UL LLC ("UL"), hereby submits comments pertaining to 47 CFR Part 15 and 47 CFR Part 18 under ET Docket No. 18-370 as referenced by DA 18-1260 (FCC Bureaus and Offices Seek Public Comment in 2108 Biennial Review of Telecommunications Regulation).

The scope of our comments includes the following requests:

Review and revise radiated emissions limits and associated specification distances;

Review and revise test site requirements, antenna requirements and measurement units for radiated emissions measurements below 30 MHz; and

Consider an alternative antenna for radiated emissions measurements below 30 MHz.

1. UL requests that the Office of Engineering and Technology ("OET") review and revise existing limits for field strength and their associated distances.

Currently radiated emission limits are specified at distances of 30 meters, 300 meters and 1600 meters under 47 CFR Part 18 §18.305, and at distances of 30 meters and 300 meters for frequencies below 30 MHz under 47 CFR Part 15 §15.209. Measurements of devices at these distances is impracticable and not common practice in today's laboratory environment. Practical testing of devices that are covered by these rule parts routinely occur at 3 meters and/or 10 meters. The data is then extrapolated to the limit distance by using extrapolation factors as specified or referenced by the rule parts.

Under §15.31(f)(2) laboratories are required to make multiple measurements along a given radial to determine a product-and-site-specific extrapolation factor, or use an inverse square ($1/d^2$) 40 dB/decade extrapolation factor.

There is a similar, but procedurally more complicated, allowance under Part 18 as described in §18.305 as well as by §18.311 where a reference to FCC Measurement Procedure MP-5 is made. Both §18.305 Note 2 and Clause 2.2.6 of MP-5 specify that measurements are made at multiple radials and at several distance intervals along each radial to determine the expected field strength at the specification distance. MP-5 clarifies in further detail that these measurements are to be made at intervals of no more than 20 degrees in azimuth direction, then an average extrapolation factor is calculated. An alternative 1/d attenuation factor (inverse linear, or 20 dB/decade) is allowed in these same references.

Furthermore clause 4.6 of MP-5 specifies a 3-meter measurement distance for microwave ovens and medical diathermy equipment operating above 900 MHz. In this case three possible extrapolation factors are allowed: the actual extrapolation characteristics of the FCC Laboratory Test Site, the actual extrapolation characteristics of another site, or inverse linear variation of field with distance.

These wide variations in both measurement procedures and possible extrapolation factors promote more errors and less repeatability from both lab to lab and product to product (within any given product type).

We therefore ask that the OET consider updating radiated emission limits and measurement distances where current distances of 30 meters or more are specified, and standardize on measurement distances of 3 meters and/or 10 meters. Specifying that labs make direct measurements of field strength at 3 and/or 10 meters with modern techniques and measurement distances will yield improvements to both 47 CFR Part 15 and 47 CFR Part 18 by eliminating unnecessary sources of error.

2. Concurrent with specifying limit distances of 3 meters and/or 10 meters, we also request that the OET review and revise existing site requirements for testing below 30 MHz, in particular the requirement that such testing be performed without a ground plane.

This requirement is currently incorporated by references to ANSI C63.4-2014 from §15.31(a)(4) and §15.38(g)(2), and to ANSI C63.10-2013 from §15.31(a)(3) and §15.38(g)(3).

While we note that this requirement (given in clause 5.3 of ANSI C63.4 and clause 5.2 of ANSI C63.10) is certainly a practical specification for test distances of 300 meters and 1600 meters (and to some extent for a 30 meter test distance as well), measurement results at any distance are significantly impacted by soil type, water content, pavement design, terrain discontinuities, buried pipes, metallic objects and unburied power or control cables. Clause 5.5 of MP-5 discuses most of these issues and concludes that a ground screen is desirable but not mandatory. ANSI C63.10 requires that the site not have any buried pipes or metal objects. ANSI C63.4 specifies an obstruction-free area above the ground but allows items such as buried pipes. Both ANSI standards allow various types of terrain as well as terrain discontinuities.

A maximum test distance of 10 meters readily allows changing this requirement, hence to specify that magnetic field tests be performed over a ground plane. Furthermore, other desirable characteristics can be included by applying ANSI C63.7 requirements for sites between 30 and 1000 MHz, excluding Normalized Site Attenuation (NSA), to test sites below 30 MHz. This will yield better reproducibility from lab to lab, better repeatability from spring through winter, and eliminate the impact due to variations in soil type, pavement, buried pipes and terrain discontinuities.

Specifying that ANSI C63.7 site requirements for 30 to 1000 MHz (except for NSA) also apply to sites used below 30 MHz will yield further improvements to both 47 CFR Part 15 and 47 CFR Part 18 by eliminating additional unnecessary sources of error associated with the current requirements.

3. We acknowledge that in general not all the above recommendations are feasible for in situ tests, and that none of them are applicable to measurements of BPL devices.

4. We also request that the OET review and revise existing antenna requirements and radiated emissions measurement units below 30 MHz.

Given the repeated emphasis that the OET has made over many years regarding the use of loop antennas below 30 MHz, it is clear that there is significant confusion in this matter. We believe there are essentially two causes: (1) radiated emissions limits below 30 MHz are specified in terms of electric field strength; and (2) in some cases tuned dipole antennas are specified between 18 and 30 MHz.

Part 15 requires the use of loop antennas (which inherently measure magnetic field strength) rather than monopole/rod antennas (which inherently measure electric field strength) for electric field strength measurements below 30 MHz, based on excluded clauses 4.5.3 and 8.2.2 in ANSI C63.4-2014 as referenced by §15.31(a)(4).

Both ANSI C63.4 (in clause 4.5.1) and ANSI C63.10 (in clause 4.3.1) specify that the loop antenna magnetic field factors are converted to E-field values assuming a free-space impedance of 377 ohms.

Part 18, via clause 2.2.4 of MP-5, requires the use of shielded balanced loop antennas for electric field strength measurements below 18 MHz, and either shielded balanced loop or calibrated tuned half-wave dipole antennas for electric field strength measurements from 18 to 30 MHz.

Tuned half-wave dipole antennas between 18 and 30 MHz are not practicable for either 3 meter or 10 meter measurements, and are barely practicable for 30-meter measurements. Furthermore, the Roberts dipoles as historically referenced by the FCC only cover 30 to 1000 MHz. Shielded balanced loop antennas are far more available and practicable for measurements in this frequency range.

MP-5 does not provide any instructions regarding the loop antenna factors to be used when performing measurements of electric field strength, however we believe that standard laboratory practice is to follow the guidance provided in the ANSI C63 standards cited above.

The utilization of unintended (from the perspective of the inherent antenna design) electric field antenna factors for measurements made with magnetic loop antennas allows an unnecessary source of error, even when the correct antenna is properly chosen to make the measurement.

As of 1990 CISPR changed their expression of magnetic field emission limits below 30 MHz from units of electric field strength to units of magnetic field strength. Both 47 CFR Part 15 and 47 CFR Part 18 Rules would benefit by making a similar change.

Such limits (either existing or future, pending adoption of the above suggestions regarding specification limit distances) can be derived in a straightforward manner by multiplying the electric field strength limit in uV/m by 1/(377 ohms), which can be equivalently expressed as 1/377 (A/V), to yield the corresponding magnetic field strength limit in uA/m. This derivation yields mathematically identical results as compared with the antenna factor conversion guidance currently in use, with less chance for error during testing due to inadvertently swapping multiplication with division, or making +/- sign changes with logarithmic expressions. We note that neither ANSI C63.4 nor C63.10 specifies whether the magnetic field factor is multiplied by 377 ohms or divided by 377 ohms to yield the corresponding

electric field antenna factor. This change is generally suitable for all radiated emissions limits below 30 MHz, including BPL device limits.

The OET can easily eliminate all confusion regarding the required antenna type for measurements below 30 MHz by expressing these limits in terms of magnetic field strength and disallowing the use of tuned dipole antennas between 18 and 30 MHz under Part 18.

These proposed changes would be appropriate for all tests, including in situ and of BPL devices.

5. We request that the OET consider allowing Loop Antenna Systems (LAS), in addition to conventional shielded balanced loop antennas, for performing magnetic field strength measurements below 30 MHz.

An LAS consists of three mutually orthogonal Large Loop Antennas (LLA). The EUT is placed at the center of each LLA coil then a current, proportional to the perpendicular magnetic moment of the EUT, is induced in each LLA. Some of the benefits of LLAs are that they do not require manipulation of a turntable or antenna polarization, and are relatively insensitive to environmental factors such as reflecting objects and ambient signals. These antennas are limited to devices that are small enough to fit inside the LLA without introducing excessive capacitive coupling to the loops.

Two approaches are available to compare LLA measurements with limits. (1) Suitable conversion factors from induced current to magnetic field strength at 3 meters and to magnetic field strength at 10 meters are provided in Annex C.6 of CISPR 16-1-4:2012. These are currently being evaluated and refined by the ANSI C63.30 working group. (2) Induced current limits can be published separately from magnetic field limits. An example of this latter approach is given by Tables 8 and 9 of CISPR 15:2018.

The relatively modern concept of LLAs enables more practicable measurements of magnetic field emissions, increased productivity and less chance of errors, on suitably sized devices.

Sincerely,

UL LLC