

**Before the  
FEDERAL COMMUNICATIONS COMMISSION  
Washington, D.C. 20554**

In the Matter of	)	
	)	
Reassessment of Federal Communications	)	ET Docket No. 13-84
Commission Radiofrequency Exposure Limits and	)	
Policies	)	
Proposed Changes in the Commission's Rules	)	ET Docket No. 03-137
Regarding Human Exposure to Radiofrequency	)	
Electromagnetic Fields	)	

**COMMENTS OF VERIZON AND VERIZON WIRELESS**

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## TABLE OF CONTENTS

<b>I. INTRODUCTION AND SUMMARY.....</b>	<b>1</b>
<b>II. THE COMMISSION SHOULD REVISE AND CLARIFY SOME OF ITS PROPOSED ROUTINE EVALUATION EXEMPTION CRITERIA.....</b>	<b>2</b>
A. The Commission Should Amend its Single Transmitter MPE-Based Exemption Thresholds for Certain Access Controlled Facilities.....	3
B. The Commission Should Clarify that Carriers Have Flexibility in Determining Which Method to Use to Evaluate the Contributions of Each Transmitter in a Multiple Transmitter Environment. ....	8
C. The Commission Should Clarify Carrier Obligations in Multiple Transmitter Scenarios. .	9
<b>III. THE COMMISSION SHOULD ADOPT CERTAIN “SAFE HARBORS” TO ADDRESS COMPLIANCE AT TRANSMITTER SITES THAT PRODUCE EMISSIONS OVER THE GENERAL POPULATION LIMIT. ....</b>	<b>10</b>
<b>IV. CONCLUSION.....</b>	<b>16</b>

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**COMMENTS OF VERIZON AND VERIZON WIRELESS<sup>1</sup>**

**I. INTRODUCTION AND SUMMARY.**

In this proceeding the Commission is appropriately taking a fresh look at several issues related to radio frequency (“RF”) emissions from wireless network transmitters and from mobile devices.<sup>2</sup> Consumers and the industry will benefit from an updated record on these issues. Verizon’s initial comments here focus on fixed network wireless transmitter sites and the Commission’s proposals in the Further Notice to update rules that determine when RF transmitter sites are exempt from “routine evaluation” (because the potential for RF exposure above Commission limits is negligible) and safety measures at sites that produce emissions over certain thresholds. Verizon supports safe and effective guidelines for RF emissions at fixed

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<sup>1</sup> In addition to Verizon Wireless, the Verizon companies participating in this filing (collectively “Verizon”) are the regulated, wholly owned subsidiaries of Verizon Communications Inc.

<sup>2</sup> *Reassessment of Federal Communications Commission Radiofrequency Exposure Limits and Policies*, ET Docket No. 13-84; *Proposed Changes in the Commission’s Rules Regarding Human Exposure to Radiofrequency Electromagnetic Fields*, ET Docket No. 03-137, First Report and Order, Further Notice of Proposed Rulemaking and Notice of Inquiry, 28 FCC Rcd 3498 (2013) (“Order,” “Further Notice,” or “NOI,” as appropriate).

network transmitter sites and rules that clearly articulate the Commission’s expectations for compliance with those standards.

The Further Notice proposes a number of positive changes to the Commission’s RF transmitter site rules that the Commission should adopt with appropriate and necessary modifications. In these initial comments Verizon focuses on three areas. First, while Verizon supports updating the RF transmitter site criteria used to exempt certain sites from proscriptive evaluation and assessment requirements, the proposed maximum permissible exposure (“MPE”)-based single transmitter exemption criteria should be revised for transmitter locations that are difficult to access by design such as towers, utility structures, and water tanks. Second, the Commission should clarify the proposed exemption criteria at multiple transmitter sites and the obligations of each carrier that operates at these co-located sites. Finally, for sites where transmitters produce emissions over the Commission’s “general population” threshold, the Commission should adopt clear safe harbor carrier mitigation procedures that better balance the Commission’s goals in this proceeding.

## **II. THE COMMISSION SHOULD REVISE AND CLARIFY SOME OF ITS PROPOSED ROUTINE EVALUATION EXEMPTION CRITERIA.**

The Commission’s existing rules identify categories of RF transmitting network facilities at which licensees are required to conduct regular, strict environmental evaluations to determine compliance with RF guidelines. These transmitter sites are referred to as sites that are subject to “routine evaluation” (a term of art in the Commission’s RF rules).<sup>3</sup> If a transmitter site is subject to routine evaluation, a licensee is required to determine whether the transmitters at the site produce emissions that are above the Commission’s general population emission’s limit at the

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<sup>3</sup> See 47 C.F.R. §1.1307(b).

time the site is put in service, whenever modifications that affect the RF emissions are made to transmitters located at the site, and routinely thereafter.<sup>4</sup> If transmitters produce emissions that are above the general population emissions limit, a licensee is required either to restrict access to the site or to prepare and submit an Environmental Assessment (“EA”) to the Commission.<sup>5</sup> At other wireless network transmitter sites the Commission’s rules are less proscriptive because – based on certain power, distance, and frequency criteria – the risk of RF exposure in excess of Commission standards is negligible.<sup>6</sup> Under the new terminology proposed by the Commission in the Further Notice,<sup>7</sup> these transmitter sites are referred to as sites that are exempt from routine evaluation. Even at transmitter sites that are exempt, however, licensees are still required to ensure compliance with the Commission’s RF limits.<sup>8</sup> The Further Notice proposes to change the exemption criteria that exclude certain transmitter sites from routine evaluation.<sup>9</sup>

**A. The Commission Should Amend its Single Transmitter MPE-Based Exemption Thresholds for Certain Access Controlled Facilities.**

For single transmitter sites, Verizon supports updating the exemption criteria excluding certain sites from routine evaluation but proposes an alternative, yet still safe and effective, formula. The proposed MPE-based single transmitter exemption criteria are overly strict and will result in a substantial number of network facilities – potentially including small cell and DAS transmitters – losing their exempt status. In keeping with the Commission’s goals of developing rules that protect the public without imposing undue burdens and increases in costs,

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<sup>4</sup> *Id.*

<sup>5</sup> *Id.*

<sup>6</sup> *See* Further Notice at ¶ 114.

<sup>7</sup> *Id.* at 113.

<sup>8</sup> *Id.* at 120; *see also* 47 C.F.R. §1.1307(c) and (d).

<sup>9</sup> Further Notice at ¶¶ 119, 130.

Verizon proposes an alternative, but still safe and effective MPE-based exemption threshold formula for single transmitters located on structures where access can more readily be controlled. These structures include towers (as that term is defined in the Commission’s rules<sup>10</sup>), light poles, utility poles or structures, and water tanks. Access to these RF transmitting sites is significantly restricted by design. Verizon proposes that, for single transmitters operating at frequencies between 400 MHz and 3 GHz and located on access controlled structures, a transmitter should require routine evaluation if the ERP  $\geq 76 R^2$ . The technical specifics of Verizon’s proposed exemption criteria formula are described in the attached Technical Appendix.<sup>11</sup>

The Commission’s MPE limits are stated in terms of power density, which can be measured in two ways: “spatial averaged power density,” which refers to the power density averaged over a human body; or “theoretical distance-based spatial peak power density,” which refers to the power density at a single, particular point on the human body – typically the head. The Commission’s proposed single transmitter exemption formula mixes technical factors appropriate for each of these two power density measurements, and therefore over-estimates what is known as the predicted “far-field power density.”<sup>12</sup> As a result, the Commission’s formula sets the threshold power density too low, meaning that more transmitters will produce emissions above the threshold level and not be considered exempt.<sup>13</sup> That result is inconsistent

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<sup>10</sup> 47 C.F.R. Part 1, Appendix C, Section II.14.

<sup>11</sup> See Technical Appendix A, at 1-3.

<sup>12</sup> *Id.*

<sup>13</sup> *Id.*

with the Commission’s objective to make only “relatively minor” adjustments in updating the exemption criteria and to avoid significant, unjustified increases in network costs.<sup>14</sup>

Correcting this problem requires a change to the proposed equation. Specifically, the Commission would need to determine whether it wants its equation to reflect spatial average power density or spatial peak power density, then use factors or values appropriate for that method. Verizon’s proposed formula reflects predicted spatial peak power density. It starts with the same formula used by the Commission used, but replaces values appropriate for predicting spatial average power density with those appropriate for predicting spatial peak power density.<sup>15</sup>

Verizon’s alternative exemption formula is appropriate for several reasons. First, as discussed above and in the Technical Appendix, its formula uses consistent factors for predicting spatial peak power density as opposed to mixing factors. Verizon’s proposed alternative approach is justified based on literature from leading scientific experts and standards.

Second, Verizon’s proposal is safe and will not put workers or the public at any greater risk of exposure. In proposing new exemption thresholds, the Commission did not find that more strict exemption criteria were needed or that the existing criteria exempted transmitter sites that produced RF emissions over the general population limit.<sup>16</sup> In any event, Verizon is proposing only that its modified exemption formula be applied to transmitters located on towers and other structures where access can more easily be controlled by licensees or their agents (*e.g.*, towers and water tanks). These sites are far less likely to experience visits from transients and untrained workers than, for example, roof-tops and other similar locations.

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<sup>14</sup> Further Notice at ¶ 114

<sup>15</sup> Technical Appendix A, at 1-3.

<sup>16</sup> *See* Further Notice at ¶ 119.

Third, the Commission proposed new transmitter exemption criteria to eliminate distinctions between service classifications (to avoid necessary changes down the road), to allow greater simplicity, and to achieve technological neutrality.<sup>17</sup> Verizon’s proposed exemption threshold formula is consistent with these goals in that it uses a simple formula and it applies to all technologies and service classifications, present and future.<sup>18</sup>

Fourth, Verizon’s proposed exemption threshold formula will eliminate undue burdens that would be created under the Commission’s proposed threshold criteria. In particular, the proposal would continue to allow many tower- or pole-mounted macro transmitters<sup>19</sup> and low-powered small cell and other similar transmitters to be exempt. That is appropriate since these sites are generally difficult to access and/or relatively low-powered. For example, under the current rules, a non-building mounted transmitter that is 10 meters or greater in height above ground level and has a power level of not greater than 1,000 or 2,000 watts (depending on the band and use) is exempt from routine evaluation.<sup>20</sup>

Moreover, it is particularly important to make sure that the “relatively minor”<sup>21</sup> changes to exemption criteria in this proceeding do not inadvertently make it uneconomical for carriers to

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<sup>17</sup> *Id.* at ¶ 119.

<sup>18</sup> While the formula proposed by Verizon would apply only to transmitters operating in the 400 MHz to 3GHz frequency bands, the formula for bands below 400 MHz and above 3 GHz can be derived by using the IEEE Std C95-1-2005 spatial peak power density figures for those bands. IEEE Std C95-1-2005, *IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300 GHz*, approved October 2005, at Section 4.6, page 28 (“IEEE Std C95-1-2005”).

<sup>19</sup> The term “macro transmitters” is used to refer to the transmitters typically deployed in CMRS networks. As compared to small cell transmitters, macro transmitters are higher powered and are mounted at greater heights so that they can provide coverage to larger geographic areas.

<sup>20</sup> See 47 C.F.R. § 1.1307(b), Table 1 (exemption criteria for non-building mounted antennas in the Cellular, PCS, and Miscellaneous Wireless Communications Services).

<sup>21</sup> Further Notice at ¶ 114.



deploy small cells. As the demand for data services continues to grow and strain capacity on limited spectrum resources, particularly in urban and other high traffic areas, the industry expects to rely significantly on small cells. These transmitters promote more efficient spectrum use by increasing capacity and throughput in targeted geographic areas. To illustrate the potential impact on small cells, Verizon prepared a study analyzing the impact of the proposed single transmitter exemption threshold criteria in the Further Notice on small cells that Verizon Wireless plans to deploy on existing telephone booths in a major city.<sup>22</sup> As demonstrated in the study, the small cells would not produce RF emissions above the Commission's general population limit, and would be exempt under both the Commission's existing exemption criteria and Verizon's proposed exemption threshold formula, but still would not qualify as exempt under the Commission's proposed criteria.<sup>23</sup>

The Commission's single transmitter exemption threshold criteria will also impact existing and proposed macro transmitter sites, particularly those between 10 meters (roughly 33 feet) and 50 feet above ground level.<sup>24</sup> The Commission already determined that any changes to exemption criteria should not affect the exempt status of existing facilities,<sup>25</sup> but when the relevant configurations of those transmitters are modified (which carriers do regularly), they will need to be re-evaluated under the new rules and may lose their exempt status. Therefore, the proposed rule change would eventually result in many existing transmitter locations losing their exempt status, and many more future macro and small cell transmitters requiring routine evaluation.

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<sup>22</sup> See Verizon Example Impact Study: Small Cells, attached as Appendix B.

<sup>23</sup> *See id.*

<sup>24</sup> *See* Technical Appendix A at 3.

<sup>25</sup> Order at ¶ 103.

**B. The Commission Should Clarify that Carriers Have Flexibility in Determining Which Method to Use to Evaluate the Contributions of Each Transmitter in a Multiple Transmitter Environment.**

At network sites where multiple carriers are co-located with RF transmitter facilities, the Commission proposes to adopt a MPE-based exemption threshold formula where further evaluation would be required if certain new criteria are met. The Commission’s proposed new multiple-transmitter formula recognizes four distinct methods to determine the RF “contribution,” expressed in terms of a ratio of actual emissions to the applicable emissions threshold, of each transmitter. The methods include: (1) for transmitters with small separation distances, by using Table 2 from the Further Notice to compare the transmitter’s actual power to the applicable threshold power limit; (2) to compare the known SAR of a transmitter to the Commission’s SAR limit; (3) for transmitters with larger separation distances, to compare the actual transmitter ERP with the applicable ERP threshold limit; and (4) to take actual measurements of each transmitter’s ambient power density or field strength and compare that measurement with the Commission’s MPE limit (referred to in the equation as the ambient exposure quotient or “AEQ”). In the proposed equation, when the ratio for each transmitter is summed, if the total is equal to or greater than 1, then the exemption does not apply and routine evaluation is required.<sup>26</sup>

Verizon does not quarrel with the proposed equation to determine RF contributions of carriers at multiple-transmitter sites. But since each method is independently reasonable, carriers should be allowed to use any appropriate method to determine the contributions of each transmitter at a multiple transmitter location. Thus, for example, Verizon prefers, due to the difficulty of obtaining information (such as a transmitter’s SAR) necessary to calculate ratios

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<sup>26</sup> Further Notice at ¶ 141.

using some methods, cost considerations, and/or its comfort level with one method over others, to consider the contributions of every transmitter at a location by using either the ERP ratio or by taking actual measurements (AEQ). It therefore requests that the Commission not require any particular contribution determination method be used for any particular transmitter and clarify that, so long as the contribution determination method is appropriate for the transmitters for which it is used, a carrier may use any of the four methods for determining the contributions of each transmitter at a multiple transmitter location for purposes of computing this equation.

**C. The Commission Should Clarify Carrier Obligations in Multiple Transmitter Scenarios.**

The Commission's existing rules provide that, in areas where multiple fixed transmitters are operating, actions necessary to bring the area into compliance with Commission rules are the shared responsibility of all licensees ("responsible licensees") whose transmitters produce more than 5% of the power density exposure limit.<sup>27</sup> In the Further Notice, the Commission proposes that responsible licensees also be jointly responsible for mitigating actions when RF emissions at the co-located site exceed the general population exposure limit.<sup>28</sup> These rules and proposals imply but do not make clear that licensees whose transmitters that do *not* produce more than 5% of the applicable power density exposure limit are considered exempt from routine analysis and neither need to consider the impacts of other transmitters in their analysis nor have shared responsibility for bringing a site that is over the general population limit into compliance. This clarification is both consistent with the existing 5% rule and appropriate – since the exemption would only apply to transmitters that by definition produce emissions well below the general

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<sup>27</sup> 47 C.F.R. § 1.1307(b)(3).

<sup>28</sup> Further Notice at ¶ 193.

population limit. The Commission should clarify this understanding so that all licensees have the same expectations and can appropriately coordinate compliance with the new rules at multiple transmitter sites.

In addition, because the Further Notice does not include a proposed equation to determine whether a carrier's transmitter exceeds the 5% power threshold at a multiple transmitter site, Verizon developed one.<sup>29</sup> The Commission should include this equation in any final rule that changes the exemption formula for multiple transmitter sites.

### **III. THE COMMISSION SHOULD ADOPT CERTAIN “SAFE HARBORS” TO ADDRESS COMPLIANCE AT TRANSMITTER SITES THAT PRODUCE EMISSIONS OVER THE GENERAL POPULATION LIMIT.**

For fixed transmitter sites, the Commission proposes to adopt a set of training, access restriction, and signage requirements. In particular, the Commission proposes to divide fixed transmitter sites into four categories: (1) locations where operational characteristics would not cause RF exposure to exceed the general population threshold; (2) locations where the exposure limit for the general population would be exceeded but not the exposure limit for occupational personnel; (3) locations where the exposure limit for occupational personnel would be exceeded and has the potential to exceed this limit by up to a factor of ten; and (4) locations where the exposure limit for occupational personnel would be exceeded by at least a factor of ten or where there is a possibility for serious contact injury (*e.g.*, electrocution). Each category (with the exception of Category 1) would entail an escalating level of access control, transient access restrictions, and training and protection requirements for occupational personnel.<sup>30</sup>

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<sup>29</sup> See Technical Appendix A at 3-4.

<sup>30</sup> Further Notice at ¶¶ 184-203.

Verizon agrees with the Commission that clear rules are needed so all affected parties know what to expect at RF transmitter sites and that carriers know with certainty what actions are required to appropriately protect the public and workers from RF exposure. It is concerned, however, that the proposed rules, like the current rules, expose carriers to liability for actions and events beyond their control. To address that concern, Verizon proposes that the Commission adopt a clear set of “safe harbor” actions, each of which is under a carrier’s reasonable control.

The current Commission rules and guidance provide that a licensee is compliant with RF transmitter site requirements, even if the facility or operation exceeds the Commission’s general population exposure limits, where accessibility is “appropriately restricted.”<sup>31</sup> Neither the rules nor OET Bulletin 65 set forth clear guidelines for determining how access should be restricted. And, as a practical matter, carriers cannot be present to monitor access at transmitter sites at all times. Many sites are located on roof-tops or other structures that wireless carriers do not own and that can be accessed relatively easily or with moderate effort. Carriers alone cannot control transient individuals nor employees of others that may access areas surrounding transmitters at these sites for occupational reasons.

In many respects, therefore, the current rules and guidance are unworkable to the extent there is no action carriers can take, short of making sure that no facilities or operations exceed the general population limit (which is not practical), to be certain that they are compliant. The rules proposed in the Further Notice perpetuate this problem to a significant extent. For example, transient individuals would only be allowed in areas that do not exceed the

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<sup>31</sup> FCC OET Bulletin 65, *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields*, Edition 97-01, August 1997 (“OET Bulletin 65”) at 58.

occupational exposure limit and only if accompanied by trained individuals.<sup>32</sup> Thus it would appear that the Commission is suggesting even if signs and access control requirements set forth for each category are in place, and even if building managerial personnel are notified about the risks of exposure and offered training, that if a roof-top door intended to be locked is left unlocked (for whatever reason) at the time of inspection, a carrier may still be deemed to have violated the Commission's rules.

Among the Commission's goals in revisiting its RF safety rules was avoiding undue burden in complying with the rules.<sup>33</sup> Making compliance dependent on the actions of third parties that carriers cannot control is not consistent with that objective and is not a workable standard in any event. To alleviate this problem, the Commission should adopt minimum "safe harbor" requirements which, if met, would satisfy the Commission's RF safety rules at transmitter sites. These safe harbors should be reasonably tailored to actions that licensees can actually control. And if an appropriate measures are not under a carrier's control, such as placing and maintaining locks or alarms on roof-top access doors, then the carrier could be required to make best efforts to have the responsible party implement and maintain appropriate access control mechanisms. To ensure worker and transient safety, the safe harbor requirements should include the following elements: category-appropriate signage, access controls, indicative or physical barricades, RF safety training, information about RF exposure risks in accessible areas, and 24/7 contact information. Basing compliance on a clear set of safe harbor requirements that are under a carrier's reasonable control (or appropriate best efforts when not) is consistent with the Commission's goals in this proceeding and strikes an appropriate balance.

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<sup>32</sup> Further Notice at ¶ 196.

<sup>33</sup> *See id.* at ¶¶ 1, 109.

In establishing safe harbor requirements, the Commission should balance public safety concerns with concrete actions under licensees' control. For example, in its proposed requirements for Category 3 (locations that exceed the occupational exposure limit), the Commission proposes to require controls or indicators (such as chains, railings contrasting paint, diagrams) surrounding the area in which the occupational exposure limit is exceeded.<sup>34</sup> However, while carriers are generally able to place signs, barricades or other indicators within the leased areas on a roof-top, building owners/managers may refuse permission or otherwise limit carrier's ability to place controls or indicators outside of the leased areas. Accordingly, any safe harbor requirements to place or erect controls or indicators must be flexible and allow carriers to demonstrate, in the event such barriers or access restrictions cannot be erected, that the carrier made best efforts to put appropriate access controls in place that provide adequate warning to workers and transients of the areas where exposure risks occur. These best efforts could include negotiated lease terms as roof-top leases come up for renegotiation and carrier site inspection plans.

Another area that warrants a flexible approach is in implementing any requirement for carriers to place new or additional signs at locations that might be accessible to workers or transients. In the Further Notice, the Commission proposes to adopt standardized warning signs that will identify the particular exposure category present at accessible locations.<sup>35</sup> In addition, by stating that the requirements for each category are in addition to requirements for the lesser categories that may apply, the Further Notice appears to propose that multiple signs could be required at a particular transmitter location. For example, if a transmitter on a roof-top produces

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<sup>34</sup> *Id.* at ¶ 196. Barricades and/or indicators may also be required to prevent access or inform the public about Category 2 exposures.

<sup>35</sup> *Id.* at ¶ 190.

emissions that exceed the occupational exposure limit, the proposed rules would require “*additional signs*” with the appropriate word “Caution” and yellow color to be placed to designate where the occupational limit is exceeded.<sup>36</sup> Presumably, then, carriers would be required to place both Category 2, “Notice” signs, and Category 3 “Caution” signs near the same transmitting antennas.

Any new RF signage requirements will take significant time and resources to implement across the industry. Verizon Wireless alone has thousands of roof-top antenna locations, each of which may have multiple locations requiring signs to be changed or added, and each of which will require multiple site visits – first to take measurements to determine the appropriate Category or Categories that apply and then again to place the signs in appropriate locations. In addition, winter weather concerns and the fact that carriers will be approaching a limited number of RF and sign vendors will make bringing sites into compliance with any new requirements expensive and time consuming.

To help mitigate these concerns, Verizon recommends, first, that the Commission eliminate the proposed requirement to place multiple signs at a transmitter location. Requiring multiple signs at a particular location will not only add to the expense and difficulty of complying with the requirement, but will also risk creating confusion and “over-signage,” which may result in disregard of meaningful postings.<sup>37</sup> To illustrate, the area on a roof-top where a transmitter exceeds the occupational exposure limit category may only extend a few feet in front of the area where the general population limit is exceeded. In this situation, which is common, requiring carriers to place both Category 2 “Notice” and Category 3 “Caution” signs will not

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<sup>36</sup> *Id.* at ¶ 196 (emphasis added).

<sup>37</sup> *See Id.* at ¶ 194 (warning of the dangers of “over-signage”).



likely provide useful information regarding where one Category stops and the other begins and will only result in confusion.<sup>38</sup> To avoid this situation, the Commission should only require that the carrier place signs for the highest category present at the location. Second, the Commission should give carriers ample time – a minimum of two years -- to bring new and existing sites into compliance with any new requirements.

Finally, the Commission should be clear about where signs must be located – both access point and antenna-mounted signs – and about what these signs should say. Clear expectations for warning sign locations and content will help educate the public about RF exposure through a consistent experience whenever individuals are near transmitter sites and will also help licensees comply with Commission rules.

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<sup>38</sup> The proposed rule for Category 3 provides that when the boundaries between Category 2 and 3 are such that the required signs would be in the same location, then the Category 2 sign is optional. *Id.* at Appendix B. However, this rule allowance does not address the situation when signs may be only a few feet apart.



**TECHNICAL APPENDIX A**

**COMMENTS OF VERIZON AND VERIZON WIRELESS**

**ET Docket No. 13-84**  
**ET Docket No. 03-137**

September 3, 2013

## I. Derivation of Verizon's Proposed MPE-based Exemption Formula

Verizon proposes that, for single transmitters operating at frequencies between 400 MHz and 3 GHz and located on towers, light poles, utility poles or structures and water tanks, the Commission amend its proposed single transmitter MPE-based exemption criteria and adopt an exemption threshold formula requiring routine evaluation if the  $ERP \geq 76 R^2$ .<sup>2</sup> The starting point for the equations proposed by the Commission was an equation for predicting worst-case far-field power density with 100% reflection of incoming radiation.<sup>1</sup> That equation is  $ERP = \frac{\pi SR^2}{1.64}$ , where S is the power density MPE limit stated in  $W/m^2$ . The Commission's equation uses a power density MPE limit that is appropriate for predicting spatial averaged power density. Richard A. Tell, a leading expert in the field, however, advises that including a reflection factor is appropriate for predicting spatial peak power density, but not spatial averaged power density:

[I]t is common for individuals to compute RF fields using conventional far-field formulations to obtain a value for the RF field at a point in space and, then, to multiply this value by a factor, typically 2.56 as called out in FCC OET-65, to account for the possibility of ground reflections. For assessing the spatial peak value of [the] field, this is a reasonable approach. However, when calculating RF fields in terms of spatial averages, inclusion of the ground reflection factor, in general, will yield values that are excessive. This can be understood by simply considering the phase addition AND phase cancellation of resulting fields as a function of height above ground. On average, along a six-foot vertical line, one would expect that the spatial average field (power density) would tend to approximate the free-space computed value, without applying a ground reflection factor.<sup>2</sup>

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<sup>1</sup> Further Notice at Appendix C, *citing* FCC OET Bulletin 65, Equation 6. One hundred percent reflection assumes that 100% of the emissions are reflected back into the measured field thus doubling the predicted field strength and causing a four-fold increase in far-field power density. OET Bulletin 65 at 22.

<sup>2</sup> Letter from Richard A. Tell, President, Richard Tell Associates, Inc., to Robert F. Cleveland, PhD, FCC Office of Engineering and Technology, dated October 6, 1998, available at: <http://www.radhaz.com/docs.php>.

Because the Commission's formulae mixes factors appropriate for spatial averaged power density MPE limits (its power density MPE limit) with factors appropriate for spatial peak power density (the assumption that 100% of incoming radiation is reflected), the Commission's threshold equation over-estimates the predicted far-field power density resulting in an overly strict set of exemption thresholds. To correct this problem, Verizon developed its proposed equation by using the same equation as the Commission, including keeping the 100% reflection factor, but substituting a value for S (power density) that is appropriate for predicting spatial peak power density. Verizon's power density value was derived from IEEE Standard C95.1-2005, the most recent version of the standard relied on extensively by the Commission in OET Bulletin 65 to derive its equations.<sup>3</sup> It provides:

The spatial peak value of the power density or mean squared field strength shall not exceed 20 times the square of the allowed spatially averaged values at frequencies below 400 MHz, and shall not exceed the equivalent power density of **40 W/m<sup>2</sup>** at frequencies between 400 MHz and 3 GHz, 18.56 (f)<sup>0.699</sup> W/m<sup>2</sup> at frequencies between 3 and 30 GHz, and 200 W/m<sup>2</sup> at frequencies above 30 GHz.<sup>4</sup>

Taking the Commission's equation then and cross-multiplying, one gets the following equation:

$$\blacktriangleright R^2 * S * \pi = (1.64 * ERP)$$

By using 40 W/m<sup>2</sup> (from the IEEE C95-1-2005 standard) as the value for S, and solving for ERP, one arrives at Verizon's proposed threshold equation for frequencies between 300 MHz and 3 GHz.

$$\blacktriangleright R^2 * \left(40 \frac{W}{m^2}\right) * \pi = 1.64 * ERP_{Threshold}$$

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<sup>3</sup> See, e.g., OET Bulletin 65 at 8-9.

<sup>4</sup> IEEE Std C95-1-2005 at Section 4.6, page 28 (emphasis added).

$$\blacktriangleright 76 * R^2 = ERP_{Threshold}$$

## II. Impact of the Commission’s Proposed Exemption Criteria

To illustrate how the Commission’s proposed exemption threshold could impact transmitters, consider, for example, a cellular transmitter mounted on a structure 34 feet above ground level with an ERP of 1000 W. This transmitter would be exempt under the current rules both because it’s height is greater than 10 M and its ERP is less than 1000 W. Under the Commission’s proposed exemption threshold formula however, where the frequency is 850 MHz, and the separation distance (“R”) is 8.53 m, a transmitter would not be exempt if the ERP  $\geq (0.0128) * (8.53 \text{ meters})^2 * (850 \text{ MHz}) = 791.639 \text{ W ERP}$ . Thus, the transmitter described above with 1000 W ERP, would no longer qualify as exempt from routine evaluation. Under Verizon’s proposed equation, the same transmitter would be exempt, since  $76 * (8.53 \text{ meters})^2 = 5529.82 \text{ W ERP}$ , which is greater than the ERP of the transmitter in the example.

## III. Verizon’s Proposed Five Percent Threshold Equation

Verizon has developed the following equation for use in determining whether an individual licensee’s transmitters at a multiple transmitter site exceeds the 5% ERP threshold:

**VZW Proposal:  
AEQ Exemption Equation**

$$\sum_{k=1}^c \left( \frac{ERP_k}{ERP_{th,k}} \right) \leq 0.05$$

Where:

$c$  = number of fixed RF sources using ERP, according to restrictions on  $ERP_k$ .

$ERP_k$  = ERP of RF source  $k$ .

$ERP_{th,k}$  = exemption threshold ERP for RF source  $k$ , either at a distance of at least 20 cm up to 40 cm if using Table 2 or at any distance of  $\lambda/2\pi$  or greater, if using Table 1.

This equation compares the ERP of a particular licensee's transmitters at a multiple transmitter location to the applicable ERP exemption threshold.

**APPENDIX B**

**COMMENTS OF VERIZON AND VERIZON WIRELESS**

**ET Docket No. 13-84**  
**ET Docket No. 03-137**

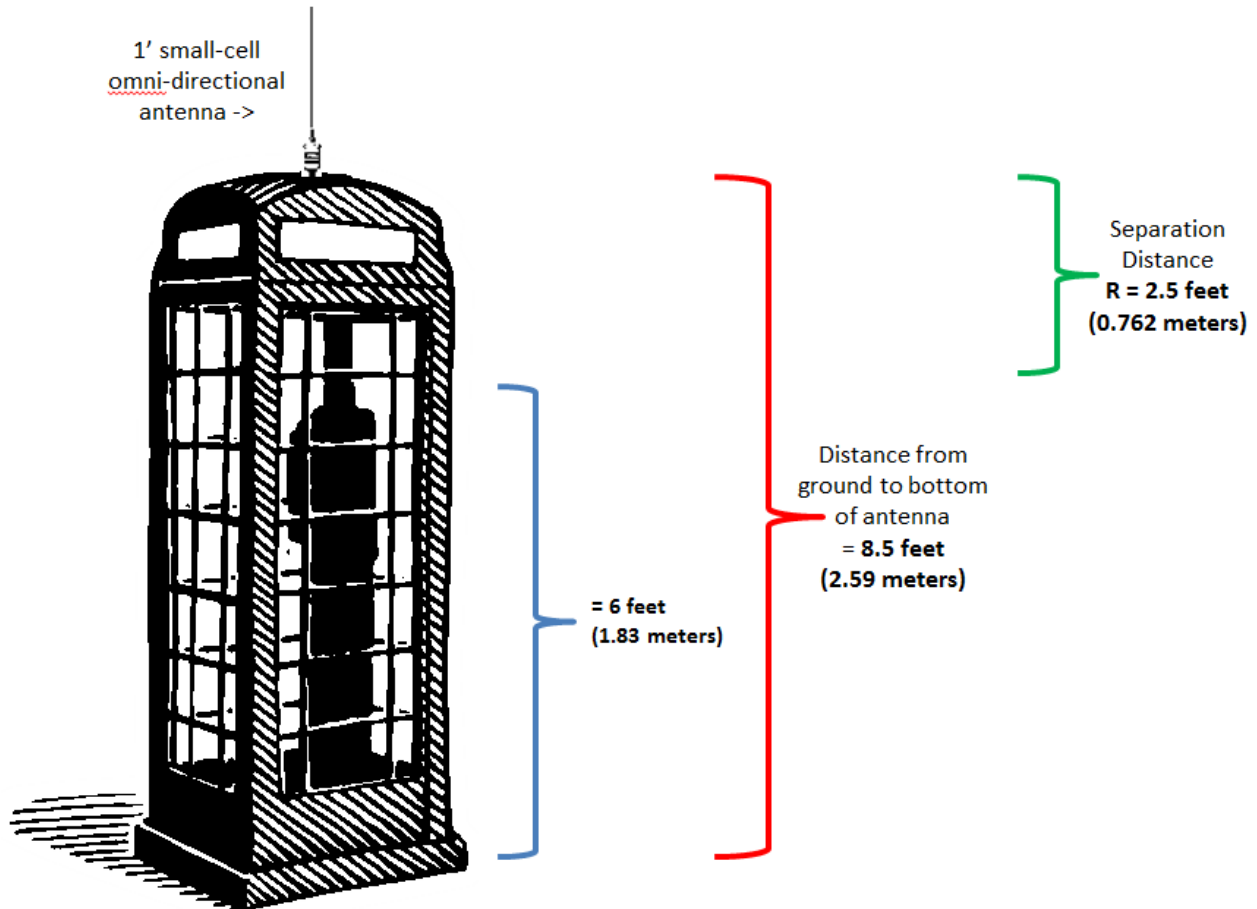
September 3, 2013



# Example Impact Study: Small Cells

## Real Scenario:

Verizon Wireless plans to place small-cell antennas on 8.5' tall phone booths in a major city.



## Anticipated Antenna & Power Specifications:

**Minimum Small-Cell Transmitter Power** =  $2 \times 5$  (watts) = 10 watts

**Minimum Antenna Gain** = 0 dBd = 1 dB (numeric)

**Loss** = 0 dB

**Horizontal Beamwidth** = 360 degrees

**Transmit Frequency** = 746 MHz (LTE only)

**Effective Radiated Power (ERP)** = Power (watts) x Antenna Gain (numeric) = 10 watts

**Separation Distance "R"** = 2.5 feet (0.762 meters)

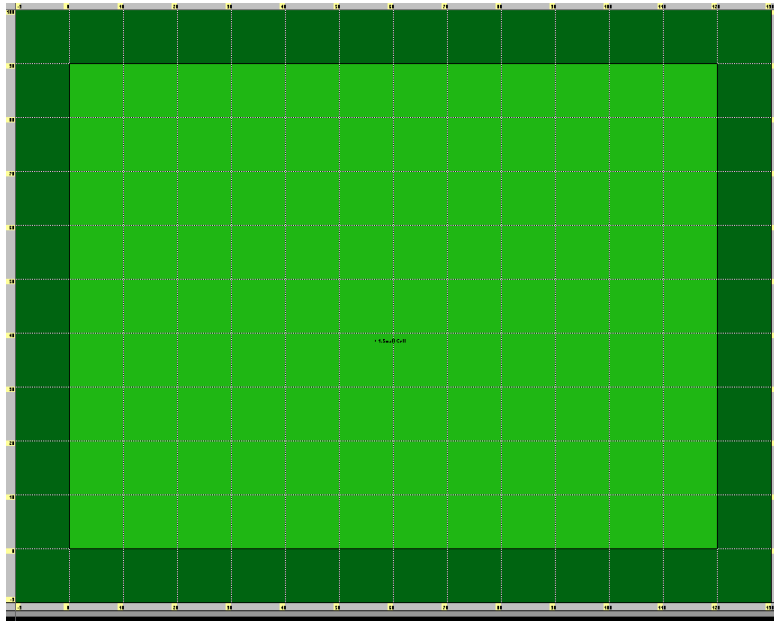
**FCC-Proposed Threshold ERP** =  $0.0128 * R^2 * f$

=  $(0.0128) * (0.762 \text{ meters}) * (0.762 \text{ meters}) * (746 \text{ MHz}) = 5.54 \text{ watts ERP}$

**Ground-Level RF Analysis (Via Richard Tell's RoofView Application):**

Ren	Del	P		-> Col		X ApHt	Expo	A	O	AntHt												
Cle	Ins	H	Update	Calcul		Impo	A	O	Show	Calculator Done with												
Antenna Data Table																						
Last File Imported-> Rooftop Example Site Data.xls																						
Ant Num	ID	Name	(MHz) Freq	Trans Power	Trans Count	Coax Len	Coax Type	Other Loss	Input Power	Calc Power	Mfg	Model	(ft) X	(ft) Y	(ft) Z	(ft) Type	dBd Aper	Gain	BWdth Pt Dir	ON flag	Antenna Pkcel X Y Z	Ant Num
1	Small Cell	Small Cell	746.00000						10.0	10.0			57.0	39.0	8.5	X	1.0		omni	ON	57 39 8.5	1

**(Antenna Data)**



**(RF Exposure Plot: Total Analyzed Area = 120' x 90')**

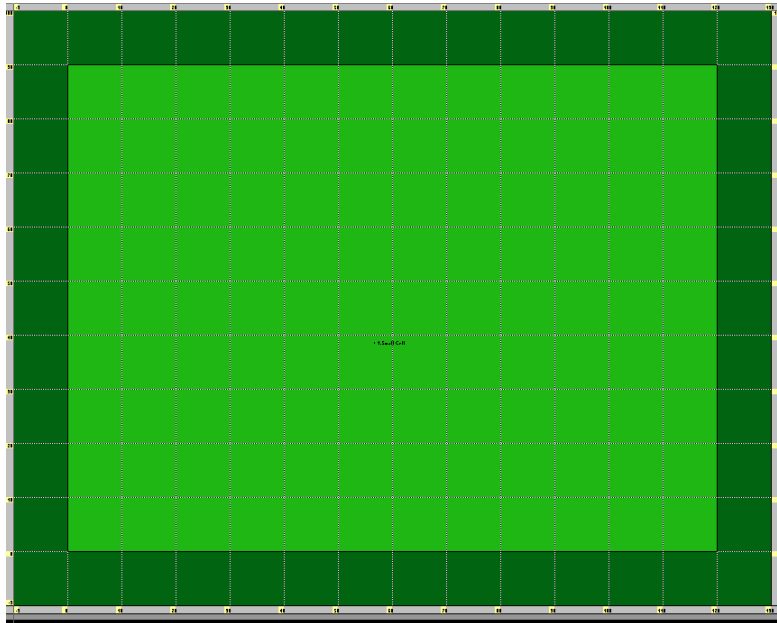
Statistical Summary		
%MPE	SQ. FT.	%SQ. FT.
	10800	100.00 % of total ROOF Area
0-20	10800	100.00 % of Selected Area
21 - 100	0	0.00 % of Selected Area
101 - 1000	0	0.00 % of Selected Area
> 1000	0	0.00 % of Selected Area
Roof Area 10800 sq. ft.		
Max %MPE 17.1 %		
Min %MPE 0.0 %		
Using Near/Far Spatial Avg Model		
With FCC 1997 Public Standard		

**(Statistical Summary)**

**Antenna-Level RF Analysis (Via Richard Tell's RoofView Application):**

Ren	Del	P	Update	-> Col	X ApHt	Expo	A	O	Calculator	Done with														
Cle	Ins	H		Calcul	Impo	A	O	Show																
Antenna Data Table																								
Last File Imported-> Rooftop Example Site Data.xls																								
Ant Num	ID	Name	(MHz) Freq	Trans Power	Trans Count	Coax Len	Coax Type	Other Loss	Input Power	Calc Power	Mfg	Model	(ft) X	(ft) Y	(ft) Z	(ft) Type	dBd Aper	Gain	BWdth Pt Dir	ON flag	Antenna Pixel X	Antenna Pixel Y	Antenna Pixel Z	Ant Num
1	Small Cell	Small Cell	746.00000						10.0	10.0			57.0	39.0	0.0	X	1.0		omni	ON	57	39	0.0	1

**(Antenna Data)**



**(RF Exposure Plot: Total Analyzed Area = 120' x 90')**

Statistical Summary		
%MPE	SQ. FT	%SQ. FT.
	10800	100.00 % of total ROOF Area
0 -20	10787	99.88 % of Selected Area
21 - 100	13	0.12 % of Selected Area
101 - 1000	0	0.00 % of Selected Area
> 1000	0	0.00 % of Selected Area
Roof Area 10800 sq. ft.		
Max %MPE 57.1 %		
Min %MPE 0.0 %		
Using Near/Far Spatial Avg Model		
With FCC 1997 Public Standard		

**(Statistical Summary)**

**Summary:**

Max % General Population (Ground Level) Spatially-Averaged MPE = **17.1%**

Max % General Population (Ground Level) Spatially-Averaged MPE = **57.1%**

## **Conclusion:**

- Configuration **does not exceed** spatially-averaged General Population MPE limits on the ground or near the antenna. According to the Commission's proposed rule, however, this configuration would require annual evaluations to demonstrate compliance:

Actual ERP = **10 watts**, which is **greater than** the FCC-proposed threshold of **5.54 watts**. Thus, this configuration would require routine (annual) evaluations to demonstrate compliance.

- Existing rules indicate that because the bottom of the antenna is below 10 meters (~33 feet) AND the ERP is LESS than 1000 watts, this configuration would NOT require routine (annual) evaluations to demonstrate compliance.
- The recommended ERP threshold is  $76 * R^2 = 76 * (0.762)^2 = 44.13$  watts which would remove the annual evaluation requirement since the actual ERP is less than the recommended ERP threshold.
- The anticipated antenna specifications for small cells are as follows:
  - Low gain (**greater than** 0 dBd in most cases) antennas.
    - With regard to the example used above, the ERP is more likely to be higher than 10 watts.
  - 2x5 watts (10 watts total transmitter power) for LTE service.
  - 2x5 watts (10 watts total transmitter power) for AWS service in the near future.
  - No transmission line loss because of the utilization of remote radio heads.
  - The horizontal beamwidth of the antennas will vary from 33 to 360 degrees.