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March 31, 2015, updated February 22, 2016
To reflect revised equipment configuration and location

RE: Revision to proposed installation of radio base station antennas and associated equipment for the Verizon Wireless Personal Wireless Services facility to be located within the steeple of the Plymouth Congregational Church, 582 Pleasant St, Belmont, MA.

PURPOSE

I write in addendum to my report dated March 31, 2015 regarding the proposed installation at the above location. Additional theoretical calculations of maximal radio-frequency (RF) fields have been prepared due to recent changes to equipment configuration and location. The physical conditions are that Verizon Wireless proposes to install personal wireless services (PWS) directional panel antennas behind louvers of the church steeple. The antenna arrangement will include antennas in four "arrays" aimed about 90° apart. The mounting centerline height of the antennas is proposed to be at 46.1' above ground level (AGL) within the steeple. This report provides written proof that the proposed facility complies with the FCC regulations RF exposure guidelines, including without limitation in the common and residential areas within the subject building, and in the surrounding neighborhood.

This report considers the contributions of the Verizon Wireless PWS transmitters operating at their proposed capacity. The calculated values of RF fields are presented as a percent of current Maximum Permissible Exposures (%MPE) as adopted by the Federal Communications Commission (FCC),[i,ii] and those established by the Massachusetts Department of Public Health (MDPH).[iii]

SUMMARY

Theoretical RF field calculations data indicate the summation of the proposed Verizon Wireless RF contributions would be well within the established RF exposure guidelines; see Figure 2. Levels within the building will be well within the established RF exposure guidelines as well (See Figures 3-5). These results indicate there could be many more similar installations at this location, and still be within Federal and State guidelines for RF exposure.

Based on the theoretical RF fields I have calculated, it is my expert opinion that this facility would comply with all regulatory guidelines for RF exposure to members of the public including residents of and visitors within the subject building. The antenna installation proposed by Verizon Wireless would not produce a significant change to the ambient RF environment.

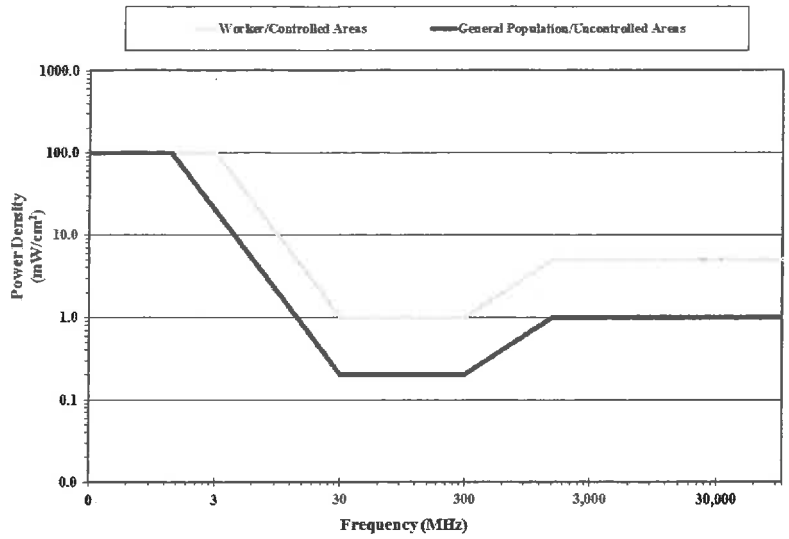


Figure 1: FCC Limits for Maximum Permissible Exposure (MPE)

EXPOSURE LIMITS AND GUIDELINES

The RF exposure guidelines adopted by the FCC are a combination of the standards published by the American National Standards Institute (ANSI) [iv] and the National Council on Radiation Protection and Measurement (NCRP). [v] Also applicable are those published by the MDPH. The RF exposure guidelines are divided into two categories: "Controlled/Occupational areas" (those areas restricted to access by RF workers only) and "Uncontrolled/Public Areas" (those areas unrestricted for public access). Listed in Table 1 below and shown in Figure 1 above are the applicable RF exposure guidelines for uncontrolled areas as they pertain to the operating frequency band of the PWS facility.

Table 1: Maximum Permissible Exposure Values for Uncontrolled/Public Areas

Frequency Band:	Maximum Permissible Exposure:
300 - 1500 MHz	f/ 1.5 in $\mu W/cm^2$
1500 - 100,000 MHz	1000 $\mu W/cm^2$ *

Note: 1 μW = 0.000001 Watt

* For equivalent plane-wave power density, where f is the frequency in MHz (10^6 Hz).

THEORETICAL RF FIELD CALCULATIONS - GROUND LEVELS

METHODOLOGY

These calculations are based on what are called "worst-case" estimates. That is, the estimates assume 100% use of all transmitters simultaneously. Additionally, the calculations make the assumption that the surrounding area is a flat plane. The resultant values are thus conservative in that they over predict actual resultant power densities. The calculations are based on the following information for VERIZON WIRELESS:

1. Effective Radiated Power (ERP) = Power out per channel (CH) X # channels per remote radio head (RRH) X #RRHs X gain the antenna provides within that frequency band.
   a. LTE-PCS: 2178 watts (30 watts/CH x 2 CH x 1 RRH x 15.6 dB) @ 1865-1870 MHz;
   b. LTE-700: 3035 watts (30 watts/CH x 2 CH x 2 RRH x 14.03 dB) @ 746-787 MHz;
   c. AWS: 2524 watts (30 watts/CH x 2 CH x 1 RRH x 16.24 dB) @ 2110-2120 MHz.
2. Antenna height (centerline, above ground level (AGL)): 46.1' AGL.
3. Antenna vertical radiation patterns; the source of the negative gain (G) values. "Directional" antennas are designed to focus the RF signal, resulting in "patterns" of signal loss and gain. These patterns (see **APPENDIX A**) display the loss of signal strength relative to the direction of propagation due to elevation angle changes. The gain values, expressed as "G^E", are also in **APPENDIX A** for the exact antennas specified.

Note: G is a unitless factor usually expressed in decibels (dB); where $G = 10^{(dB/10)}$.

For example: for an antenna *gain* of 3 dB, the net factor (G) = $10^{(3/10)} = 2$.

For an antenna *loss* of -3 dB, the net factor (G) = $10^{(-3/10)} = 0.5$.

To determine the magnitude of the RF field, the power density (S) from an isotropic RF source is calculated, making use of the power density formula as outlined in FCC's OET Bulletin 65, Edition 97-01: [vi]

$$S = \frac{P \cdot G}{4 \cdot \pi \cdot R^2}$$

Where:
P → Power to antenna (watts)
G → Gain of antenna
R → Distance (range) from antenna source to point of intersection with the ground (feet)
$R^2 = (\text{Height})^2 + (\text{Horizontal distance})^2$

Since: P · G = EIRP (Effective Isotropic Radiated Power) for broadcast antennas, the equation can be presented in the following form:

$$S = \frac{EIRP}{4 \cdot \pi \cdot R^2}$$

In the situation of off-axis power density calculations, apply the negative elevation gain (G^E) value from the vertical radiation patterns with the following formula:

$$S = \frac{EIRP \cdot G^E}{4 \cdot \pi \cdot R^2}$$

Ground reflections may add in-phase with the direct wave, and essentially double the electric field intensity. Because power density is proportional to the *square* of the electric field, the power density may quadruple, that is, increase by a factor of four (4). Since ERP is routinely used, it is necessary to convert ERP into EIRP; this is readily done by multiplying the ERP by the factor of 1.64, which is the gain of a half-wave dipole relative to an isotropic radiator. Therefore, downrange power density estimates can be calculated by using the formula:

$$S = \frac{4 \cdot (ERP \cdot 1.64) \cdot G^E}{4 \cdot \pi \cdot R^2} = \frac{ERP \cdot 1.64 \cdot G^E}{\pi \cdot R^2} = \frac{0.522 \cdot ERP \cdot G^E}{R^2}$$

To calculate the % MPE, use the formula:

$$\% \text{ MPE} = \frac{S}{MPE} \cdot 100$$

The results of the percent Maximum Permissible Exposure (%MPE) calculations for the summation of the **proposed** Verizon Wireless contributions are depicted in Figure 2 as plotted against linear distance from the base of the building (data represents updated configuration since my report from my report dated March 31, 2015). The values have been calculated for a height of six feet above ground level in accordance with regulatory rationale. In addition to the six foot height and depicted on the graph for reference only, values have been plotted for a height of 16 feet above ground level for comparison with a typical two-story structure. A logarithmic scale was used to plot the calculated theoretical %MPE values in order to compare with the MPE of 100%, which is so much larger that it would be off the page in a linear plot. The curves in the figure resemble a straight-line on the log-linear plots at distances beyond one thousand feet. Within that distance, the curves are variable due to the application of the vertical radiation patterns.

OBSERVATIONS IN CONSIDERATION WITH FCC RULES §1.1307(B) & §1.1310

Is it physically possible to stand next to or touch any omni-directional antenna and/or stand in front of a directional antenna on the rooftop? No, access to the building rooftop is restricted, and the building will adhere to RF safety guidelines regarding potential access to the proposed PWS antennas mounted on the roof, including appropriate signage.

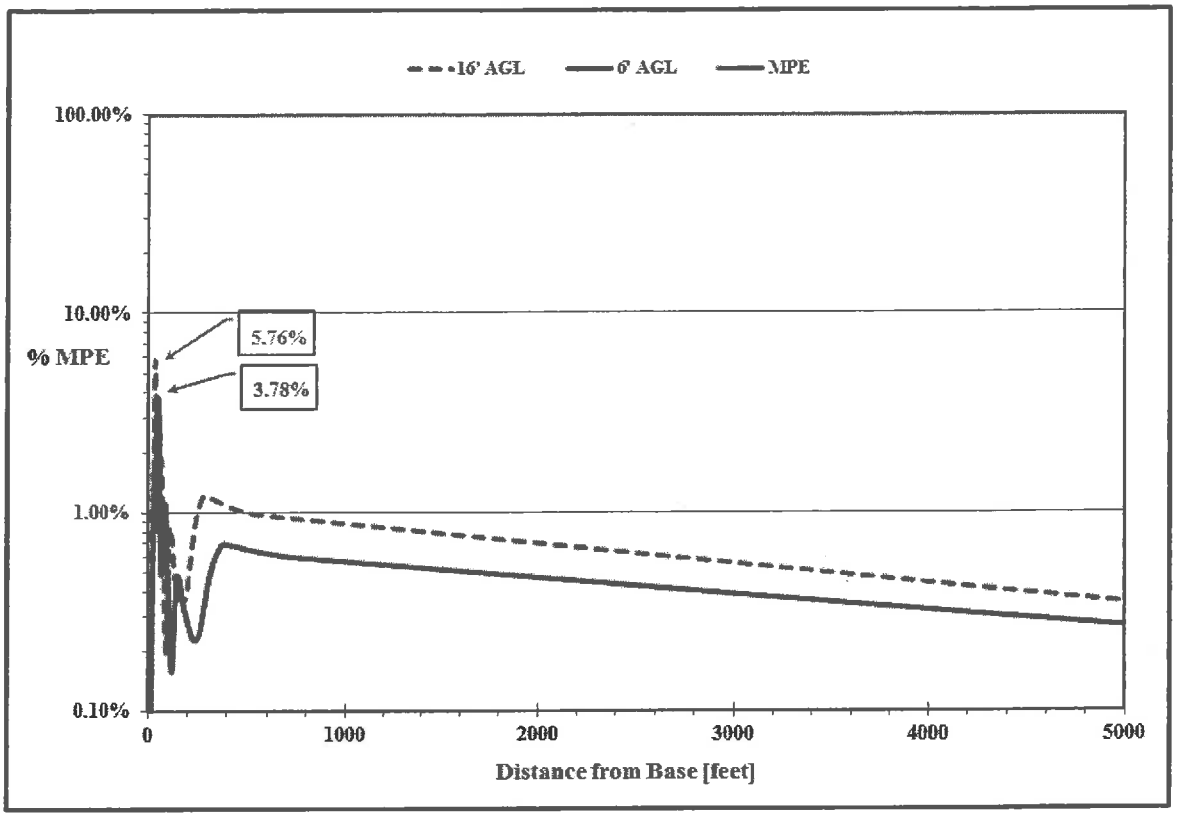


Figure 2: Theoretical Cumulative Maximum Percent MPE - vs. – Distance Proposed Verizon Wireless RF Contributions

THEORETICAL RF FIELD CALCULATIONS - WITHIN THE BUILDING

METHODOLOGY

Theoretical RF field calculations for the near proximity of RF source terms (in this case AT&T and Verizon Wireless transmit antennas) are not straight forward. For these theoretical calculations, a cylindrical model is used, where "spatially averaged plane-wave equivalent power densities parallel to the antenna may be estimated by dividing the net antenna input power by the surface area of an imaginary cylinder surrounding the length of the radiating antenna". Calculations using the previously mentioned formula would considerably overestimate the resultant power densities. The calculations performed for this analysis represent the "worst case" and assume 100% usage of all the antennas.

The power density estimates can be calculated by using the formula:

$$S = \frac{P_{net}}{2 \cdot \pi \cdot R \cdot h}$$

Where: P_{net} = Net power to antenna (watts)
R = Distance (range) from antenna
h = aperture height of the antenna

The results of the RF field calculations for the summation of the proposed Verizon Wireless antennas are depicted in Figures 3-5. NOTE: Antennas shown for positional information only; they are proposed to be installed within the steeple and NOT on each floor.

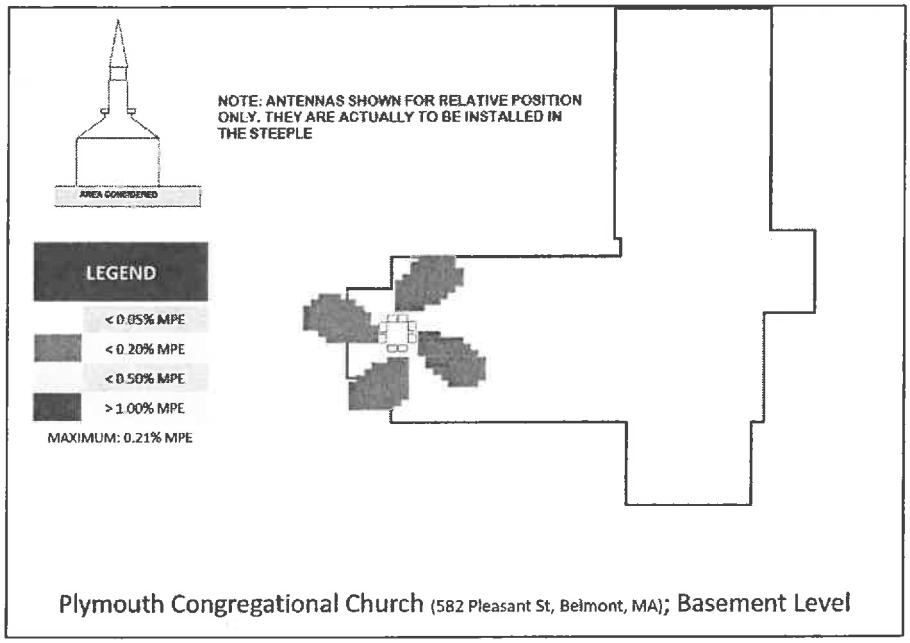


Figure 3: RF field calculations for the summation of proposed Verizon Wireless antennas; Plymouth Congregational Church: Basement Floor

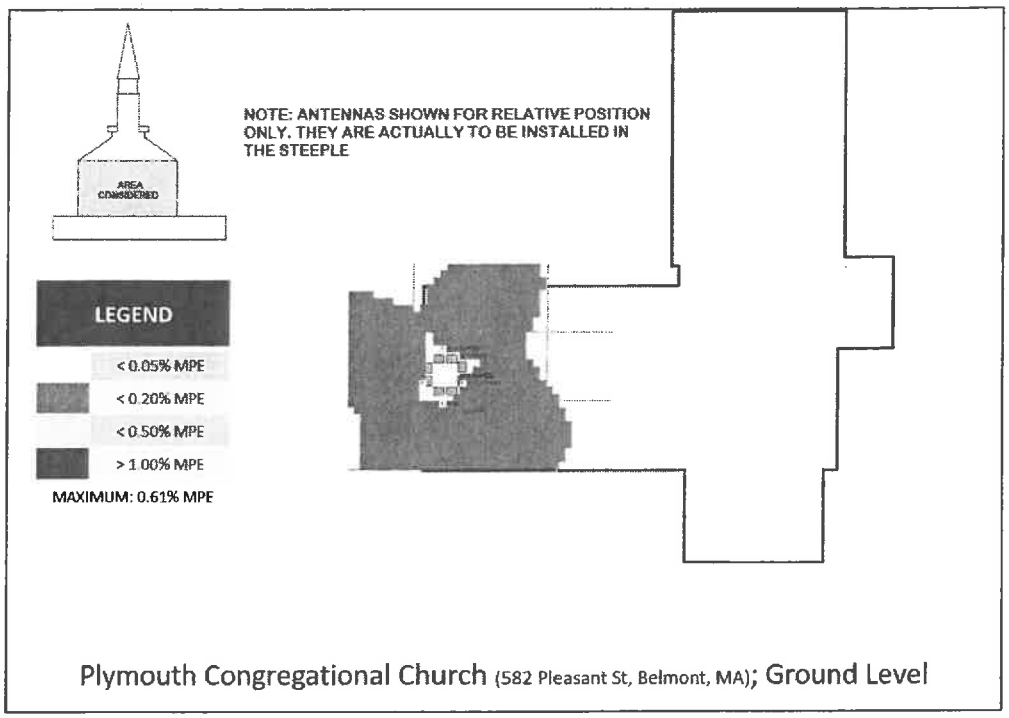


Figure 4: RF field calculations for the summation of proposed Verizon Wireless antennas; Plymouth Congregational Church: Ground Floor

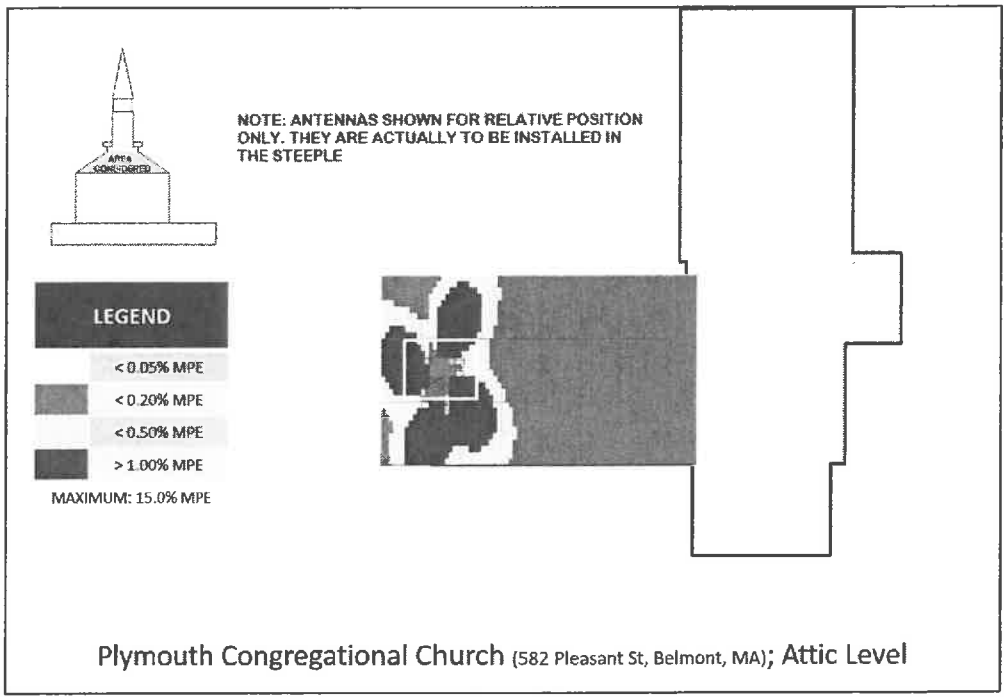


Figure 5: RF field calculations for the summation of proposed Verizon Wireless antennas; Plymouth Congregational Church: Attic Level

CONCLUSION

Theoretical RF field calculations data indicate the summation of the proposed Verizon Wireless RF contributions would be well within the established RF exposure guidelines; see Figure 2. Levels within the building will be well within the established RF exposure guidelines as well (See Figures 3-5). These results indicate there could be many more similar installations at this location, and still be within Federal and State guidelines for RF exposure.

The number and duration of calls passing through PWS facilities cannot be accurately predicted. Thus, in order to estimate the highest RF fields possible from operation of these installations, the maximal amount of usage was considered. Even in this so-called "worst-case", the resultant increase in RF field levels are far below established levels considered safe.

Based on the theoretical RF fields I have calculated, it is my expert opinion that this facility would comply with all regulatory guidelines for RF exposure to members of the public including residents of and visitors within the subject building. The antenna installation proposed by Verizon Wireless would not produce a significant change to the ambient RF environment.

Feel free to contact me if you have any questions.

Sincerely,

Donald L. Haes, Jr., Ph.D
Certified Health Physicist

Note: The analyses, conclusions and professional opinions are based upon the precise parameters and conditions of this particular site; Building at 582 Pleasant St, Belmont, MA. Utilization of these analyses, conclusions and professional opinions for any personal wireless services installation, existing or proposed, other than the aforementioned has not been sanctioned by the author, and therefore should not be accepted as evidence of regulatory compliance.

APPENDIX A

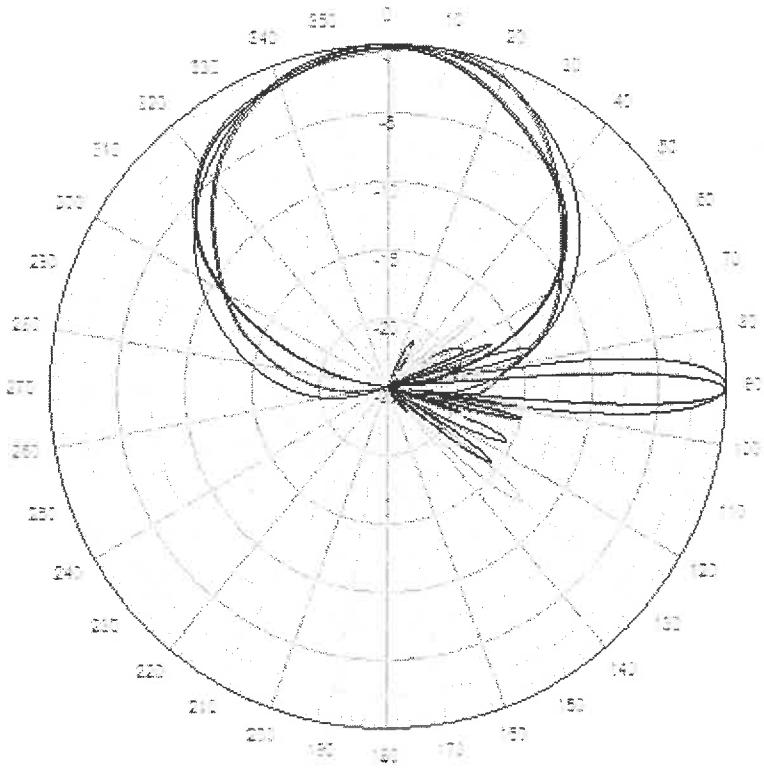
COMMSCOPE®

Base Station Antennas

Model: SBNHH-1D65C

Legend

Description	Port	Frequency	Tilt	Cut	Color
Dual Polarization	Port 1 +45	740	0	A	
Dual Polarization	Port 1 +45	740	0	V	
Dual Polarization	Port 1 +45	740	0	H	
Dual Polarization	Port 3 +45	1950	1	A	
Dual Polarization	Port 3 +45	1950	1	V	
Dual Polarization	Port 3 +45	1950	1	H	
Dual Polarization	Port 3 +45	2130	1	A	
Dual Polarization	Port 3 +45	2130	1	V	
Dual Polarization	Port 3 +45	2130	1	H	



Composite Horizontal and Vertical Radiation Patterns for Commscope SBNHH-1D65 Antennas at Specific Verizon Wireless Proposed PWS Frequencies

SBNHH-1D65C_Port 1 +45_00DT_0739

MAKE	ANDREW
FREQUENC	740
H_WIDTH	66
V_WIDTH	8.9
FRONT_TO	29
GAIN	14.03 dBd
TILT	ELECTRICAL

VERTICAL 360

Angle (deg)	Factor (dB)	Angle (deg)	Factor (dB)	Angle (deg)	Factor (dB)	Angle (deg)	Factor (dB)	Angle (deg)	Factor (dB)	Angle (deg)	Factor (dB)
0	0.00	-61	-34.24	-122	-45.56	-183	-32.58	-244	-43.35	-305	-24.07
-1	-0.13	-62	-34.90	-123	-48.51	-184	-32.47	-245	-43.45	-306	-24.81
-2	-0.55	-63	-35.19	-124	-52.74	-185	-32.41	-246	-44.26	-307	-25.49
-3	-1.27	-64	-35.33	-125	-60.68	-186	-32.43	-247	-46.00	-308	-26.05
-4	-2.32	-65	-35.54	-126	-63.83	-187	-32.52	-248	-48.86	-309	-26.41
-5	-3.76	-66	-36.03	-127	-53.65	-188	-32.72	-249	-51.30	-310	-26.57
-6	-5.64	-67	-36.96	-128	-48.69	-189	-33.02	-250	-48.46	-311	-26.57
-7	-8.11	-68	-38.57	-129	-45.33	-190	-33.46	-251	-44.19	-312	-26.49
-8	-11.38	-69	-41.22	-130	-42.73	-191	-34.09	-252	-40.97	-313	-26.45
-9	-15.80	-70	-45.59	-131	-40.57	-192	-34.96	-253	-38.61	-314	-26.51
-10	-20.85	-71	-50.82	-132	-38.71	-193	-36.10	-254	-36.86	-315	-26.76
-11	-20.94	-72	-46.78	-133	-37.07	-194	-37.47	-255	-35.55	-316	-27.20
-12	-17.97	-73	-42.18	-134	-35.63	-195	-38.83	-256	-34.58	-317	-27.80
-13	-16.25	-74	-39.54	-135	-34.39	-196	-39.61	-257	-33.91	-318	-28.38
-14	-15.74	-75	-38.10	-136	-33.34	-197	-39.30	-258	-33.50	-319	-28.57
-15	-16.26	-76	-37.51	-137	-32.47	-198	-38.22	-259	-33.37	-320	-28.00
-16	-17.82	-77	-37.55	-138	-31.80	-199	-37.00	-260	-33.52	-321	-26.74
-17	-20.75	-78	-38.05	-139	-31.30	-200	-36.02	-261	-34.01	-322	-25.19
-18	-26.05	-79	-38.74	-140	-30.97	-201	-35.36	-262	-34.89	-323	-23.70
-19	-31.33	-80	-39.22	-141	-30.80	-202	-35.01	-263	-36.24	-324	-22.44
-20	-24.67	-81	-39.18	-142	-30.76	-203	-34.94	-264	-38.17	-325	-21.44
-21	-20.22	-82	-38.69	-143	-30.85	-204	-35.05	-265	-40.80	-326	-20.70
-22	-17.71	-83	-38.15	-144	-31.06	-205	-35.29	-266	-43.93	-327	-20.19
-23	-16.30	-84	-37.83	-145	-31.38	-206	-35.57	-267	-45.72	-328	-19.85
-24	-15.63	-85	-37.83	-146	-31.81	-207	-35.84	-268	-44.43	-329	-19.62
-25	-15.55	-86	-38.10	-147	-32.36	-208	-36.05	-269	-42.46	-330	-19.44
-26	-15.97	-87	-38.44	-148	-33.03	-209	-36.18	-270	-41.17	-331	-19.25
-27	-16.87	-88	-38.60	-149	-33.84	-210	-36.21	-271	-40.69	-332	-19.05
-28	-18.23	-89	-38.41	-150	-34.74	-211	-36.10	-272	-40.91	-333	-18.89
-29	-19.99	-90	-37.99	-151	-35.73	-212	-35.84	-273	-41.68	-334	-18.89
-30	-21.95	-91	-37.63	-152	-36.76	-213	-35.44	-274	-42.72	-335	-19.17
-31	-23.45	-92	-37.61	-153	-37.77	-214	-34.92	-275	-43.45	-336	-19.90
-32	-23.68	-93	-38.10	-154	-38.77	-215	-34.33	-276	-43.26	-337	-21.26
-33	-22.81	-94	-39.31	-155	-39.82	-216	-33.74	-277	-42.28	-338	-23.50
-34	-21.69	-95	-41.52	-156	-41.10	-217	-33.18	-278	-41.13	-339	-26.29
-35	-20.79	-96	-45.36	-157	-42.91	-218	-32.67	-279	-40.17	-340	-26.20
-36	-20.22	-97	-51.23	-158	-45.83	-219	-32.24	-280	-39.43	-341	-22.45
-37	-19.98	-98	-49.29	-159	-51.56	-220	-31.91	-281	-38.79	-342	-19.04
-38	-20.02	-99	-43.85	-160	-62.48	-221	-31.71	-282	-38.11	-343	-16.62
-39	-20.31	-100	-40.65	-161	-48.90	-222	-31.68	-283	-37.21	-344	-15.06
-40	-20.80	-101	-38.78	-162	-43.09	-223	-31.84	-284	-36.01	-345	-14.24
-41	-21.43	-102	-37.75	-163	-39.62	-224	-32.24	-285	-34.55	-346	-14.18
-42	-22.14	-103	-37.35	-164	-37.26	-225	-32.91	-286	-32.94	-347	-15.02
-43	-22.84	-104	-37.44	-165	-35.59	-226	-33.91	-287	-31.27	-348	-17.23
-44	-23.40	-105	-37.93	-166	-34.41	-227	-35.29	-288	-29.63	-349	-22.38
-45	-23.74	-106	-38.74	-167	-33.61	-228	-37.17	-289	-28.09	-350	-30.58
-46	-23.82	-107	-39.72	-168	-33.11	-229	-39.68	-290	-26.68	-351	-18.46
-47	-23.70	-108	-40.65	-169	-32.84	-230	-43.15	-291	-25.41	-352	-12.44
-48	-23.50	-109	-41.16	-170	-32.73	-231	-48.18	-292	-24.31	-353	-8.66
-49	-23.34	-110	-41.03	-171	-32.72	-232	-54.81	-293	-23.38	-354	-5.97
-50	-23.29	-111	-40.38	-172	-32.75	-233	-53.23	-294	-22.62	-355	-3.96
-51	-23.41	-112	-39.52	-173	-32.79	-234	-49.10	-295	-22.03	-356	-2.46
-52	-23.74	-113	-38.74	-174	-32.83	-235	-47.02	-296	-21.60	-357	-1.36
-53	-24.29	-114	-38.17	-175	-32.85	-236	-46.18	-297	-21.32	-358	-0.60
-54	-25.06	-115	-37.89	-176	-32.89	-237	-46.11	-298	-21.20	-359	-0.16
-55	-26.05	-116	-37.93	-177	-32.94	-238	-46.45	-299	-21.23		
-56	-27.26	-117	-38.29	-178	-32.98	-239	-46.75	-300	-21.40		
-57	-28.65	-118	-38.99	-179	-32.99	-240	-46.55	-301	-21.71		
-58	-30.18	-119	-40.04	-180	-32.96	-241	-45.74	-302	-22.15		
-59	-31.73	-120	-41.45	-181	-32.87	-242	-44.69	-303	-22.70		
-60	-33.14	-121	-43.27	-182	-32.73	-243	-43.81	-304	-23.35		

SBNHH-1D65C_Port 3 +45_00DT_1949

MAKE	ANDREW
FREQUENC	1950.00
H_WIDTH	65.00
V_WIDTH	5.20
FRONT_TO	27.00
GAIN	15.6 dBd
TILT	ELECTRICAL
VERTICAL	360

Angle (deg)	Factor (dB)	Angle (deg)	Factor (dB)	Angle (deg)	Factor (dB)	Angle (deg)	Factor (dB)	Angle (deg)	Factor (dB)	Angle (deg)	Factor (dB)
0	0.00	-61	-39.26	-122	-49.11	-183	-31.02	-244	-32.51	-305	-22.96
-1	-0.63	-62	-49.27	-123	-49.00	-184	-31.88	-245	-32.26	-306	-24.45
-2	-2.19	-63	-44.34	-124	-47.78	-185	-32.39	-246	-32.94	-307	-26.49
-3	-4.95	-64	-38.63	-125	-46.26	-186	-32.94	-247	-34.89	-308	-29.28
-4	-9.61	-65	-36.99	-126	-45.56	-187	-33.80	-248	-38.82	-309	-33.41
-5	-18.30	-66	-37.87	-127	-45.98	-188	-34.90	-249	-47.80	-310	-40.74
-6	-20.26	-67	-41.28	-128	-47.04	-189	-36.04	-250	-53.93	-311	-57.12
-7	-14.49	-68	-48.14	-129	-47.22	-190	-36.70	-251	-43.68	-312	-43.48
-8	-13.45	-69	-61.74	-130	-44.93	-191	-35.72	-252	-41.10	-313	-39.84
-9	-15.34	-70	-67.97	-131	-41.01	-192	-33.58	-253	-40.47	-314	-35.16
-10	-20.01	-71	-51.78	-132	-37.18	-193	-31.95	-254	-40.14	-315	-29.78
-11	-20.75	-72	-45.34	-133	-34.18	-194	-31.40	-255	-38.89	-316	-25.54
-12	-16.18	-73	-42.65	-134	-32.12	-195	-31.85	-256	-36.71	-317	-22.44
-13	-14.14	-74	-42.10	-135	-30.93	-196	-32.82	-257	-34.50	-318	-20.25
-14	-14.35	-75	-42.57	-136	-30.45	-197	-33.60	-258	-32.89	-319	-18.85
-15	-16.83	-76	-42.99	-137	-30.47	-198	-33.95	-259	-32.06	-320	-18.27
-16	-22.97	-77	-43.29	-138	-30.73	-199	-34.39	-260	-31.98	-321	-18.60
-17	-31.98	-78	-43.71	-139	-31.01	-200	-35.28	-261	-32.42	-322	-20.10
-18	-21.94	-79	-43.33	-140	-31.28	-201	-35.97	-262	-32.80	-323	-23.31
-19	-18.53	-80	-41.58	-141	-31.72	-202	-35.18	-263	-32.55	-324	-29.94
-20	-17.98	-81	-39.81	-142	-32.53	-203	-33.37	-264	-31.78	-325	-36.55
-21	-19.47	-82	-38.90	-143	-33.62	-204	-31.96	-265	-31.06	-326	-27.38
-22	-23.23	-83	-38.89	-144	-34.58	-205	-31.45	-266	-30.74	-327	-23.65
-23	-30.82	-84	-39.23	-145	-35.03	-206	-31.83	-267	-30.82	-328	-22.19
-24	-35.65	-85	-38.97	-146	-35.33	-207	-32.83	-268	-31.19	-329	-22.13
-25	-29.97	-86	-37.96	-147	-36.17	-208	-34.01	-269	-31.54	-330	-23.14
-26	-28.43	-87	-37.01	-148	-37.76	-209	-34.92	-270	-31.38	-331	-24.37
-27	-27.11	-88	-36.61	-149	-39.44	-210	-35.41	-271	-30.53	-332	-23.76
-28	-24.63	-89	-36.77	-150	-40.03	-211	-35.63	-272	-29.48	-333	-21.57
-29	-22.64	-90	-37.24	-151	-39.83	-212	-35.79	-273	-28.79	-334	-19.90
-30	-22.08	-91	-37.55	-152	-39.83	-213	-35.82	-274	-28.66	-335	-19.47
-31	-23.32	-92	-37.33	-153	-40.25	-214	-35.35	-275	-29.04	-336	-20.49
-32	-27.26	-93	-36.87	-154	-41.20	-215	-34.39	-276	-29.87	-337	-23.17
-33	-32.27	-94	-36.56	-155	-42.37	-216	-33.52	-277	-31.02	-338	-25.85
-34	-24.37	-95	-36.18	-156	-41.14	-217	-33.30	-278	-32.04	-339	-23.14
-35	-18.80	-96	-35.35	-157	-37.67	-218	-34.03	-279	-32.29	-340	-19.42
-36	-15.37	-97	-34.52	-158	-35.01	-219	-36.00	-280	-32.03	-341	-17.22
-37	-13.16	-98	-34.42	-159	-33.70	-220	-40.00	-281	-32.14	-342	-16.28
-38	-11.81	-99	-35.48	-160	-33.33	-221	-49.91	-282	-33.14	-343	-16.29
-39	-11.18	-100	-37.81	-161	-33.01	-222	-49.01	-283	-35.08	-344	-16.94
-40	-11.20	-101	-41.22	-162	-31.84	-223	-40.86	-284	-37.32	-345	-17.86
-41	-11.83	-102	-45.13	-163	-30.15	-224	-38.13	-285	-37.52	-346	-18.88
-42	-13.04	-103	-49.34	-164	-28.77	-225	-37.66	-286	-35.37	-347	-20.22
-43	-14.81	-104	-52.16	-165	-28.01	-226	-38.80	-287	-33.49	-348	-21.98
-44	-17.19	-105	-48.85	-166	-27.88	-227	-41.17	-288	-32.67	-349	-22.80
-45	-20.25	-106	-45.84	-167	-28.20	-228	-43.86	-289	-32.39	-350	-21.46
-46	-24.15	-107	-44.56	-168	-28.62	-229	-45.27	-290	-31.40	-351	-20.38
-47	-28.32	-108	-44.16	-169	-28.83	-230	-43.87	-291	-29.39	-352	-21.49
-48	-28.96	-109	-43.91	-170	-28.81	-231	-40.08	-292	-27.30	-353	-23.51
-49	-26.41	-110	-43.62	-171	-28.84	-232	-36.68	-293	-25.71	-354	-16.83
-50	-24.40	-111	-43.55	-172	-29.21	-233	-34.64	-294	-24.64	-355	-10.37
-51	-23.32	-112	-43.99	-173	-30.05	-234	-33.99	-295	-23.99	-356	-6.04
-52	-22.93	-113	-45.27	-174	-31.40	-235	-34.61	-296	-23.63	-357	-3.11
-53	-23.01	-114	-47.69	-175	-33.09	-236	-36.30	-297	-23.42	-358	-1.22
-54	-23.44	-115	-51.50	-176	-34.36	-237	-38.49	-298	-23.23	-359	-0.20
-55	-24.17	-116	-56.79	-177	-33.93	-238	-39.71	-299	-22.94		
-56	-25.21	-117	-60.24	-178	-32.21	-239	-38.97	-300	-22.47		
-57	-26.58	-118	-56.05	-179	-30.56	-240	-37.44	-301	-21.94		
-58	-28.40	-119	-52.03	-180	-29.59	-241	-35.96	-302	-21.55		
-59	-30.81	-120	-49.82	-181	-29.44	-242	-34.60	-303	-21.53		
-60	-34.12	-121	-49.02	-182	-30.03	-243	-33.38	-304	-21.98		

SBNHH-1D65C_Port 3 +45_00DT_2109

MAKE	ANDREW
FREQUENC	2110
H_WIDTH	63
V_WIDTH	5
FRONT_TO	28
GAIN	16.24 dBd
TILT	ELECTRICAL
VERTICAL	360

Angle (deg)	Factor (dB)	Angle (deg)	Factor (dB)	Angle (deg)	Factor (dB)	Angle (deg)	Factor (dB)	Angle (deg)	Factor (dB)	Angle (deg)	Factor (dB)
0	-0.01	-61	-28.21	-122	-43.05	-183	-41.66	-244	-48.17	-305	-27.51
-1	-0.79	-62	-31.42	-123	-40.27	-184	-47.56	-245	-45.02	-306	-26.86
-2	-2.71	-63	-36.20	-124	-38.54	-185	-53.97	-246	-41.73	-307	-26.13
-3	-6.13	-64	-41.79	-125	-37.91	-186	-39.75	-247	-39.44	-308	-25.40
-4	-12.08	-65	-45.77	-126	-38.47	-187	-34.42	-248	-38.58	-309	-24.88
-5	-24.77	-66	-47.77	-127	-40.24	-188	-31.85	-249	-39.33	-310	-24.81
-6	-19.17	-67	-44.80	-128	-43.00	-189	-31.19	-250	-41.65	-311	-25.52
-7	-14.96	-68	-41.11	-129	-45.74	-190	-32.19	-251	-44.48	-312	-27.53
-8	-15.06	-69	-39.64	-130	-46.92	-191	-34.67	-252	-45.39	-313	-32.05
-9	-18.12	-70	-39.95	-131	-46.62	-192	-37.68	-253	-44.77	-314	-38.05
-10	-22.11	-71	-40.65	-132	-46.16	-193	-39.42	-254	-43.56	-315	-30.43
-11	-19.43	-72	-39.88	-133	-46.49	-194	-40.55	-255	-41.22	-316	-25.56
-12	-16.97	-73	-37.92	-134	-48.20	-195	-42.23	-256	-38.08	-317	-23.17
-13	-17.28	-74	-36.10	-135	-51.64	-196	-42.64	-257	-35.14	-318	-22.36
-14	-20.56	-75	-35.13	-136	-56.11	-197	-40.94	-258	-33.05	-319	-22.95
-15	-29.49	-76	-35.00	-137	-57.02	-198	-38.79	-259	-31.97	-320	-25.20
-16	-30.83	-77	-35.01	-138	-54.43	-199	-36.83	-260	-31.72	-321	-30.36
-17	-23.38	-78	-34.65	-139	-50.89	-200	-35.68	-261	-31.95	-322	-42.22
-18	-21.71	-79	-34.61	-140	-48.03	-201	-35.90	-262	-32.30	-323	-31.74
-19	-23.24	-80	-35.56	-141	-46.72	-202	-37.74	-263	-32.52	-324	-26.97
-20	-30.13	-81	-37.20	-142	-46.09	-203	-40.71	-264	-32.33	-325	-25.57
-21	-36.52	-82	-38.32	-143	-43.86	-204	-41.90	-265	-31.47	-326	-26.37
-22	-24.83	-83	-37.78	-144	-40.57	-205	-40.91	-266	-30.20	-327	-29.72
-23	-22.35	-84	-36.23	-145	-38.23	-206	-40.41	-267	-29.00	-328	-38.58
-24	-23.45	-85	-35.04	-146	-37.42	-207	-40.56	-268	-28.09	-329	-39.03
-25	-26.48	-86	-34.67	-147	-38.29	-208	-41.20	-269	-27.58	-330	-31.38
-26	-25.28	-87	-34.68	-148	-41.03	-209	-42.35	-270	-27.49	-331	-28.71
-27	-22.53	-88	-34.48	-149	-44.26	-210	-41.69	-271	-27.77	-332	-26.87
-28	-22.40	-89	-34.15	-150	-42.79	-211	-38.33	-272	-28.25	-333	-24.21
-29	-25.73	-90	-34.03	-151	-40.37	-212	-35.46	-273	-28.65	-334	-21.29
-30	-37.84	-91	-34.07	-152	-39.95	-213	-33.89	-274	-28.83	-335	-19.04
-31	-28.13	-92	-34.11	-153	-41.67	-214	-33.44	-275	-28.82	-336	-17.79
-32	-20.83	-93	-34.34	-154	-45.71	-215	-33.92	-276	-28.83	-337	-17.75
-33	-17.04	-94	-35.27	-155	-52.16	-216	-35.13	-277	-29.09	-338	-19.17
-34	-14.74	-95	-37.33	-156	-57.61	-217	-36.76	-278	-29.75	-339	-22.40
-35	-13.48	-96	-40.04	-157	-57.84	-218	-38.41	-279	-30.87	-340	-25.86
-36	-13.16	-97	-41.23	-158	-56.79	-219	-39.56	-280	-32.48	-341	-23.99
-37	-13.73	-98	-41.85	-159	-47.59	-220	-39.35	-281	-34.65	-342	-21.59
-38	-15.13	-99	-44.99	-160	-40.30	-221	-37.98	-282	-37.59	-343	-21.01
-39	-17.31	-100	-51.66	-161	-36.31	-222	-36.80	-283	-41.85	-344	-21.36
-40	-20.24	-101	-49.71	-162	-35.04	-223	-36.51	-284	-47.63	-345	-21.25
-41	-23.88	-102	-47.28	-163	-36.65	-224	-37.14	-285	-46.01	-346	-20.44
-42	-27.91	-103	-48.87	-164	-42.14	-225	-38.44	-286	-40.75	-347	-20.14
-43	-30.33	-104	-53.53	-165	-42.21	-226	-39.81	-287	-37.28	-348	-21.38
-44	-29.16	-105	-51.21	-166	-36.67	-227	-40.36	-288	-34.93	-349	-24.75
-45	-27.01	-106	-45.44	-167	-34.87	-228	-39.55	-289	-33.32	-350	-25.96
-46	-25.37	-107	-42.93	-168	-35.35	-229	-38.00	-290	-32.24	-351	-21.67
-47	-24.39	-108	-43.01	-169	-37.34	-230	-36.80	-291	-31.46	-352	-19.86
-48	-23.87	-109	-44.68	-170	-40.10	-231	-36.70	-292	-30.81	-353	-21.28
-49	-23.55	-110	-45.51	-171	-41.56	-232	-37.99	-293	-30.29	-354	-19.69
-50	-23.14	-111	-45.32	-172	-40.44	-233	-40.57	-294	-30.09	-355	-12.34
-51	-22.56	-112	-46.62	-173	-40.26	-234	-43.67	-295	-30.51	-356	-7.10
-52	-21.99	-113	-50.12	-174	-43.63	-235	-46.97	-296	-31.89	-357	-3.64
-53	-21.76	-114	-53.89	-175	-47.74	-236	-50.91	-297	-34.60	-358	-1.42
-54	-22.11	-115	-54.30	-176	-39.67	-237	-48.79	-298	-37.84	-359	-0.23
-55	-23.04	-116	-53.03	-177	-35.64	-238	-45.58	-299	-36.61		
-56	-24.20	-117	-51.88	-178	-34.38	-239	-45.56	-300	-33.18		
-57	-25.00	-118	-52.40	-179	-34.89	-240	-48.33	-301	-30.93		
-58	-25.29	-119	-54.60	-180	-36.47	-241	-51.16	-302	-29.61		
-59	-25.54	-120	-52.40	-181	-38.18	-242	-50.43	-303	-28.75		
-60	-26.37	-121	-47.05	-182	-39.56	-243	-49.60	-304	-28.10		

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STATEMENT OF CERTIFICATION

1. I certify to the best of my knowledge and belief, the statements of fact contained in this report are true and correct.

2. The reported analyses, opinions, and conclusions are limited only by the reported assumptions and limiting conditions, and are personal, unbiased professional analyses, opinions and conclusions.

3. I have no present or prospective interest in the property that is the subject of this report and I have no personal interest or bias with respect to the parties involved.

4. My compensation is not contingent upon the reporting of a predetermined energy level or direction in energy level that favors the cause of the client, the amount of energy level estimate, the attainment of a stipulated result, or the occurrence of a subsequent event.

5. This assignment was not based on a requested minimum environmental energy level or specific power density.

6. My compensation is not contingent on an action or event resulting from the analyses, opinions, or conclusions in, or the use of, this report.

7. The consultant has accepted this assessment assignment having the knowledge and experience necessary to complete the assignment competently.

8. My analyses, opinions, and conclusions were developed and this report has been prepared, in conformity with the *American Board of Health Physics* (ABHP) statements of standards of professional responsibility for Certified Health Physicists.

Date: February 22, 2016

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Certified Health Physicist

ENDNOTES

[i]. Federal Register, Federal Communications Commission Rules; *Radiofrequency radiation; environmental effects evaluation guidelines* Volume 1, No. 153, 41006-41199, August 7, 1996. (47 CFR Part 1; Federal Communications Commission).

[ii]. Telecommunications Act of 1996, 47 USC; Second Session of the 104th Congress of the United States of America, January 3, 1996.

[iii]. 105 CMR 122.000: Massachusetts Department of Public Health, *Non-Ionizing Radiation Limits for: The General Public from Non-Occupational Exposure to Electromagnetic Fields, Employees from Occupational Exposure to Electromagnetic Fields, and Exposure from Microwave Ovens.*

[iv]. ANSI/IEEE C95.1-1999: American National Standard, *Safety levels with respect to human exposure to radio frequency electromagnetic fields, from 3 KHz to 300 GHz* **(Updated in 2010)**.

[v]. National Council on Radiation Protection and Measurements (NCRP); *Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields*, NCRP Report 86, 1986.

[vi]. OET Bulletin 65: Federal Communications Commission Office of Engineering and Technology, *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields*; Edition 97-01, August 1999.