Before the
Federal Communications Commission
Washington, DC 20554

In the Matter of	)	
Unlicensed Operation in the TV Broadcast Bands	)	ET Docket No. 04-186
Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz	)	ET Docket No. 02-380

COMMENTS OF THE CONSUMER ELECTRONICS ASSOCIATION

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The Consumer Electronics Association ("CEA") submits these comments in response to the Notice of Proposed Rule Making ("*Notice*") in the above-captioned proceeding.[1]

I. INTRODUCTION

The Consumer Electronics Association is the principal U.S. trade association of the consumer electronics and information technologies industries. Our members design, manufacture, distribute and sell digital and analog television receivers, monitors and associated electronics such as digital video recorders ("DVRs"), video cassette recorders ("VCRs"), direct broadcast satellite radios ("DARS"), satellite television receivers ("DBS"), broadcast AM and FM radios, and similar products. Our members also design and manufacture unlicensed devices such as Wi-Fi network devices that connect personal computers, personal digital assistants

[1] Unlicensed Operations in the TV Broadcast Band, ET Docket No. 04-186, Notice of Proposed Rulemaking ("*Notice")*, Released May 25, 2004.

("PDAs") and laptops to peripheral devices and networks, cordless phones, baby monitors, and wireless headsets.

CEA's more than 1,700 member companies include the world's leading consumer electronics manufacturers. CEA supports the Commission's intent in this proceeding to allow unlicensed device operation in vacant TV broadcast bands while ensuring that TV broadcast is fully protected from interference. Allocating this spectrum for unlicensed use would advance the deployment of many new and innovative products and services. Television manufacturers, broadcasters, semiconductor manufacturers, and networking companies have spent many hours considering the benefits and implications of this proceeding in multi-party venues, like IEEE and CEA.

When changing rules to allow for secondary unlicensed use, the probability and consequence of interference with current users must be fully examined. Due to the extremely large population of television receivers currently in American homes, 287 million by CEA's estimate[2], ensuring that TV broadcast reception is fully protected must be the primary objective.

After much examination, CEA believes that the proposed rules need to be refined to prevent unintentional yet widespread interference. Although CEA typically argues for minimal rules related to unlicensed devices, the environment of licensed services into which these unlicensed devices would be introduced is not empty or even sparsely populated in this case.

Furthermore, we are extremely concerned with the potential negative implications interference could have on the DTV transition. For the DTV transition to be successful, we must

[2] *2004 CE Ownership and Market Potential Study*, June 2004, eBrain Consumer Research (a business unit of the Consumer Electronics Association)

strive for absolute consumer satisfaction with their digital TV signal. Therefore, we generally support use of vacant TV broadcast bands by fixed access device, but believe greater caution must be taken for personal/portable devices by introducing them at a lower power level after reliable, non-interfering operation has been demonstrated.

II. Potential Interference Concerns Require Further Testing and Examination

To provide a full and thorough evaluation of the Commission's proposal, CEA first identified the following list of possible interference concerns that require further examination.

- The Control signal required for personal/portable operation does not have specific requirements to ensure it is only receivable at locations for which its available channel list is accurate.[3] We believe the Commission intends that accurate Control signal information is the responsibility of the signal provider. There is however, no guidance for example, as to how a control signal contained in a broadcast television signal can ever be assured to only be receivable within the applicable Grade B contour.

- Using 10 meters[4] as the distance for calculating whether an unlicensed device will interfere may lead to interference in dense environments, like apartments. This distance defines a sphere, some 65 feet in diameter, within which interference can be ignored for calculating available channels. The Commission bases this distance on an assumption that the area inside this sphere is controlled by the user of the unlicensed device. This generous distance clearly does not apply for apartments or even small lot-size detached homes. CEA plans to collect a limited amount of data on the amount of attenuation experienced by signals in passing from inside a house to outside. If that attenuation is small or has a high standard deviation, the 10 meter distance is suspect.

- The allowed transmit power for both fixed access and personal/portable devices will create field strengths that exceed the 100 mV/m Direct Pickup limit contained in 47 C.F.R. 15.118.[5] This appears to be a critical issue that may have been overlooked in the *Notice*. The potential for interference due to direct pickup in cable television receiving equipment cannot be ignored. The population of potential devices suffering from interference is no longer limited to broadcast receivers. It extends to all TVs and VCRs connected to cable systems and potentially to all receivable TV channels. CEA has

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[3] *Notice* Appendix B: Proposed Rules, §15.244 (f)

[4] *Id*. fn 50

[5] 47 C.F.R. 15.118 (c) (3) Direct pickup interference.

conducted basic field strength measurements using an experimentally licensed 100 mW transmitter.

- The proposed rules consider only co-channel and adjacent channel Desired/Undesired (D/U) ratios.[6] However, televisions are built of real tuners and filters that cannot ignore overload conditions or signals from second, third, or fourth adjacent channels. The industry carefully developed ATSC A/74 as a receiver recommended practice and a place in which these practical design limitations are documented.

- Does the Grade B contour protection region proposed by the Commission disadvantage rural reception where users may employ reception means beyond those assumed for Grade B calculation? Although the Commission must draw the line somewhere, this decision to allow interference outside the Grade B contour may affect cable system operation and broadcast television receivers.

- Although the *Notice* does not currently allow autonomous selection of available channels by an unlicensed device, there is much work underway in industry for using spectrum sensing to assess available (empty) channels. CEA is supportive of this approach once more data is collected in the field to fine-tune the parameters by which spectrum sensing can reliably be accomplished and once such systems can be demonstrated in the field.

III. The Introduction of Fixed Access Devices is Broadly Supported

For a variety of reasons, the introduction of the fixed access category of devices proposed by the Commission is less controversial than the personal/portable category.[7] The propagation characteristics of television frequencies make them a natural candidate for rural broadband access. For the same reason that these bands are well suited to cover large broadcast regions, these bands make sense as another option in sparsely populated areas for broadband wireless service.

CEA advocates the introduction of fixed/access devices as the most sensible re-use of this valuable spectrum. At the same time, the higher 1 Watt power limit indicates extreme caution in deploying these systems. CEA urges that the Commission require a registration process for

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[6] *Notice* Appendix B: Proposed Rules, §15.244 (f)

[7] *Notice* ¶19.

fixed/access systems to capture in one location the significant operating parameters of the system: location, equipment type, identifying signal details, and owner/operator contact details.

IV. The Personal/Portable Device Category Should be Introduced at a Lower Power Limit after Demonstration of a Reliable, Non-interfering System

Due to the high likelihood that personal/portable devices will be co-mingled with existing television receivers in every conceivable environment, great caution must be taken in their introduction. Even with the transmission of identification signals, presumably so that interfering equipment can be identified, it is very unlikely that consumers will understand that they are being interfered with by an unlicensed device. As the Commission properly noted,[8] the cliff effect of digital reception gives no indication of why a desired channel is not being received.

There are two factors that argue strongly for Personal/Portable devices being limited to less than 100 mW. First, the 10 meter interference computation distance proposed by the Commission is unproven for this application and will likely lead to interference in apartments and small-lot subdivisions. Second, the proposed 100 mW power limit is guaranteed to create interfering field strengths that exceed the Commission's own benchmark of 100 mV/m direct pickup immunity in 47 C.F.R 15.118. The result is the potential for widespread interference to cable television reception from devices that are fully compliant with longstanding Commission rules. More details on direct pickup are provided in a subsequent section in this filing.

CEA proposes that the transmitted power limit for personal/portable devices be limited to 20 mW with an antenna gain limited to 0 dBi. Doing so has a host of benefits. It allows the

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[8] *Id.* ¶ 15.

industry to more safely introduce products and gain experience. It mitigates the DPU problem. It lessens the risk associated with closely located neighbors, and the lower power limit generally reduces the amount of energy television receivers must tolerate to tune desired television channels. Furthermore, starting with a lower power limit establishes a regulatory framework that can be easily modified once more experience is gained.

In addition to the reduced power for personal/portable devices, we urge that demonstrated field-testing be conducted before this category is introduced. Specifically, there is on-going debate as to the utility of a control signal-based approach, leading to interest in autonomous vacant channel detection. CEA recommends, however, that the efficacy of spectrum sensing technology for this application be demonstrated and tested, before acceptance by the Commission, in an environment that includes the practical realities of electrical device noise, splatter from adjacent-channel DTV transmissions, omni-directional sensing antennas, the variability of building attenuation affecting the sensing device, and realistically high levels of multipath fading. Such a practical approach is consistent with the proper caution with which the Commission has handled the entire DTV transition.

CEA supports the Commission's conservative approach to testing and certification. CEA believes that any systems introduced under these new rules should be subject to industry examination as to how they ensure television reception is not damaged. Furthermore, the Commission must mandate a traceable, easily detected identification signal with a registration database for addressing interference cases.

V. The Control Signal for Personal/Portable Devices Must Be Clearly Defined

In the discussion of Unlicensed Personal/Portable Operations in paragraph 21 of the *Notice*, the Commission proposes that "the control signal could be a data stream from a digital TV station, information transmitted in the vertical blanking interval (VBI) of an analog TV station, subcarrier data from an FM radio station, data transmitted by a licensed wireless provider, or channel availability data from a fixed/access unlicensed device." This paragraph provides some guidance on the Commission's intention with respect to control signals. The proposed rules in Appendix B of the *Notice* under 15.244 (f) are not so specific, stating, "An intentional radiator used for portable operation must be capable of receiving a control signal from an unlicensed transmitter, or a TV or FM broadcast station indicating the TV channel(s) that are vacant within the service area of the unlicensed transmitter, TV or FM station."

Understandably, the Commission is attempting to grant some flexibility in how control signals are delivered. CEA is concerned that this flexibility may be readily misused. Specifically, the allowance of control signals received from unlicensed devices is tantamount to no rules other than an after-the-fact assessment of whether the control signal contained inaccurate channel vacancy information. Since the control signal can come from an unlicensed device, it can be passed from unlicensed device to unlicensed device or even computed locally by an unlicensed device and passed to other peers. If the control signal concept is to survive and be reliable, the rules for its use must be clearly defined and have more traceability.

The use of licensed broadcast transmitters for control signals begs the question as to how the reception range of these signals will be known. Presumably, the source of the control signal is responsible for ensuring that the signal is only received in locations for which the signal contains an accurate list of available channels. For every given transmitter antenna configuration

and power, the area over which the control signal can be received is determined by the antenna configuration of the receiver. The proposed rules do not seem to preclude the use of a high-gain antenna to receive a control signal that might not be applicable to the receiver's location.

Furthermore, in an example case of a control signal transmitted by a TV station with city-wide coverage, the complete list of stations receivable in, for example, the northern fringes of its Grade B area would likely be entirely different from the list of receivable stations in its southern fringes, and therefore the unlicensed device could not get an "available frequency list" without also knowing its location autonomously. Such location determination is unreliable at best (e.g., GPS does not work indoors) and subject to abuse at worst (if the user of the unlicensed device enters false location information in order to fool his device into enabling transmissions).

VI. CEA Is Conducting Field Tests of Several Critical Parameters Related to the Operation of Unlicensed Devices in TV Broadcast Bands

CEA has previously submitted its test plan in the public record of this docket[9]. The plan provides for some tests that generate data directly affecting the way rules should be written and some tests that generate data to be used by the industry in designing products for operation in these bands. Unfortunately, the complexity of establishing a test plan, hiring skilled measurement professionals, and locating appropriate houses results in a scheduled completion after these comments are due. CEA expects to provide more data in ex parte filings and during the reply comment phase. One set of data that is available is the field strength caused by a 100 mW transmitter at three and ten meters. This data is discussed in the section on direct pickup.

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[9] CEA *Ex Parte Presentation,* ET Docket Nos. 04-186, 02-380 (October 14, 2004)

CEA is supportive of industry efforts to use cognitive radio techniques to facilitate determination of vacant television channels. To that end, the bulk of CEA's test plan relates to collecting data that should prove helpful to the industry and the Commission in moving from the analytical phase to the practical phase of these proposed techniques. Specifically, CEA plans to collect data related to the noise environment in which the unlicensed device's sensing antenna is located, data regarding the difference in signal strength from an antenna on a rooftop to an antenna inside the home, and spectrum plots typical of what would be seen by an unlicensed device inside a home.

VII. Proposed Rules Do Not Address the Physical Realities of Practical Tuner Design

One challenge in allowing for unlicensed device operation in TV bands without interference is the accurate computation of available channels. The Commission asks that this computation be based on D/U signal levels for co-channel and adjacent channels in the fixed/access case and co-channel only in the personal/portable case. This approach essentially mimics the regime by which TV stations are allocated but overlooks the physical realities of receiver design. All receivers that tune one channel out of a band of contiguous channels use some form of filtering to reject the energy of everything except the desired (tuned) channel. Filters can never completely reject the energy in adjacent channels and generally reject more energy from channels that are farther away frequency-wise from the tuned channel. This reality governing how selective a receiver can be is described in ATSC A/74, *Receiver Performance Guidelines*, in the section on Taboo Channel Rejection.

CEA believes that personal/portable devices must also consider adjacent channels in the calculation of available channels in the same manner that fixed/access devices are required to do so. It is presumptive to assume that personal/portable devices cannot exceed adjacent channel

D/U ratios and does no harm to require these devices to include adjacent channels in the calculation of D/U ratios.

VIII. Introduction of Unlicensed Devices Will Raise the Noise Floor in the TV Band

In paragraph 39 of the *Notice*, the Commission proposes out of band emission limits consistent with existing Part 15 digital transmission systems, and specifically the Commission proposes "to require that emissions outside the TV channel(s) where an unlicensed device operates comply with the general limits in Section 15.209(a)." CEA believes that the proposed out-of-band emission limits are appropriate for the intended service. Some parties may be inclined to seek relaxation of the 15.209 limit to simplify the transmitter filtering requirements for new unlicensed devices. Given that these devices will necessarily raise the noise floor in the TV bands, the Commission should not relax any out-of-band emission limits.

IX. Proposed Rules May Lead to Severe Direct Pickup Problems

Direct pickup (DPU) is a phenomenon in which a receiver connected to a cable system, or the cable plant itself, receives undesired off-air signals directly. These signals are mixed with the desired channels being delivered through the cable plant and result in interference. The Commission and cable and consumer electronics industries have dealt with this problem for many years, and determined the DPU immunity level of 100 mV/m for analog cable ready television. Until this *Notice*, DPU was only a factor for receivers or plant equipment near broadcast transmitters where field strengths are relatively high. With the proposed introduction of unlicensed transmitters in broadcast television bands, DPU must be considered among the other potential interference issues.

The interfering field strength from the proposed unlicensed devices can be easily calculated. For the 100 mW transmit power in the personable/portable category, the field

strengths at 3 meters and 10 meters respectively are, 1150 mV/m and 343 mV/m. To confirm this theoretical field strength, CEA included measurement of a 100 mW transmitter in its test plan. The results of this test are provided in Appendix A and summarized in the table below.

Signal Strength and Field Strength Data Summary

	Antenna Distance and Height					
	3 meter (distance)			**10 meter (distance)**		
	1 meter (height)	2 meter (height)	Theoretical*	1 meter (height)	2 meter (height)	Theoretical*
Average Field Strength	**872 mV/m**	**1335 mV/m**	**1150 mV/m**	**442 mV/m**	**347 mV/m**	**343 mV/m**
Average Signal Strength	**-15.0 dBm**	**-11.3 dBm**	**-12.6 dBm**	**-20.9 dBm**	**-23.0 dBm**	**-23.1 dBm**
STDEV	2.00 dB	1.95 dB	--	2.21 dB	2.47 dB	--

* = Free space

In all cases the field strength exceeds the 100 mV/m DPU immunity level established in Commission rules. Since cable services pass more than 90% of homes in the US and unlicensed devices can be anticipated to be installed anywhere, the field strength from these devices must be brought in line with the expected immunity of receivers. Therefore, CEA proposes that the power limit for personal/portable devices be set at 20 mW EIRP.

X. CONCLUSION

CEA supports the intent to allow for unlicensed use in the vacant TV broadcast bands. However, we must ensure that such uses do not interfere with the broadcast signal. This is vitally important as we move from analog to digital. For the DTV transition to be successful, we must strive for ultimate consumer satisfaction. We support allowing unlicensed use for fixed access devices and suggest including a system registration requirement. For portable devices, we

urge that greater caution be taken by introducing products at a lower power limit after the conclusion of field-testing. We look forwarding to continue working with the Commission and other interested parties on this proceeding and will forward our remaining test results when available.

Respectfully submitted,

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APPENDIX A

DIRECT PICKUP (DPU) SIGNAL STRENGTH MEASUREMENTS

October 26, 2004

Conducted for the Consumer Electronics Association by Shure Incorporated

I. PREFACE

The allowed signal strength from proposed unlicensed devices is likely to exceed the 100mV/m DPU immunity specified for analog cable-ready devices in 47 CFR 15.118. For TVs and VCRs connected to cable, the effect will be uncorrelated direct pickup noise. This test measures the signal strength at 3 and 10 meter distances for a 100mW unlicensed transmitter operating into a 6dB gain antenna.

II. TEST SETUP AND PROCEDURE

- A radio frequency (RF) signal generator is set to generate a continuous-wave (CW) signal at a frequency of 677 MHz. (Note: These tests were conducted under an FCC experimental license granted to Shure Incorporated in July 2004.)
- The CW signal is applied to an RF amplifier to a conducted power level of 100mW (+20dBm).
- A +6dBi directional antenna (transmitter) is connected to the output of the RF amplifier through a coaxial 50-Ohm cable.
- An RF spectrum analyzer is setup at a distance away from the directional antenna. A +0dBi omni-directional antenna (receiver) is connected to the input of the spectrum analyzer through a coaxial 50-Ohm cable.
- Both antennas are adjusted at the same height. Measurements are taken for antenna heights of one and two meters above ground. The directional transmitter antenna is aimed at bore-sight to the omni-directional receiver antenna.
- RF power levels are recorded at distances of 3 and 10 meters separation between transmitter and receiver antennas at four random locations within the measurement area.

A block diagram of the equipment setup is shown below.

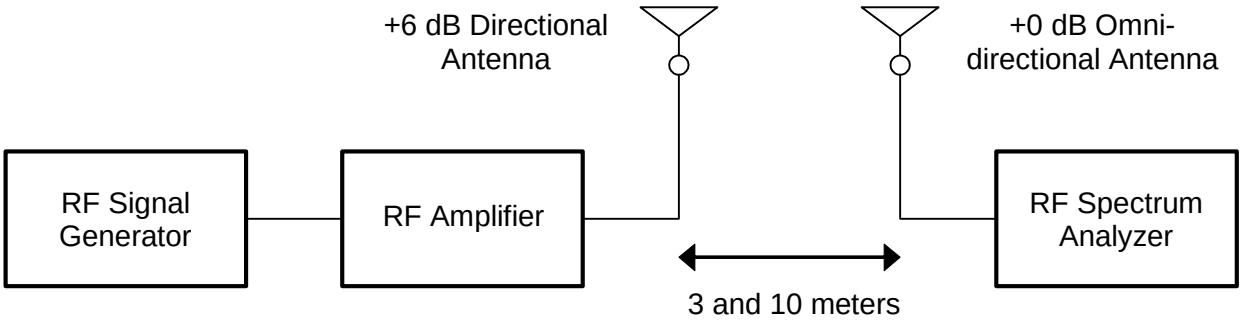

Figure 1. Equipment Setup Diagram

Photographs of the transmitting and receiving equipment are also shown below.

Photo 1. 100mW Transmitter into +6dBi Directional Antenna Equipment Setup

Photo 2. Spectrum Analyzer with 0dBi Omni-directional Antenna Equipment Setup

III. Theoretical Analysis

The theoretical received signal strength is calculated using a free-space path loss model for distances of 3 and 10-meter separation between transmitter and receiver antennas.

	Antenna Distance	
	3 meters	**10 meters**
Transmit Output Power	+20 dBm	+20 dBm
Transmit Antenna Gain	+6 dBm	+6 dBm
Receive Antenna Gain	+0 dBm	+0 dBm
Theoretical Path Loss	-38.6 dB	-49.1 dB
Theoretical Received Power	**-12.6 dBm**	**-23.1 dBm**
Theoretical Field Strength	**1150 mV/m**	**343 mV/m**

IV. Measured Signal Strength Setup and Environment

The signal strength measurements were conducted within a corporate office building in a relatively open area. A set of four measurements were taken at random locations for each of the 3 and 10 meter antenna separations. Another set of four measurements were taken in the same random locations for each of the 1 and 2 meter antenna heights (above ground). A total of 16 signal strength measurements were taken in total. The average signal strength is then calculated along with the standard deviation for each antenna height and separation.

Photographs of the 3 and 10-meter measurement setups are shown below.

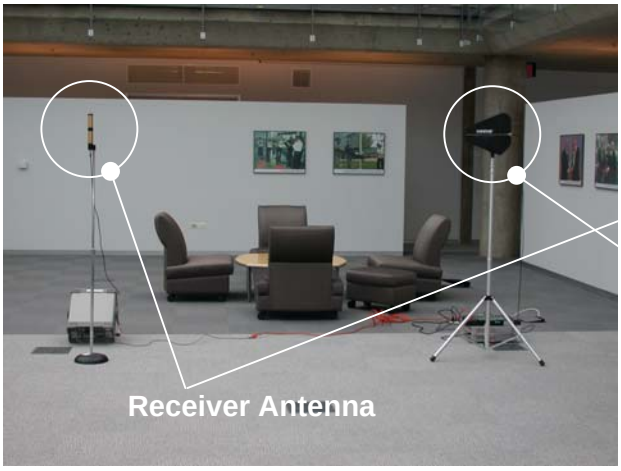

Photo 3. 3-Meter Measurement Setup

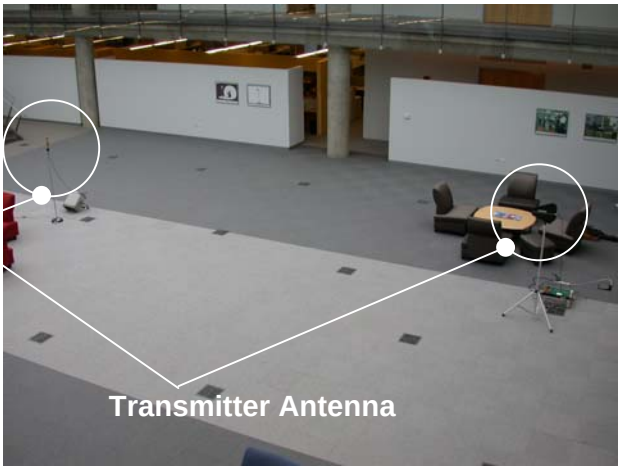

Photo 4. 10-Meter Measurement Setup

A plan diagram of the measurement environment is show below.

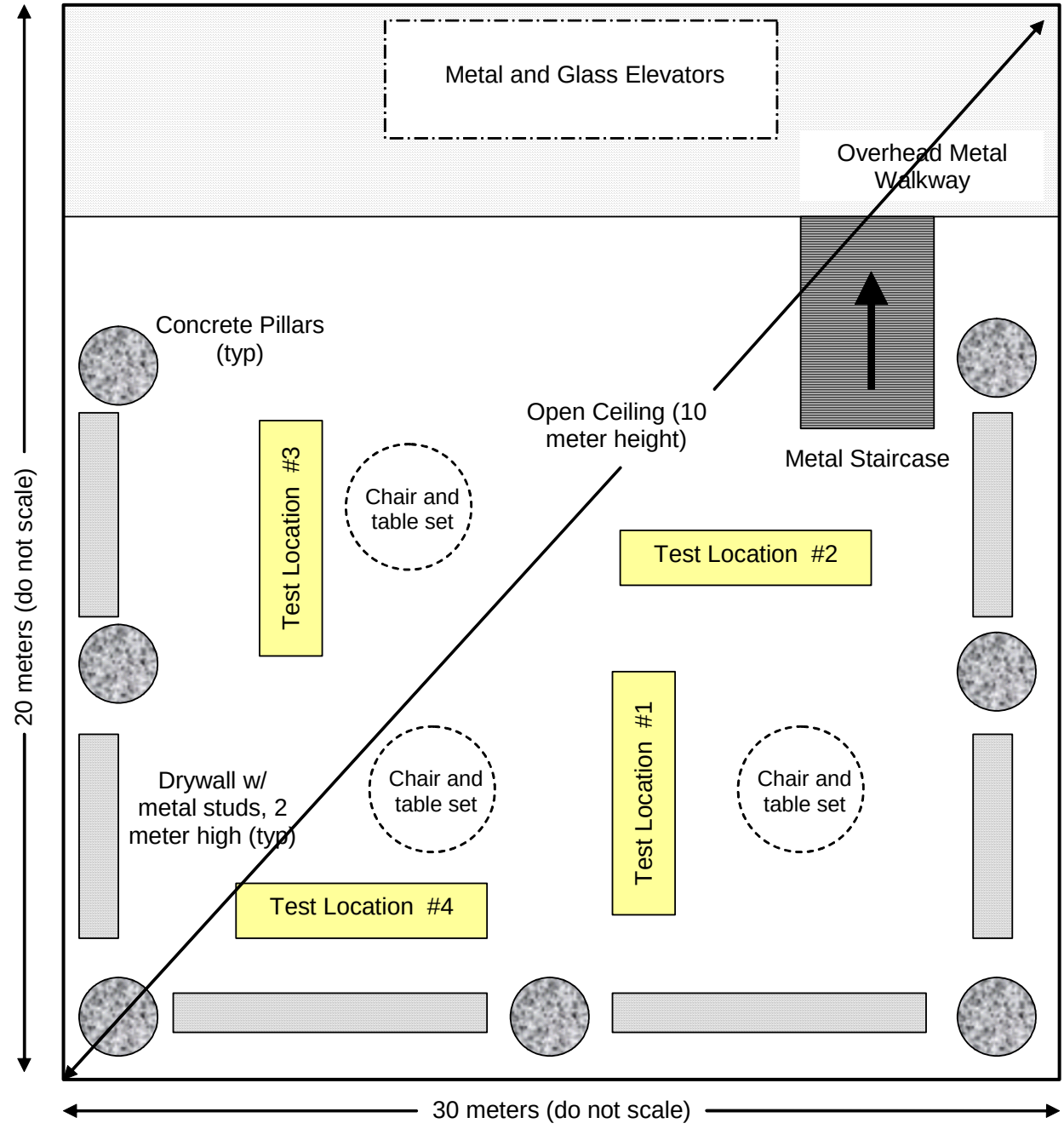

Figure 2. Test Environment Diagram

A cross-section diagram of the test environment is also shown below.

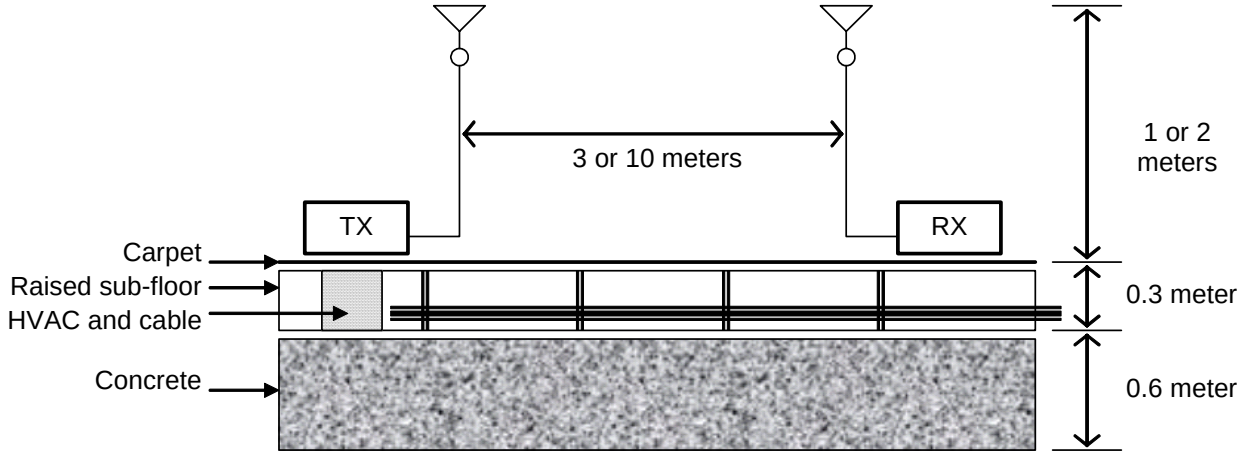

Figure 3. Measurement Environment Cross-Section

V. Measured Signal Strength Data

Antenna Height = 1 meter above ground

- Spectrum analyzer RBW = 10kHz
- Cable losses of 2dB are included (1dB per cable, per antenna)

Measured Signal Strength (1 meter antenna height)

Location	Measurement Distance	
	3 meters	10 meters
1	-12.0	-22.3
2	-15.9	-18.5
3	-15.5	-19.6
4	-16.4	-23.2
Average Power	**-15.0 dBm**	**-20.9 dBm**
STDEV	**2.00 dB**	**2.21 dB**
Average Field Strength	**872 mV/m**	**442 mV/m**

Antenna Height = 2 meters above ground

- Spectrum analyzer RBW = 10kHz
- Cable losses of 2dB are included (1dB per cable, per antenna)

Measured Signal Strength (2 meter antenna height)

Location	Measurement Distance	
	3 meters	10 meters
1	-11.2	-21.8
2	-8.6	-20.1
3	-13.2	-25.1
4	-12.0	-25.0
Average	**-11.3 dBm**	**-23.0 dBm**
STDEV	**1.95 dB**	**2.47 dB**
Average Field Strength	**1335 mV/m**	**347 mV/m**

VI. Signal Strength Data Summary

A summary of all measured and calculated signal strengths is shown below. All measurements and calculations are based on a 100mW transmitter into a +6 dBi directional antenna and a 0 dBi omni-directional receiver antenna.

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STDEV	2.00 dB	1.95 dB	--	2.21 dB	2.47 dB	--

* = Free space