Many of the commenters agree that the HEAR-IT NOW petition asks the Commission to reverse course and slow down the introduction of broadband PCS in the United States, and thereby delay the additional competition and investment in new wireless systems and technologies.[6] The majority of the commenters concur that a rule making to limit or revoke the exemption is inappropriate, particularly when inter-industry efforts are underway to address and resolve the electromagnetic interaction ("EMI") issues,[7] and the evidence presented by the Petitioner is insufficient and in some instances, mischaracterized.[8] Accordingly, these commenters,

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by the Digital Mobile Telephone System, Global System for Mobile Communications,(GSM), NAL Report No. 131, National Acoustic Laboratories, Sydney, Australia, iii (May 1995) ("1995 Australian Study").

[6] American Personal Communications ("APC") Comments at 2, 11, 15; BellSouth Corporation ("BellSouth") Comments at 3-10; CTIA Comments at 26-29; GSM MOU Association ("GSM MOU") Comments at 1-2, 15; Northern Telecom, Inc. ("Nortel") Comments at 1, 3; Personal Communications Industry Association ("PCIA") Comments at 4; Siemens Stromberg-Carlson ("Siemens") Comments at 2.

[7] APC Comments at 9-11; BellSouth Comments at 10-11; CTIA Comments at 11-15; The Ericsson Corporation ("Ericsson") Comments at 7-8; GSM MOU Comments at 18-20; Nokia Mobile Phones, Inc. ("Nokia") Comments at 2; Nortel Comments at 3-4; Pacific Bell Mobile Services ("Pacific Bell") Comments at 2; PCIA Comments at 3-4; Southwestern Bell Mobile Systems, Inc. ("SBMS") at 4-5; Siemens Comments at 2; Telecommunications Industry Association ("TIA") Comments at 2-3.

[8] APC Comments at 5-9, 11-13; CTIA Comments at 17-24; Ericsson Comments at 2, 9-10; GSM MOU Comments at 4-11; Nortel Comments at 4-5; Pacific Bell Comments at 2; PCIA Comments at 2; SBMS Comments at 2-3; Siemens Comments at 1-2.

along with CTIA, support a denial of the petition and ask the Commission to allow the affected industries to continue their research and make appropriate recommendations to define and resolve the EMI issue.[9]

A handful of commenters, however, chose to ignore the responsible and well-settled approach for dealing with accessibility and compatibility issues in a wireless digital environment, *i.e.*, the inter-industry approach.[10] Instead, they support government intervention and the banning of one RF modulation, *i.e.*, GSM, even though the record is clear that given the many sources of RF interference, RF emissions from wireless digital telephones is a relatively minor source of interference to hearing aid users. CTIA has already addressed their claims in its original comments.

In this Reply, CTIA responds to three issues: 1) Qualcomm's misleading characterization of its tests conducted on EMI between hearing aids and CDMA and GSM telephones; 2) the Hearing Industry Association's ("HIA") attempt to

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[9] APC Comments at 9-11; BellSouth Comments at 11; CTIA Comments at 11-15; GSM MOU Comments at 3-4; Nokia Comments at 3; Pacific Bell Comments at 3; PCIA Comments at 4; SBMS Comments at 5; Siemens Comments at 2; TIA Comments at 3-4. *Cf.* Ericsson Comments at 9 (While Ericsson does not object to HEAR-IT NOW's proposal, it strongly objects to HEAR-IT NOW's inference that interference to hearing aids is solely a GSM problem and questions the relevancy of the studies provided by HEAR-IT NOW to support its Petition.)

[10] *See* HEAR-IT NOW Comments; Liss Communications Research ("Liss") Comments.

mistakenly portray the wireless industry comments as solely suggesting that increasing the immunity level of the hearing aid is the only solution for solving EMI between hearing aids and wireless digital telephones; and 3) the incorrect assumption that the Part 68 HAC requirement is an appropriate method for providing hearing aid users with compatibility and hence accessibility to wireless digital telephones.

II. The Evidence Submitted By Qualcomm Is Inconclusive.

In its comments, Qualcomm provides a report of tests it conducted to compare the level of EMI between hearing aids and CDMA-based technology and GSM-based technology.[11] According to Qualcomm, its tests demonstrate that the most significant factor in determining the degree of interference between hearing aids and other susceptible electronic equipment is the peak transmitter power of the portable telephone, not the average power.[12] Qualcomm also states hearing aid wearers can make CDMA calls with 800 MHz and 1800 MHz units "with no objectionable interference in most parts of a well-designed CDMA system," while most hearing aid users cannot make a telephone call with a GSM portable phone operating at any feasible power level.[13]

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[11] Qualcomm Comments at 3.

[12] Qualcomm Comments at 3-4.

[13] Qualcomm Comments at 4.

Qualcomm has acknowledged that EMI exists for all wireless digital technologies, including CDMA devices and hearing aids.[14] By qualifying its statement with modifiers such as "with no *objectionable* interference," and "*in most parts* of a well-designed CDMA system," Qualcomm has fudged its conclusions and stopped short of claiming that CDMA technology causes no interference with hearing aids currently available.

As the attached Technical Appendix explains, the Qualcomm report is misleading on certain key points. First, the submitted report does not provide the full range of testing that Qualcomm has conducted on this matter. CTIA understands that Qualcomm has conducted comparative tests at 200mW for GSM technology operating at 800 MHz in addition to the results included in Attachment A of Qualcomm's response.[15] If the Commission is to consider the Qualcomm tests, it is only appropriate that the Commission has the benefit of Qualcomm's full analysis of the tests.

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[14] *See Hearing Aid Users Say Wireless Industry Must Solve GSM Interference Problem*, COMM. DAILY, July 13, 1995, at 2-3 (quoting Mr. Kevin Kelly, Vice President of External Affairs, Qualcomm). *See also* Siemens Comments at 2 (acknowledging that all PCS technologies interfere with hearing aids with varying degrees.)

[15] *See GSM Hearing-Aid Debate Ignites Into War,* RADIO COMM. REP., July 24, 1995, at 6 ("[A] Qualcomm test report of November 1993 found their own [CDMA] technology can produce interference under certain conditions.")

Secondly, the Qualcomm report does not use the appropriate U.S. GSM standard for comparison. In its tests, Qualcomm used parameters (800 MHz, 2.0 Watt peak transmit power) which do not represent the applicable standard in the United States. The applicable standard for GSM systems in the United States is PCS 1900 with a maximum power level of 1W.[16] Accordingly, the Qualcomm tests, like the European and Pacific Rim studies, must be reviewed in proper perspective with regard to the power levels associated with U.S. digital telephones.

Third, the Qualcomm report suggests that under normal operation, the transmit power level will vary for all CDMA phones, thereby having a lower typical average range of peak output power.[17] As the Technical Appendix explains, this is true for all wireless phones, not just CDMA.[18] Finally, Qualcomm suggests that by employing a "full rate constrained" mode of operation, CDMA telephones could be used by hearing aid wearers. Qualcomm, however, fails to point out that devices such as vocoders which are designed to achieve "full

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[16] *See* Technical Appendix at 1-4. *See also* Siemens Comments at 1.

[17] E. Lambert, *Measurement of RF Interference by CDMA and GSM Digital Cellular Portable Telephones on Hearing Aids* 6 (July 6, 1995)(Attachment A of Qualcomm Comments).

[18] *See* Technical Appendix at 4-5.

rate constrained" mode of operation are not the standard for CDMA systems. They are being considered by the CDMA Development Group as an option and are still in the test stages.

With respect to HAC requirements, Qualcomm makes no claim that its CDMA mobile units are hearing aid compatible.[19] Like CTIA, Qualcomm recognizes the need for additional research on EMI between hearing aids and all wireless digital telephones, and is supporting the inter-industry efforts to resolve EMI issues by its participation in the Hearing Aid Project at the Center for the Study of Wireless Electromagnetic Compatibility.[20]

III. Increasing the Immunity Level of Hearing Aids Is An Effective Solution And One Method For Solving the Complex EMI Problem.

In its comments, HIA suggests that increasing the immunity level, *i.e.*, shielding, of hearing aids is not an effective solution and should not be relied upon to achieve electromagnetic compatibility ("EMC") between hearing aids and wireless digital telephones.[21] While HIA notes that the vast

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[19] Qualcomm also makes no recommendation to the Commission concerning the limitation or revocation of the exemption from HAC requirements.

[20] Qualcomm is a member of the Hearing Aid Design Group, Hearing Aid Project at the Center for the Study of Wireless Electromagnetic Compatibility. *See* Exhibit 4 of CTIA Comments.

[21] HIA Comments at 3.

majority of hearing aids sold in the United States are in-the-ear models, they claim that these models are too small to shield.[22] In addition, HIA asserts that it is highly unlikely, in the near future, that hearing aid technology will be able to protect hearing aid users from the EMI between the hearing aid and the various digital-based technologies for broadband PCS.[23]

Contrary to HIA Comments, it appears that hearing aid technology is available today that permits compatibility between some hearing aids (high immunity models) and wireless digital telephones, including GSM-based technologies. In the 1995 Australian Study, researchers tested a variety of hearing aids: behind-the-ear and in-the-ear models, ranging from low to high power, and equipped with various gain amplifiers.[24] "The hearing aids were found to vary from some *(high-immunity) models for which no interference was detectable even with the hearing aid within a few centimetres from the telephone,* to others (low-immunity) models for which interference was detectable at several metres or more."[25] Thus, there are some

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22 *Id.*

23 *Id.*

24 1995 Australian Study at 59.

25 1995 Australian Study at iii (emphasis added).

hearing aids with a high level of immunity that are compatible with wireless digital telephones.[26] The use of these hearing aids facilitates the hearing aid user's access to a wireless digital telephone.

Consumer demand and the competition among hearing aid manufacturers to meet those demands will also determine whether increasing the immunity level of hearing aids will continue to be a suitable method for achieving compatibility. While studies have estimated the average life span of hearing aids as five years, there is some indication that hearing aid users may replace their hearing aids more frequently than the five year norm.[27] One scientist postulates that in cases where the health insurance system does not effectively determine the life span of a hearing aid, changes in

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[26] In a letter to Chairman Hundt, Dr. Ole Lauridsen states that "in the existing population of hearing aids, one third had immunity to be used with a GSM telephone." Letter from Dr. Ole Lauridsen to Chairman Reed Hundt (Mar. 26, 1995) (discussing the "misinterpretation and unauthorized comments" attributed to Dr. Lauridsen in a report issued by HEAR-IT NOW's parent, the Wireless Communications Council, concerning EMI between hearing aids and GSM technology) ("March 26th Letter to Chairman Hundt").

See also Nortel Comments at 4 ("Future interference potential is likely to decline because...aid manufacturers are adding more shielding in new aids, in part to sell into foreign markets where more shielding is required.")

[27] D. Sorkin, *Understanding Our Needs: The SHHH Member Survey Looks at Hearing Aids,* SHHH JOURNAL, July/Aug. 1995, at 32 (75 percent of SHHH members indicated that they had replaced at least one of their hearing aids within the past three years.)

technology may be a dominating factor determining a hearing aid's life cycle.

> Introduction of significant improvements to hearing aid performance in general, or for specific auditory environments may significantly precipitate the interest of hearing aid wearers in replacing their existing devices. One such improvement could be hearing aid immunity to electromagnetic fields generated by today's electronic devices, and in particular[,] immunity improvements addressing concerns in relation to wireless telephones, computers, etc."[28]

It appears that HIA's conclusions on this matter are based upon a misinterpretation of the 1995 Australian Study finding that low immunity models were susceptible to interference and retrofitting hearing aids may be impractical. Notwithstanding HIA's claims, the 1995 Australian Study, which is based upon GSM phones operating at twice the U.S. power level, specifically concludes that increasing the immunity level via shielding is an effective method for achieving EMC.

> The tests show that it is *possible* and *practical* to design hearing aids to have high immunity although it may not always be practical to treat existing hearing aids to achieve high immunity.[29]

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[28] Letter from Dr. J. Wojcik, P. Eng., Spectrum Sciences Institute/ARPEL Laboratories to Robert Roche, Director of Research, Cellular Telecommunications Industry Association (July 28, 1995).

[29] 1995 Australian Study at iv (emphasis added). Other studies also support the "high immunity" solution. *See* Denmark Study at 6; Lauridsen Study at 11; BT Lab Study at ¶ 5.

Designing hearing aids with a high immunity level cannot be disregarded as an effective tool in managing a complex problem such as EMC. As Siemens Stromberg-Carlson, a hearing aid manufacturer, correctly points out in its comments, "[electromagnetic] interference is complex and the solution is complex."[30] The investigation and resolution of EMI between hearing aids and wireless digital devices may require a multi-faceted approach, as evidenced by the number of interim solutions that are currently available to address EMI between wireless digital telephones and hearing aids.[31]

The Hearing Aid Project at the Center for the Study of Wireless Electromagnetic Compatibility is the appropriate forum whereby the affected industries can investigate the various methods and determine the most appropriate solutions to achieve EMC between hearing aids and wireless digital devices. CTIA commends HIA for its support of the inter-industry efforts that are underway to address and resolve EMI between hearing aids and wireless digital telephones. HIA's participation in the Hearing Aid Project demonstrates its

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[30] Siemens Comments at 2.

[31] *See* CTIA Comments at 21 nn.42-44; *See also European digital cellular telecommunications system (Phase 2); GSM Electro Magnetic Compatibility (EMC) considerations (GSM 05.90)*, European Telecommunications Standards Institute, ETSI Technical Report ETR 108, at 11-12 (Feb. 1994). (See Attachment 3 of GSM MOU Comments.)

commitment to inter-industry efforts to address and resolve the complex issues of EMC.[32]

IV. Part 68 of The Commission's Rules Will Not Ensure That The Hearing Impaired Have Access to Wireless Digital Telephones.

In their comments, HIA and Liss discuss hearing aid compatibility for wireless digital telephones in terms of the Commission's Part 68 definition for hearing aid compatibility for wired telephones.[33] They incorrectly assume that Part 68 of the Commission's rules will provide the hearing impaired with accessibility to wireless digital telephones.[34]

In its comments, CTIA explains why the Part 68 adoption of the t-coil technical standard and the narrow definition of hearing aid compatibility created for the wired telephone industry cannot be used to define compatibility in a wireless digital environment; and more importantly, why the t-coil technical standard does not necessarily achieve accessibility to wireless services for the hearing impaired.[35] TIA, which developed the hearing aid compatibility standard for wired

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[32] HIA is a member of the Hearing Aid Design Group, Hearing Aid Project at the Center for the Study of Wireless Electromagnetic Compatibility. *See* Exhibit 4 of CTIA Comments.

[33] HIA Comments at 3; Liss Comments at 2-3.

[34] *Id.*

[35] CTIA Comments at 25-26.

telephones, acknowledges that a HAC standard for wireless telephones does not exist and would have to be developed before the Commission could consider revocation or limitation of the HAC exemption for wireless telephones.[36]

While some wireless telephones may meet the Part 68 HAC requirements for wireline telephones,[37] experts indicate that compliance with Part 68 rules for wireless telephones is not necessarily the best solution for the hearing impaired.

> In its discussion with experts, Ericsson has been advised that compliance with Part 68 rules using any digital technology (TDMA, GSM, CDMA and/or others that may be developed in the future) may, in fact, create more problems for the hearing impaired than it solves. This is due to the fact that when a hearing aid wearer turns off the acoustic receiver so that he or she receives a magnetic signal, the acoustic feedback is eliminated. However, the hearing aid is then significantly more susceptible to a wide variety of magnetic interference coming from sources including, but not limited to, fluorescent lights, computer monitors, security stations at airports, etc."[38]

Although a wireless telephone may meet the current HAC requirements for wireline telephones, *i.e.*, the t-coil

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[36] TIA Comments at 2, 4. *See also* Siemens Comments at 1 (acknowledging that an HAC standard does not exist for wireless telephones).

[37] Ericsson Comments at 2-3. (Ericsson currently manufactures wireless telephones in accordance with Part 68 standards and plans to do so for PCS phones.)

[38] Ericsson Comments at 3 n.4. *See also* Qualcomm Comments, Attachment A at 5 (One of the six hearing aid users tested found the interference in variable rate objectionable when using a t-coil/high gain hearing aid.)

technical standard for "leaking" electromagnetic energy, it can still be unusable for a hearing aid user if the interference problem is not resolved.

While some wireless telephones may be designed in accordance with the HAC requirement for wireline telephones, reliance upon the Part 68 standard is inappropriate, particularly when t-coil compliance can increase the likelihood of EMI between the hearing aid and the wireless digital telephones.

As Congress and the Commission recognized in creating the exemption for wireless telephones, hearing aid compatibility for wireless devices under the Part 68 t-coil technical standard is virtually impossible due to the physical nature of RF interference between hearing aids and mobile service telephones.[39] In its Comments, CTIA recommended that a definition based upon providing hearing impaired persons with access to wireless devices is more appropriate than the constricting definition and standards provided in Part 68 of the Commission's Rules.[40]

The electromagnetic interaction between hearing aids and wireless digital devices is an interference management issue.

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[39] *See* H.R. REP. No. 674, 100th Cong., 2d Sess. 9, 13. *See also In the Matter of Access to Telecommunications Equipment and Services by the Hearing Impaired and Other Disabled Persons, First Report and Order,* 4 FCC Rcd 4596, 4600 (1989).

[40] CTIA Comments at 26.

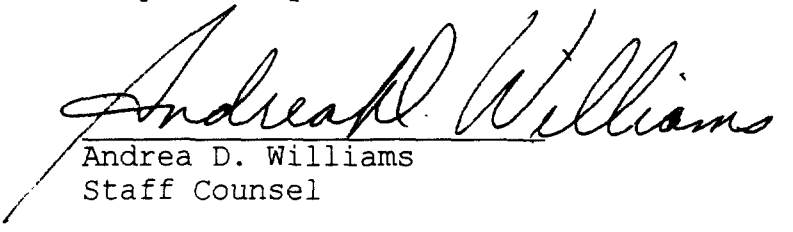
Imposing a legal definition of compatibility, particularly the t-coil standard, will not ensure access to wireless digital devices. The industry recognizes that there is a fundamental difference between compatibility and accessibility.

While Congress, the Commission and the industry have recognized that the physical nature of RF interference makes operational compatibility virtually impossible for wireless telephones, the wireless industry, nevertheless, has a proven record of providing access to wireless telecommunications services for the hearing impaired by offering analog phones and HATIS-compatible phones. The Hearing Aid Project at the Center for the Study of Wireless Electromagnetic Compatibility demonstrates the industry's commitment to manage the EMI between hearing aids and wireless devices, and thereby fostering access to wireless telecommunications services for all Americans.

V. Conclusion

For the reasons set forth above and in its original comments, the Commission should deny HEAR-IT NOW's petition for Rule Making.

Respectfully submitted,



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August 1, 1995

APPENDIX A

TECHNICAL APPENDIX

In Attachment A to its Comments,[1] Qualcomm provides a report of the tests it conducted to compare the level of electromagnetic interference ("EMI") between CDMA-based technology and hearing aids and between GSM-based technology and hearing aids. In this Appendix, CTIA highlights the misleading assumptions Qualcomm has made in its report and the more relevant conclusions that can be drawn from the Qualcomm research.

First, Qualcomm has measured the results of a CDMA mobile unit transmitting at a maximum power level which does not exist as an industry standard, and throughout the majority of its July 1995 report, compared the results of these measurements to a GSM mobile unit operating at double the United States standard of 1 watt maximum power level for GSM PCS-band phones. Second, Qualcomm assumes (correctly) that CDMA phones will operate primarily at lower than peak power levels under system power control, but then fails to extend this assumption to its comparison of GSM phones, which also will operate under system power control. Finally, Qualcomm omits from the July 1995 Report the

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[1] E. Lambert, *Measurement of RF Interference by CDMA and GSM Digital Cellular Portable Telephones on Hearing Aids* (July 6, 1995) ("July 1995 Report").

finding that, when operated at similar power levels, both CDMA and GSM phones can create audible interference within a nearly equal range of detectability.

The Qualcomm tests measured CDMA mobile units at a maximum operating level of 200 milliwatts peak power at both 800 MHz(cellular) and 1900 MHz (PCS) frequencies.[2] The U.S. standard for CDMA cellular phones, TIA/EIA IS-95(A), provides for three classes of mobile units: a 1.0 watt maximum output power (*i.e.*, 1000 milliwatts) for Class III, a 2.5 watt maximum output power for Class II, and a 6.3 watt maximum output power for Class I. The U.S. standard for CDMA PCS mobile units, ANSI J-STD-008, provides for five different classes of mobile units: 130 milliwatt maximum output power (Class V), 250 milliwatt maximum output power (Class IV), 500 milliwatt maximum output power (Class III), 1 watt (1000 milliwatt) maximum output power (Class II), and 2 watts (2000 milliwatt) maximum output power (Class I). Regardless of the U.S. CDMA standard selected, there is no CDMA mobile unit designed to operate at the 200 milliwatt maximum output power utilized by Qualcomm for its test.

Just as Qualcomm used a non-standard power level to measure its CDMA phones, throughout most of its July 1995 Report, Qualcomm selected a 2 Watt power level that does not

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[2] July 1995 Report at 2.

exist in the United States to use as its measurement of GSM phones.[3] Qualcomm states that it performed "one set of tests at 800 MHz with a simulated a GSM signal at a normal GSM phone operating level (2W peak, 217 Hz burst rate, 1/8 duty cycle)"[4] and a second set of tests at 1900 MHz "at a GSM power level of 1 watt."[5] There is no U.S. standard (or use) for GSM devices operating in the 800 MHz range at 2 W or any other power level. Qualcomm, however, correctly used the U.S. GSM standard for its tests of the output of GSM 1900 mobile units at 1 watt maximum output level.[6]

To make meaningful comparisons between similar CDMA and GSM phones, *i.e.*, the PCS hand-held mobile units that actually will be used in the United States, the results of the tests described in the July 1995 Report first must be adjusted.

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[3] The one exception is the bottom of page 4, which is the only part of the July 1995 Report where Qualcomm provides data with respect to a GSM phone operating at 1 Watt, which is the U.S. standard for GSM phones operating in the 1900 MHz (PCS) frequency band.

[4] July 1995 Report at 2.

[5] *Id.*

[6] The only data reported at U.S. PCS frequencies and power levels is in a single chart and paragraph on page 4 of the July 1995 Report.

For the sake of a more relevant comparison, Qualcomm could have selected a GSM 1900 mobile station (Class II) operating at the U.S. standard of 250 milliwatts maximum output power. *See* ANSI J-STD-007.

The first adjustment is to compare CDMA and GSM outputs at power levels and operating modes defined by U.S. standards.[7] The chart on page 4 of the July 1995 Report, *Range of Audible Interference (1900 MHz)*, even though it measures a non-standard 200 milliwatts CDMA phone, indicates that the CDMA phone in the U.S. standard variable rate vocoder mode generates audible interference for a range of approximately 0.1 meter (*i.e.*, approximately four inches) to approximately 1.3 meters (*i.e.*, slightly more than four feet).[8]

Another important adjustment involves system power control. In the Conclusion of its July 1995 Report, Qualcomm states, "In normal operation, where all CDMA phones are subject to system power control, transmit power levels vary, averaging 10 to 20 [milliwatts] of peak output power. Measurements made at 20 [milliwatts] indicate the radiating antenna must be within 2 to 13 cm (1 to 5 inches) for audible interference to be detected in hearing aids."[9] But then Qualcomm continues, "[c]onversely, a GSM TDMA portable

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[7] Consequently, the test data shown on pages 1-3, the top of page 4, page 5, and the top of page 6 do not pertain to the U.S. application of GSM and CDMA technologies.

[8] There is no U.S. standard for a locked full rate vocoder.

[9] July 1995 Report at 6.

in normal operation transmits at a nominal peak power level of 2 watts (1 watt at 1900 MHz). Tests showed that a GSM portable located within a distance of 1 to 3.5 meters from a hearing aid would cause audible interference."[10] Qualcomm fails to mention that GSM phones also operate under system power control with an operating range of 1 milliwatt to 1.0 watt. Unlike their reference to CDMA phones, Qualcomm provides no data for GSM phones operating under system power control. As the attached chart demonstrates, under the power levels established by the U.S. standard for PCS 1900 phones, power levels below 20 milliwatts also predominate.

When these adjustments are made, as Qualcomm has demonstrated in earlier studies, both CDMA and GSM phones at similar power levels can create audible interference within a range of detectability that is nearly equal.[11]

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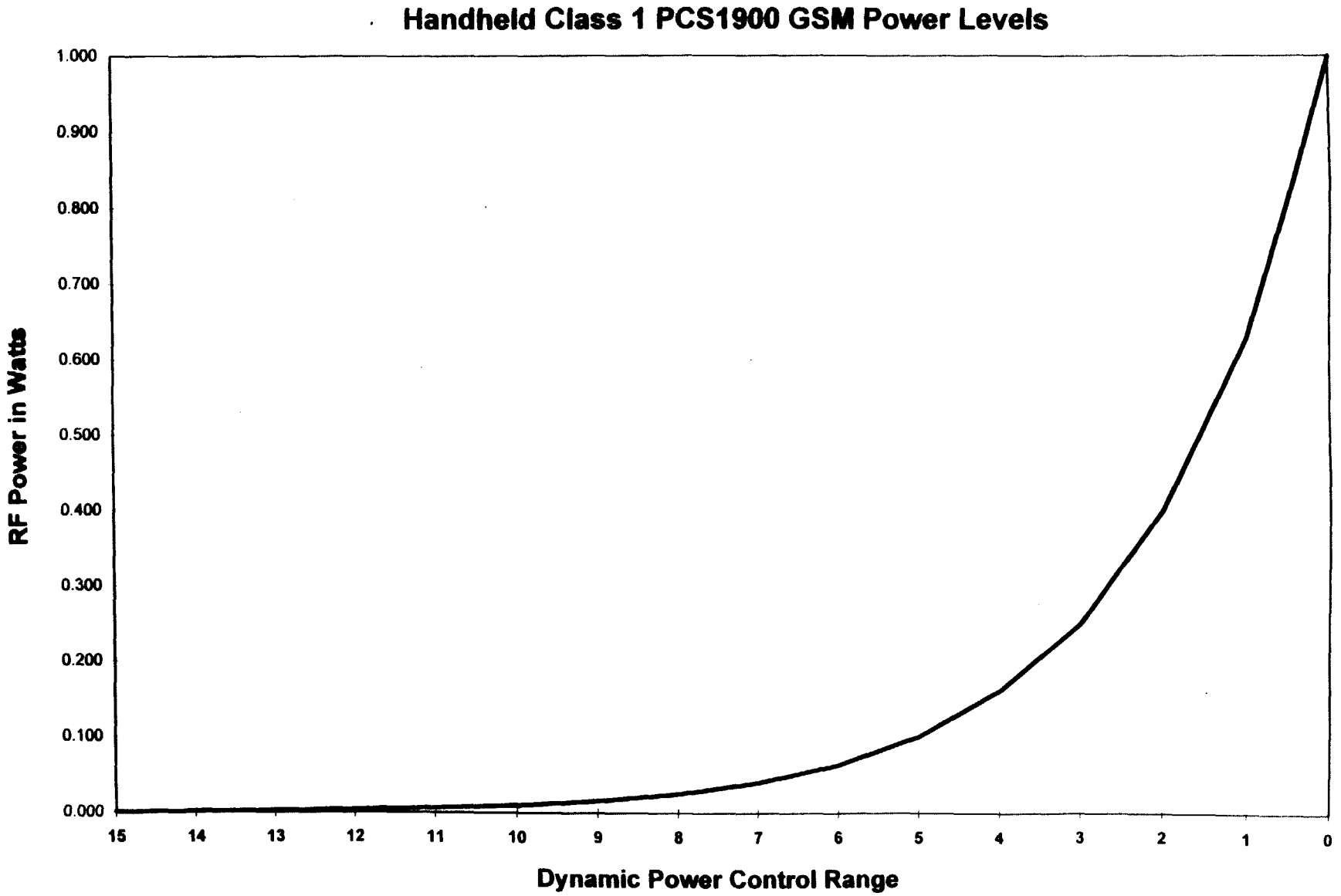
[10] July 1995 Report at 7.

[11] For example, at identical 200 milliwatt power levels, a hearing impaired listener with a Phonak PE 845 hearing aid could detect interference from a CDMA phone at 25 cm (9.8 inches), while the same listener could detect interference from a GSM phone at 30 cm (11.8 inches). In this same test, interference was judged as becoming "annoying" at 8 cm (3.1 inches) for the CDMA phone, compared to 14 cm (5.5 inches) for the GSM phone.


Handheld Class 1 PCS1900 GSM Power Levels
RF Power in Watts
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Dynamic Power Control Range

APPENDIX B

PROTOCOL FOR THE STUDY OF HEARING AID INTERACTION WITH WIRELESS PHONES

Version 2.0

CENTER FOR THE STUDY OF WIRELESS ELECTROMAGNETIC COMPATIBILITY

SCHOOL OF INDUSTRIAL ENGINEERING
UNIVERSITY OF OKLAHOMA

July 25, 1995

INTRODUCTION

This protocol has been developed in support of a study, on the interaction between various types of wireless telephones and hearing aids to be conducted at the University of Oklahoma. The overall purpose of the study is to objectively and subjectively, evaluate the interference between wireless phone technology and hearing aids. The Phase I objectives of the study are to:

1. define the test protocol for physical measurement of the interference generated in hearing aids by wireless phone signals of varying types. The resulting protocol shall produce repeatable results and include parameters such as field strength, threshold distance of interference, and intensity and frequency of the resulting audio interference output;
2. define a standard methodology for measuring the immunity of hearing aids, including standards for acceptable "noise floors"; and
3. define the test protocol for subjective measurement of the extent of the interference generated in hearing aids by wireless phone signals of varying types. The protocol shall include the use of both hearing-impaired and unimpaired individuals.

Background

This protocol is based on input from the references listed at the end of this document and from members of the Hearing Aid Wireless Phone Interaction Study Design Group. Much of the protocol is based on a study conducted by the National Acoustic Laboratories, a division of the Australian Hearing Services (Le Strange, Byrne, Joyner, and Symons, 1995).
European and Australian clinical and laboratory studies have demonstrated that audible interference ("buzzing") can be produced in hearing aids by hand-held wireless phones operated in close proximal, (a few centimeters to several meters). This effect has been demonstrated in the US but little has been published in terms of research results. This protocol encompasses both physical measurement of hearing aid interference (objective testing) and how this interference is perceived by hearing aid users (subjective testing). The model outlined by Bowen (1995) identifies one possible breakpoint that connects the objective and subjective testing. Physical testing involves the RF source, RF path, and the hearing aid (objective). Output from the hearing aid is acoustically coupled to the user who develops a perception of the interference signal (subjective). Objective and subjective tests can be independent.

PROTOCOL FOR THE STUDY OF HEARING AID INTERACTION WITH WIRELESS PHONES

CURRENT RESEARCH

Currently reported studies in Europe and Australia have examined the interference generated by GSM phones, the predominant wireless phone technology outside of the US. GSM uses a Time Division Multiple Access (TDMA) signal structure as do most digital wireless phones in the US. The TDMA principle results in the carrier being pulsed in a fashion that allows audio frequency devices (hearing aids, portable stereos, etc.) to demodulate the radio frequency (RF) envelope and produce a constant, distinctive buzzing sound. According to reports, these TDMA signals