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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
1998 Biennial Regulatory Review --	)	**ET Docket No. 98-80**
Conducted Emission Limits Below 30 MHz	)	
For Equipment Regulated Under Parts 15	)	
and 18 of the Commission's Rules	)	

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To: The Commission

REPLY COMMENTS OF ARRL,
THE NATIONAL ASSOCIATION FOR AMATEUR RADIO

ARRL, The National Association For Amateur Radio, (ARRL), on behalf of its members and of the more than 650,000 licensed amateur radio operators in the United States, by counsel and pursuant to Section 1.415 of the Commission's Rules [47 C.F.R. §1.415], hereby respectfully submits its reply comments in the captioned proceeding, relative to the *Notice of Proposed Rule Making* (the Notice), FCC 99-296. In reply to certain of the comments filed, ARRL states as follows:

1. ARRL was most interested in the comments filed in this proceeding by Adaptive Networks, and by Microsoft. Adaptive Networks asks that the rules be modified to clarify that any Electromagnetic Compatibility (EMC) requirements and associated test procedures apply to all wire and line-conducting technologies. ARRL supports this proposal. ARRL also agrees with Microsoft that it is important that unlicensed RF emitters not cause harmful interference to radio services. ARRL supports the general principle that test methods should be as easy as possible, while meeting the basic requirement that the conducted energy and radiated energy from carrier-current devices be at or below the limits as defined in the rules.

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List A B C D E

2. Many cases of actual interference from unlicensed RF emitters, in the League's experience, result from incorrect interpretations of existing rules governing test methods. Offering specific, objective test methods that are easily duplicated in laboratories or open-area test sites (OATS) will generally result in fewer instances of harmful interference to licensed services. Simplified, objective test requirements will help ensure that those entities developing new technologies or devices, especially data technologies and other devices that may be found in residential neighborhoods, will understand what absolute limits apply to the conduction and radiation of RF energy from those devices and how both can be measured with repeated results. Although meeting these limits does not necessarily protect all radio services from interference, it would provide a level of protection that better reduces the number of interference problems with deployed devices that cannot be addressed on an aftermarket basis.

3. ARRL also supports the points raised by Adaptive and Microsoft that limits on the actual conducted emissions or radiated emissions made under specific OATS conditions are an improvement over the present rules that permit radiated emissions to be measured in three "typical" installations. As noted in its own comments, ARRL has records of many actual severe interference problems caused by devices that were authorized pursuant that present rule. However, ARRL does not believe that it is necessary in all cases to apply measurements of radiated emissions to the conducted emissions of devices that are not intended to radiate. Rather, the Commission should be able to establish a limit on conducted emissions (even for carrier-current devices) that could generally result in known radiated field-strength levels.

4. Although ARRL could accept the test methods proposed by Adaptive or Microsoft as an approximation of the radiation reasonably expected from most electrical or telephone wiring

within buildings, the wire lengths and configurations proposed would not adequately represent reasonable worst-case radiation from overhead electrical power-distribution lines. These lines are typically many wavelengths long, and elevated to a considerable height above ground, both factors that would significantly increase the expected radiation over that which would occur on a one-half wavelength or smaller wire. Devices that are designed to conduct signals over power-distribution electrical wiring must be subject to both conducted limits and to *in-situ* measurements as defined in the present rules. This additional burden is justified because the potential for harmful interference from such devices is much higher, and could occur over a much larger area, than that which might occur from radiation from smaller sources, such as residential wiring.

5. Neither unintentional radiators nor carrier-current devices are intended to radiate and their signals are usually placed onto similar conducting wires (often, but not always, building electrical wiring), so an identical conducted limit should apply to both unintentional radiators and carrier-current devices. Although the method proposed by Microsoft of combining estimated, calculated field strengths that would result from the measured conducted signal levels is intended to be applied to intentional emitters, the principle that a reasonable, expected, worst-case estimate can be made of the amount of energy that will be radiated by uncontrolled wiring is a reasonable one that can be applied to carrier-current devices as well. ARRL agrees that a gain of 5 to 6 dB is a reasonable estimate of the antenna characteristics of electrical wiring and other wiring (such as telephone wiring or other long interconnection wiring) that will be found in buildings.

6. Adaptive Networks and Microsoft each proposed that actual wire antennas be used to

simulate typical "worst-case" conditions that may be encountered on radiating electrical power wiring or other conductors. ARRL agrees that this general concept may have merit as an approximation of the potential radiation from the electrical wiring found in residences or other buildings. However, this technique may not apply to all types of devices which potentially radiate, and adoption of this concept would necessitate other technical rules changes.

There are many practical concerns, in addition, with the methods that could be used. ARRL's Laboratory staff has used NEC-4 modeling (using EZNEC Pro) to evaluate the radiated fields from a number of different wiring configurations and found significant variation in the predicted electric-field values at various distances from radiating elements, depending on the distance from the antenna, wire length, wire orientation, height above ground and feed point. ARRL will continue to create new EZNEC models and would be willing to share them with the Commission's staff and others developing test methods. To the extent germane to this proceeding, ARRL can present this as an ex-parte presentation in this proceeding.

7. In its comments, Adaptive states that it has been working with the Commission's Laboratory staff on modifications to the test procedures outlined in the ANSI C63.4 measurement-procedure standard. ARRL has some concerns and questions about the summary of those modifications as discussed in Adaptive's comments. Although some of these questions may be answered in the full text of the proposed test methods, ARRL asks that the full text of the proposed changes be made available as part of this proceeding, subject to further comment. In its comments about those C63.4 modifications, Adaptive proposed that measurements be made at 3 meters and extrapolated to 30 meters using a $1/d^2$ extrapolation factor. The present rules for radiated emissions in Section 15.109 set limits on the radiated electric field. Under far-field

conditions, fields fall off as the inverse of the distance from the radiating source, not as the inverse square of the distance. Adaptive's proposal, therefore, to make measurements at a distance of 3 meters and extrapolate to 30 meters using a $1/d^2$ correction factor, could be misleading. The $1/d^2$ correction factor would be correct ONLY for measurements of power density, or for the squares of the measured fields, NOT to the measurements of fields. ARRL suggests that it may be less confusing if it is made explicit that the extrapolation can be made using a 1/d correction factor for field-strength measurements or a $1/d^2$ factor for measurements of power density or the square of the field strength.

8. Even if the appropriate calculation were made, applying a measurement made at 3 meters to the field that would be present at 30 meters distance applies only in the far field. For most HF applications, near field effects can cause significant deviation from that ideal, resulting in a calculation that could be either too high or too low, depending on the specific circumstances involved in making the 3 meter distance measurement. In general, the potential for interference from radiated fields is greater at lower HF than it is at higher HF, because of the 20log(F) factors in path-loss. Most residential radiating structures are physically large in terms of wavelength, resulting in a near-field region that for most frequencies in the HF range is much larger than 3 meters distance from the source. This can make extrapolation from 3 meters to 30 meters, the latter generally being in the far field region, somewhat problematic. The ARRL Lab has done NEC-4 antenna modeling of various small and large radiators on 3.5 MHz and seen significant variations between the actual field values at 3 and 30 meters distance from a radiating source, values that are extrapolated. The 3-meter vs. 30-meter values are also affected by other factors, such as whether the measurements are made above or to the side of the

radiating element. The Commission and other commenters will rightfully note that in these cases, the resultant extrapolated value gives a result that is above the actual NEC-4 calculated near-field value. This is an error that is in a direction that would result in less harmful interference, but, in fairness to manufacturers, would result in an unfair burden to those manufacturers, who would probably not choose this simple method of testing because of the overly conservative nature of the results.

9. While ARRL does not oppose the general concept that measurements made at 3 meters can sometimes be extrapolated to 30 meters, ARRL urges the Commission to specify exactly how, and under what conditions, such measurements can be made. The extrapolation for fields (electric or magnetic) should be $1/d$, not $1/d^2$. The near-field and ground-proximity and reflection effects can be reduced if the Commission approves a requirement that the fields be measured along the length of the radiating test fixture antenna wiring, above and to both sides of the radiating element, with the highest measurement being used to extrapolate to 30 meter far-field conditions. This approach, however, although it would result in a conservative result, would, in many cases, be overly conservative if such worst-case near-field values were extrapolated to 30 meters. Especially if the proposal by Adaptive to require that radiated field strength tests be made for 1/2 wave, 1/4 wave and 1/8 wave radiating elements is adopted, this testing would also require a large number of measurements, negating some of the benefits these rules changes are trying to create.

10. The proposed modifications to ANSI C63.4 also specify wire orientation. The language in Adaptive's comments concerning this was not clear to ARRL. Connecting wiring used to conduct signals can be either horizontally or vertically oriented, or, more likely, would

contain a combination of horizontal and vertical sections (an example being the electrical or telephone wiring in a tall apartment building). Any modifications to C63.4 should be clear that tests must be made with the orientation of the half-wavelength or smaller radiating test fixture should be both horizontal and vertical. Although this is what ARRL believes was meant in the language of Adaptive's comments, ARRL wants to be certain of this. An exception could be made if the product use and configuration would never have the conducting wiring in a particular polarization orientation.

11. Adaptive also commented that compromise configurations, such as "elbowing" a vertical section, could be used if a test site cannot accommodate a full vertical extension of the test wiring. If a test site cannot accommodate a reasonable vertical extension, that site would not be adequate to test radiated emissions at HF, especially over the lower range. ARRL could agree to a compromise as long as some minimum vertical extension, perhaps 10 meters, were to be required. Adaptive also proposes that "worst-case" horizontal testing be done with the horizontal wire elevated 1 meter above the ground plane. This is not "worst case" under most, if not all, circumstances. NEC-4 modeling performed by the ARRL Laboratory staff showed that, at 1 meter above ground, losses in the ground and conductor losses are much higher than they are for radiators located at greater height. A better height above ground than 1 meter would be 3 meters, a height more representative of residential electrical wiring, without being so high as to add significant practical difficulty to the testing.

12. In its comments, Adaptive did not discuss the specific configurations of the radiating wires to be used to make field measurements at open-area test sites. Balanced wires connected differentially to the device being tested would not represent a measurement typical of the

seriously unbalanced electrical wiring found in most buildings. (The presence of switched loads results in serious imbalance as various electrical switches are opened. This, in effect, connects single-wire radiating elements to one side of the otherwise-balanced electrical-system transmission line.) Single wires connected simultaneously to the hot and neutral wires would test only common-mode signals. If the Commission approves any OATS test methods, the rules should require that single-wire radiating elements be connected in turn to the hot and neutral wiring, and to both hot and neutral wiring simultaneously, to test the radiation of common-mode conducted signals. Although the use of LISNs can help ensure that the voltage at the source can easily be measured, the amount of power delivered to the load antenna when used with a resistive LISN very much depends on the actual impedance of the radiating element. If a LISN is placed at the end of a single-wire radiating element, the impedance present at the other end will be transformed by the radiating element.

13. The methods proposed by Microsoft have merit. Although ARRL agrees that some unique configurations of building electrical, telephone or data wiring could, accidentally, have gain, it agrees that a half-wave radiating element, perhaps in combination with the quarter-wave and eighth-wave elements proposed by Adaptive, would represent a reasonable estimate of nearly worst-case configurations. In the opinion of ARRL, the benefits gained by removing the ambiguity of the testing of 3 "typical" installations (which, by chance, could have a configuration that results in less gain than Microsoft's "worst-case" estimate), outweigh the risk that the rare installation might exceed the limits if the devices were tested using a method similar to that proposed by Microsoft. Those few exceptions could, with cooperation from manufacturers and device operators and, if necessary, Commission Enforcement Bureau staff,

be appropriately handled as a case of harmful interference, regardless of the actual radiated levels.

14. As was the case with Adaptive's comments, however, the proposal by Microsoft that measurements of large radiating elements can be made at a distance of 3 meters, then extrapolated to 30 meters, is not appropriate for all measurements made at HF. Although the present rules generally consider 3 meters to be in the far field for 30 MHz and higher, the error at 30 MHz is significant. Although only slightly higher at 27 MHz, the discrepancies could be significant, usually (but not always) in the direction of being overly conservative. Although ARRL has no objection to this specific technique being used at 27 MHz, it does not feel that a 3-meter measurement distance is appropriate on HF in general, and should not be applied to amateur HF bands, such as 28.0-29.7 MHz. If manufacturers were to make 3-meter distance measurements significantly below 30 MHz, the extrapolation errors could be even worse.

15. In its comments, ARRL asked that the regulations be made clear that the frequencies listed in 15.205 (the restricted bands for intentional radiators) apply to carrier-current devices. Although this provision would not directly benefit the Amateur Radio Service, since none of its frequency allocations are within the restricted bands, it would help ensure that manufacturers consider and develop notching and spectral masking techniques that could be applied to harmful interference in other bands. The Home Phone Networking Alliance has recently developed such protective techniques in the specification for home-phone networking devices. There are many other ways that radio services could be protected from harmful interference, however, and ARRL could accept any other reasonable method of improving the effectiveness of manufacturers and device operators in addressing actual cases of harmful interference. This could include

strong regulatory and other encouragement from the Commission and/or the development of voluntary cooperation between Part 15 manufacturers and the representatives of affected services.

Therefore, the foregoing considered, ARRL, the National Association for Amateur Radio, again respectfully requests that the Commission replace the present conducted emission limits in Parts 15 and 18 of its rules with the CISPR limits as proposed, and that the remaining clarifications and modifications in the Part 15 and 18 rules requested herein be implemented in any Report and Order adopted in this proceeding.

Respectfully submitted,

ARRL, THE NATIONAL ASSOCIATION FOR AMATEUR RADIO

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February 29, 2000

CERTIFICATE OF SERVICE

I, Christopher D. Imlay, do hereby certify under penalty of perjury that I caused to be served, this 29th day of February, 2000, via United States Mail, postage prepaid, a copy of the "REPLY COMMENTS OF ARRL, THE NATIONAL ASSOCIATION FOR AMATEUR RADIO" on the following:

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