RF personal monitors when climbing towers.

Please refer questions to the site manager, Mr. Mel Rauh, (719) 338-4650.

## 1.0 Introduction

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Cheyenne Mountain is a privately-owned antenna farm with approximately 40 radio towers. Cheyenne Mountain is located roughly six miles southwest of downtown Colorado Springs at an elevation of 9,440 feet above sea level. Geographical coordinates for the approximate center of the site are 38° 44' 43" N, 104° 51' 41" W (NAD 83). The 44-acre site is home to twelve television stations and seventeen FM broadcast stations.

## 2.0 RF Human Exposure Standards

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The possible health effects associated with exposure to radio frequency fields have been studied for more than half a century. The only established adverse effect is heating of body tissue. To protect the public from harmful exposure, the FCC requires that its licensees

comply with its published radio frequency exposure standards, found in Parts 1.1307 through 1.1310 of Title 47 of the Code of Federal Regulations [5]. FCC exposure limits are based on voluntary standards published by the American National Standards Institute (ANSI) and the National Council on Radiation Protection and Measurement (NCRP).

The term radio frequency *radiation* is often used to describe the fields emitted by radio antennas, but we must distinguish between the *non-ionizing* radiation from radio waves and the *ionizing* radiation from much higher frequency sources such as X-rays. It is physically impossible for radio frequency sources to cause ionization in the human body. Consequently, there is no similarity between the biological effects of ionizing radiation (X-rays) and non-ionizing radiation (radio waves).

We must also distinguish radio frequency fields from extremely low frequency (ELF) fields such as those associated with 60 Hz power lines. ELF fields do not readily radiate from their source and are an entirely different phenomenon.

FCC rules apply different standards for occupational, or *controlled environments* and general population, or *uncontrolled environments*. The definitions of controlled and uncontrolled environments are as follows [5]:

*Controlled Environment* - "Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure."

*Uncontrolled Environment* - "General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure."

By virtue of its rural location, Cheyenne Mountain is a controlled environment and the occupational limit applies. For controlled environments, the FCC sets a standard of 1 milliwatt/cm<sup>2</sup> in the VHF band (30-300 MHz). In the lower UHF band (300 MHz - 1.5 GHz), the FCC standard is a function of frequency and is given by the expression  $f/300$  milliwatts/cm<sup>2</sup>, where  $f$  is the frequency in MHz. In the FM and television broadcast bands, the general population limit is exactly a factor of five below the occupational limit. The FCC exposure standards are plotted as functions of frequency in Figure 1.

The human body does not react to high power densities instantaneously and short-term exposure to levels exceeding FCC power density limits does not necessarily exceed the FCC exposure limits. The FCC limits are for whole-body exposure averaged over a period of 6 minutes for controlled environments and 30 minutes for uncontrolled environments [1], [2], [5]. For example, if a radio technician is exposed to a power density of 0.5 milliwatts/cm<sup>2</sup> for a period of 4 minutes and then enters a field of 1.5 milliwatts/cm<sup>2</sup> for a period of 2

minutes, the average exposure in the six minute period is 0.83 milliwatts/cm<sup>2</sup> which is below the FCC limit for controlled environments.

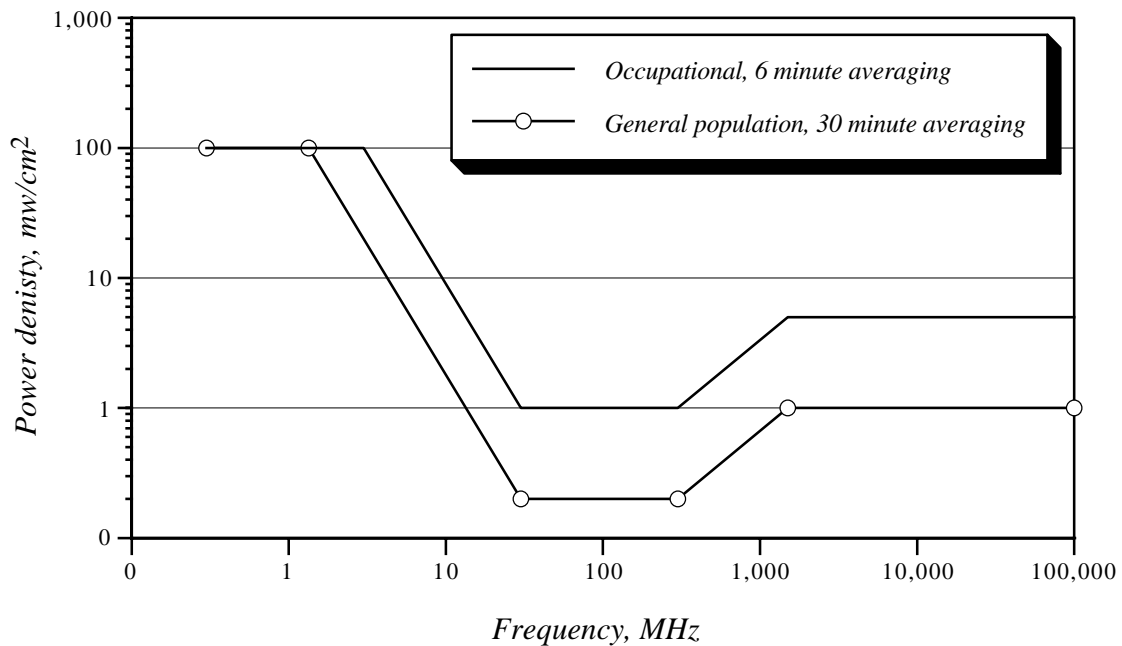


Figure 1 - FCC Exposure Standards  
(Plane wave equivalent *E*-field power density values)

Although other Federal agencies publish RF exposure standards (e.g., OSHA), the governing standard for communications sites is the FCC standard. The FCC has prepared an easy-to-read publication explaining its RF exposure policy [6]. This publication is available from the FCC web site at [www.fcc.gov](http://www.fcc.gov).

### 3.0 Ensuring Compliance with FCC Exposure Limits

If the radio site has a single transmitter, one can ensure compliance by comparing the predicted power density with the FCC standard for the transmitter frequency. When the site has multiple transmitters operating over a wide range of frequencies, it becomes more difficult to ensure compliance. For example, if a tower has a paging antenna at 929 MHz and an FM broadcast antenna at 99.9 MHz, which standard do we apply, 3.1 mW/cm<sup>2</sup> or 1.0 mW/cm<sup>2</sup>?

In these situations, the FCC directs that a fraction of the standard be computed for each source. If the sum of the fractions is less than 1.0, the site is in compliance. Mathematically, this requirement is stated as

$$Q = \sum_{i=1}^M \frac{S_i}{S_{FCC}(f_i)} \leq 1.0 \quad (1)$$

where  $M$  = the number of radiating antennas at the site,  $S_i$  = the average power density from antenna  $i$ ,  $f_i$  = the operating frequency of antenna  $i$ , and  $S_{FCC}(f_i)$  = the FCC power density standard at frequency  $f_i$ .

On congested sites, a non-compliance condition may be caused by numerous transmitters belonging to many different licensees. The FCC recognizes that it may be impractical to assign responsibility to every transmitter contributing to the measured power density, so the Commission employs a 5% rule in these situations. In other words, only those stations that contribute 5% or more of the applicable exposure standard are responsible for correcting the problem. This rule is reproduced below from 47 CFR 1.1307(b)(3) (Oct. 1, 2003):

“(3) In general, when the guidelines specified in Sec. 1.1310 are exceeded in an accessible area due to the emissions from multiple fixed transmitters, actions necessary to bring the area into compliance are the shared responsibility of all licensees whose transmitters produce, at the area in question, power density levels that exceed 5% of the power density exposure limit applicable to their particular transmitter or field strength levels that, when squared, exceed 5% of the square of the electric or magnetic field strength.”

## 4.0 Procedures

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The site owner, Cheyenne Propagation Company, has designated the site a controlled environment. To ensure that all personnel who travel to the site meet the FCC requirements for a controlled environment, the following restrictions and procedures are in place:

- *The site is not accessible to the public.* The site is 9.5 miles from Colorado Springs on a dirt road. The final 3.6 miles are behind a locked gate. There are no dwellings within several miles of the site.
- *All personnel are warned of the potential radio frequency hazards.* There is only one way to enter the site. All personnel who enter the site are greeted by the sign shown in Figure 2.
- *The site is measured regularly.* The site is measured at ground level on a regular basis to ensure compliance with FCC rules. Those areas at ground level where the power density exceeds the FCC limit for controlled environment are clearly marked with ANSI standard warning signs. The only locations in this category are guy anchors.

- *Power reduction plans are in place.* Power reduction plans are in place for most towers on the site. These plans specify the contributing broadcast stations and the reduced power level required at elevations on the tower. All tenants are required to make the appropriate power reductions when requested. The site manager, Mr. Mel Rauh, (719) 338-4650, is available for guidance and assistance on power reduction.

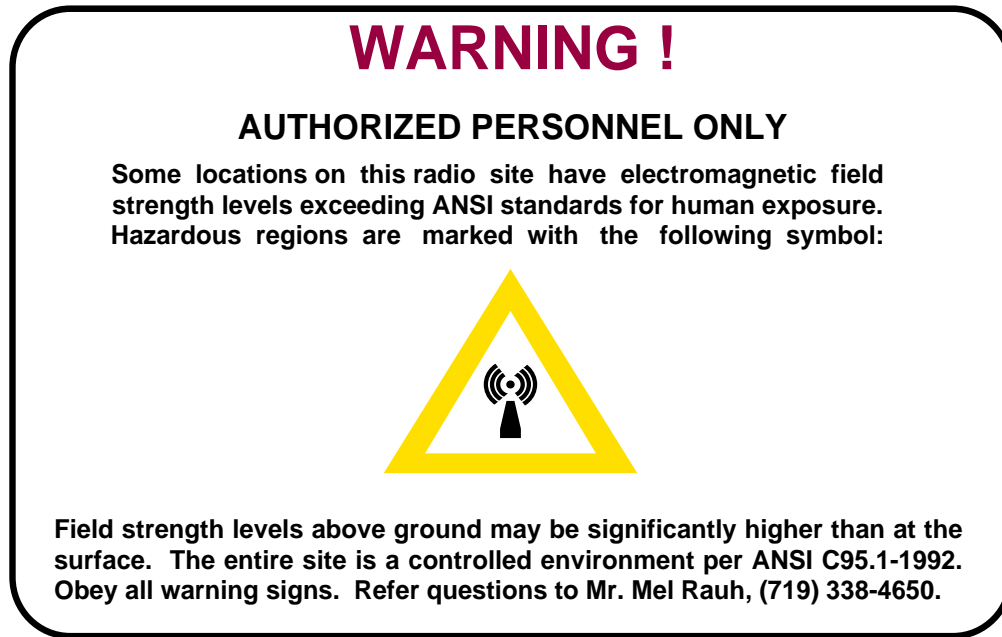


Figure 2 - Warning Sign at Entrance to Site

Controlled environment exposure limits apply to Cheyenne Mountain because personnel are exposed as a consequence of their employment, they have been made fully aware of the potential for exposure, and they can exercise control over their exposure.<sup>1</sup>

Those towers where levels may exceed the occupational exposure limit should be marked at their base with an ANSI standard warning sign, similar to the one shown in Figure 3. Tenants are responsible for properly marking their own towers.

Tower climbers should carry RF personal monitors (e.g., Nardalert™) to verify that transmitter powers have been reduced to safe levels before working in the vicinity of high power transmit antennas.

<sup>1</sup>See FCC publication OET-65, edition 97-01, August 1997 for further guidance. Specifically, the following paragraph from OET-65 applies to Cheyenne Mountain:

“There may be situations where RF levels may exceed the MPE limits for the general public in remote areas, such as mountain tops, that could conceivably be accessible but are not likely to be visited by the public. In such cases, common sense should dictate how compliance is to be achieved. If the area of concern is properly marked by appropriate warning signs, fencing or the erection of permanent barriers may not be necessary.”



Figure 3 - Sample Warning Sign (Courtesy of Richard Tell Associates, Inc.)  
(Available from Tescos, Narda, and Holaday)

Power densities originating from towers other than the one climbed may be higher than the occupational limit. For this reason, tower climbers should check with the site manager and consult the appropriate power reduction plan before climbing any tower on the site.

Tower crews must be approved by the site owner before they are allowed to work on the site. Check with Mr. Sam Wells, (719) 576-4424 for a list of approved tower rigging companies for Cheyenne Mountain.

## 5.0 Measurements

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Radio frequency power densities are measured regularly on Cheyenne Mountain. The most recent survey was accomplished on August 17, 2007. Measurements are conducted in accordance with the guidelines published in ANSI C95.3-2002 [3] and FCC Bulletin OET-65 [2]. The survey was accomplished with the test equipment listed in Table 1.

Table 1 - Test Equipment Used in Survey	
Instrument	Serial Number
Wandel & Goltermann (W&G) EMR-300	B-0053
Wandel & Goltermann Type 25.1 Probe, 300 kHz - 40 GHz	B-0053

Electromagnetic fields on the site are a complex combination of signals from several sources. Reflections from the ground, buildings, towers, and guy wires create standing waves with wide spatial variations. Moving the probe a distance of a few inches can result in significant measured variation. The FCC standard is a whole body average exposure standard, so the measurements must be taken over a volume comparable to that occupied by a standing adult. The W&G probe and meter record field strength as percent of the FCC controlled environment standard. The W&G meter also performs an automatic average as the user sweeps the volume of interest. To perform a spatial average with the W&G meter, we use the zig-zag method shown in Figure 4.

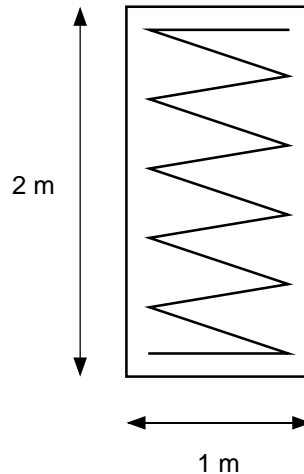


Figure 4 - Zig-zag method for automatic spatial averaging

Measurements are always taken at least 20 cm from reflecting objects in accordance with ANSI C95.3-2002. Magnetic field probes tend to exhibit false readings above 300 MHz. Because sources on Cheyenne Mountain include both VHF and UHF transmitters, we do not use a magnetic field probe.

During the last survey, we measured the 82 locations shown on the map of Figure 5. The corresponding measurement values are found in the Appendix to this report.

All measurements are below the occupational exposure limit.



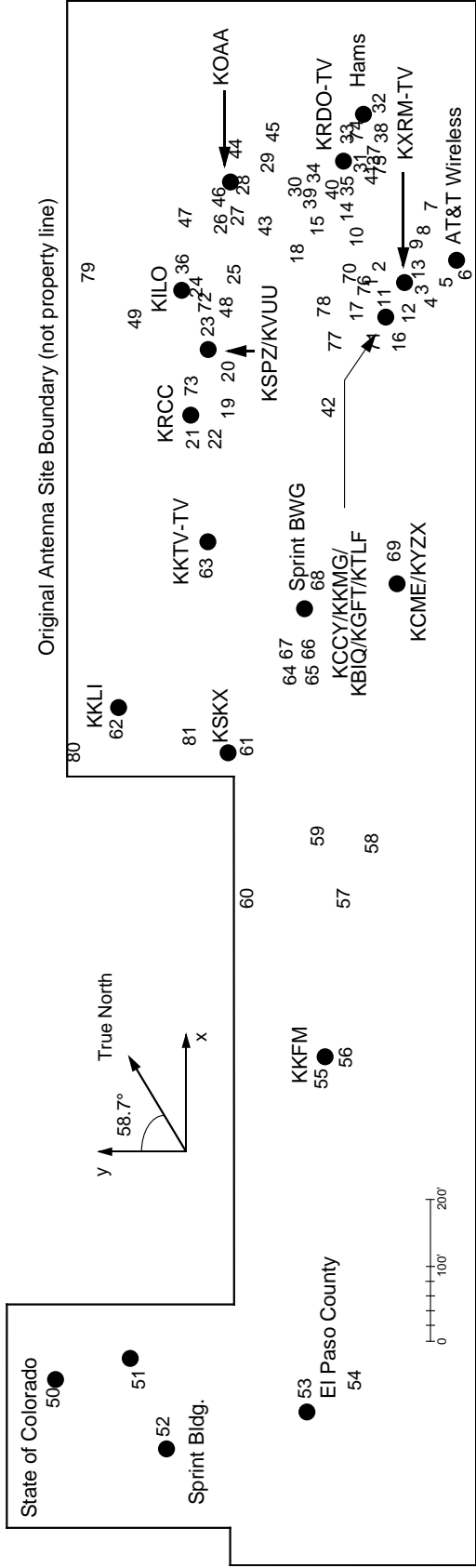


Figure 5 - Measurement Locations (See Appendix for Measurement Values)

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- [1] ANSI C95.1-1999, "Safety levels with respect to human exposure to radio frequency electromagnetic fields, 3 kHz to 300 GHz."
- [2] OET Bulletin No. 65, FCC, "Evaluating compliance with FCC guidelines for human exposure to radiofrequency electromagnetic fields," Edition 97-01, August 1997.
- [3] ANSI C95.3-2002, "Recommended practice for the measurement of hazardous electromagnetic fields - RF and microwave."
- [4] ANSI C95.2-1981, "American National Standard radio frequency radiation hazard warning symbol."
- [5] Code of Federal Regulation, Title 47, Parts 1.1307 - 1.1310, October 1, 2003.
- [6] FCC OET Bulletin 56, 4th Ed., Questions and Answers about Biological Effects and Potential Hazards of Radiofrequency Electromagnetic Fields, August, 1999.

## 8.0 Engineer's Statement

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Cheyenne Mountain  
Colorado Springs, CO

This RF Safety Plan addresses electromagnetic radiation in the band 300 kHz - 300 GHz. Fields from extremely low frequency (ELF) sources, such as those emitted by 60 Hz electrical distribution lines, were not modeled. Also, induced and contact radiofrequency currents were not measured or modeled.

Tower climbers should carry portable power density meters (e.g., Nardalert™) to verify that transmitter powers have been reduced to safe levels before working in the vicinity of high power transmit antennas.

Measurements were conducted according to procedures described in ANSI Standard C95.3-2002 and the user's manual for the appropriate meter. Our conclusions are limited to those locations actually measured. All measurements were conducted with test equipment assumed to be calibrated and working properly. If new high power transmitters are installed at the site, field strength levels may change. The measurement results reported are valid as of August 17, 2007.

All representations contained herein are true to the best of my knowledge. I am a radio engineer with over twenty years experience. I hold a Bachelor of Science degree in Electrical Engineering from Virginia Tech and a Master of Science degree in Electrical Engineering from Cornell University. I am a corporate officer and stockholder of Pericle Communications Company and a Registered Professional Engineer in the State of Colorado.

Signed this 30<sup>th</sup> day of September, 2007.

*- original signed -*

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Jay M. Jacobsmeyer, P.E.  
President  
Pericle Communications Company

## **Appendix - Measurements**

**Radio Frequency Exposure Measurements**  
*Pericle Communications Company*

Date: 8/17/07  
 Project: Cheyenne Propagation Company  
 Test Equipment: W&G EMR-300  
Type 25.1 Probe (Shaped)

Engineer: Jacobsmeier  
 S/N: B-0053  
 S/N: B-0053

Shaped Probe Type X Controlled            Uncontrolled           

No.	Location	Environment †	% of Std.
1	Bldg. 6155 KXRM front door	C	8%
2	KXRM tower base (south leg)	C	9%
3	Midway down north wall of bldg. 6155	C	5%
4	Bldg. 6155 transformer	C	3%
5	Bldg. 6157 AT&T Mobility front door (near KXRM)	C	20%
6	AT&T Mobility tower, south leg	C	3%
7	AT&T Mobility generator bldg	C	14%
8	KXRM east guy anchor	C	32%
9	Utility pole by concrete cable vault	C	8%
10	KXRM north guy anchor	C	15%
11	KXRM southwest guy anchor	C	15%
12	KXRM southwest guy, lengthwise	C	23%
13	KXRM building roof (peak location)	C	26%
14	Bldg. 6135 front door	C	5%
15	Bldg. 6145 front door	C	5%
16	300' self support tower, east leg	C	9%
17	Bldg. 6171 front door	C	2%
18	Bldg. 6165 front door	C	4%
19	Bldg. 6170 front door	C	1%
20	Bldg. 6164 front door	C	3%
21	Remy tower (bldg. 6180, 6182)	C	2%
22	Bldg. 6182 front door	C	4%
23	Springs Radio tower, east leg	C	9%
24	Bldg. 6150 front door (KILO, roped off)	C	2%
25	Bldg. 6140 front door (D&RG)	C	2%
26	Bldg. 6132 (KOAA/KTSC generator)	C	9%
27	Bldg. 6130 (KOAA)	C	13%
28	KOAA tower, south leg	C	3%
29	Bldg. 6120 front door (EPCSR)	C	6%
30	Near KRDO tower, top of hill on road	C	7%
31	KRDO below bottom FM bay	C	2%
32	Bldg. 6105 front door	C	3%
33	KRDO small tower in road	C	3%
34	KRDO fork in road	C	4%
35	Behind bldg. 6135	C	3%
36	KILO Tower	C	3%
37	Between KRDO Garage & 6105	C	5%
38	Sprint BWG Tower (new tower)	C	4%

† U = uncontrolled environment, C = controlled environment  
 All measurements are spatial averages.

No.	Location	Environment †	% of Std.
39	Behind bldg. 6145	C	4%
40	Utility pole behind bldg. 6135	C	5%
41	Stump above KRDO by east RF sign	C	3%
42	Bldg. 6175 (T-Mobile)	C	1%
43	KOAA south guy anchor	C	6%
44	KOAA northwest guy anchor	C	4%
45	KOAA northeast guy anchor	C	4%
46	KOAA fuel tank, southwest corner	C	5%
47	KILO northeast guy anchor (signed)	C	5%
48	KILO southeast guy anchor	C	7%
49	KILO southwest guy anchor	C	5%
50	Bldg. 6570 State of Colorado tower	C	0%
51	Pinnacle tower (bldg. 6550)	C	0%
52	Bldg 6560 GTE Sprint tower	C	0%
53	Bldg. 6565 El Paso County tower	C	0%
54	Bldg. 6545 U.S. Army tower	C	1%
55	KKFM tower base, west side	C	6%
56	Bldg. 6291 front door (KKFM)	C	1%
57	Bldg. 6275 Mountain Communications tower	C	3%
58	GTE Airphone	C	0%
59	Bldg. 6265 (Lojack)	C	1%
60	Bldg. 6260 (Pinnacle)	C	2%
61	KSKX tower	C	5%
62	KKLI tower	C	2%
63	KKTV tower	C	1%
64	Bldg. 6245 Arch Paging front tower	C	2%
65	Bldg. 6245 Arch Paging back tower	C	3%
66	Bldg. 6233 Comm. Solutions back tower	C	2%
67	Bldg. 6233Comm. Solutions front tower	C	4%
68	Bldg. 6233Sprint BWG Tower, east leg (old tower)	C	1%
69	Bldg. 6225 KCME tower east leg (safety cable)	C	7%
70	Bldg. 6155 KXRM, 20' north of door	C	10%
71	Bldg. 6167 KTSC Channel 8	C	0%
72	Bldg. 6160 Front Door	C	2%
73	Bldg. 6180 KRCC	C	5%
74	Bldg. 61** KRDO DTV	C	3%
75	Bldg. 61** MediaFLO Front Door	C	5%
76	Bldg. 6155 KXRM, road by Qwest post	C	9%
77	Bldg. 6185	C	1%
78	Bldg. 6173 T-Mobile Microwave Building	C	1%
79	KKTV North Guy Anchor	C	7%
80	KKTV SW Guy Anchor	C	3%
81	Bldg. 6236 KOAA DTV	C	2%
82	New 250' DTV Tower (Entravision Ch. 48)	C	6%
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90			

† U = uncontrolled environment, C = controlled environment  
All measurements are spatial averages.