HEARING AID & CELLULAR PHONE COMPATIBILITY RESOLUTION

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Hearing Aid and Digital Cellular Phones continue to have radio frequency interference and electromagnetic interference and no means to interface with T-Coil pick ups in hearing aids. This multivariate problem has been studied globally and is the basis for the hearing aid compatibility controversy that has endured for over 10 years.

There are three primary concerns: 1) radio frequency interference (RFI) noise based on the normal use of a hearing aid with the handset's antenna next to the head within the antenna's near field range; 2) electromagnetic interference (EMI) noise caused from backlighting, liquid crystal displays, power surges within the circuitry or unauthorized or unnecessary EMI leakage and 3) lack of a telecoil compatible signal generated from the cellular handset.

On July 10, 2003, the Federal Communications Commission adopted a Report and Order asking the hearing aid and carrier industry to address this issue. Three key supporters and named contributors in this Report and Order played a significant role.

Etymotic Research identified some of the variables between the hearing aid and cellular system and reported on the issue; Myers Johnson Inc. brought forth antenna technology for shaping energy around a cellular phone handset away from the head and hearing aid and conducted a test of 47 hearing aids for immunity; and TEM (Traverse Electromagnetic) Consulting identified Federal regulatory anomalies and chaired the development of the first compatibility testing standard (ANSI C63.19) which has been adopted by the Report and Order and is now being promulgated to industry as a result of the FCC's report and order.

The presenter, James R. Johnson, will discuss various aspects of the regulatory, technical and industrial components surrounding these issues.

Mr. Johnson, President of Myers Johnson Inc., together with Mark J. Sanford, M.S., CCC-A, a leading Clinical Audiologist and owner of CSG/Better Hearing Center, conducted a hearing aid compatibility test for Myers Johnson Inc. while working with Stephen Berger, President of TEM Consulting.

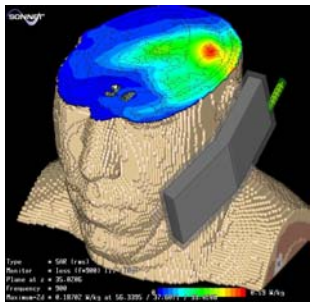
This panel presentation and discussion represents a comprehensive review of the issue and the pending and implemented issues surrounding this global problem. Included in this review will be several published papers and articles as well as demonstrations and general data collected from industry sources surrounding this issue.

Key word Hearing Aid Cell Phone Interference

Introduction

The United States Federal Communication Commission (FCC) produced a document that many hearing aid user advocates are justifiably proud of and feel substantial progress has resulted in the matter of Section 68.4(a) of the Commission's Rules Governing Hearing Aid-Compatible Telephones (1). Written by a dedicated team within the Wireless Division of the FCC, the WT Docket No. 01-309 RM-8658 is a fine example of a compilation of issues and circumstances surrounding resolution to hearing aid compatibility (HAC) on a multivariate level. The order showed good cause why HAC should be mandated. The Report and Order was adopted July 10, 2003 and released August 14, 2003 mandating that "digital wireless phones be capable of being effectively used with hearing aids." One wireless magazine identified the FCC's Report and Order as one of the top 20 most significant wireless actions occurring in 2003 (2).

The open wording of the order leaves many questions unanswered but at the same time allows the FCC to remain neutral to the type of solutions. The FCC's role is to police compliance to the Americans with Disabilities Act, not tell industry how to do it. The Report and Order provided expectations and measurements for compliance by adopting a measurement standard. As of today, there is still opposition and requests for refinements but generally, as a result of this action, there is significant attention being made by handset makers, carriers and hearing aid makers to meet the requirements ordered to be implemented by February, 2006.



This simulation above by Sonnet Software shows the absorption of energy from a typical cellular handset that would normally cause RF Interference. Removing this energy will also mitigate RF interference.

What is not expressed in the FCC's Report and Order and is of equal significance is that because of the efforts of the hearing aid user organizations and the FCC's ruling, together, they have jointly caused a global paradigm shift that will ultimately improve mobile phones for all users today and forever. By ordering a reduction in RF emissions from the cellular phone, a new directional antenna technology is required. This new technology will reduce energy to the head and hearing aid and as the FCC points out: "directional antennas have the potential to help mitigate the effects of multipath, improve frequency bandwidth performance, achieve higher gain, and provide better directional control over emissions."

Dynamics and Variables Leading to HAC Mandate

The respondents of the HAC matter can be viewed on the FCC's web site and reflects the record and positions of all of the respondents to the FCC's notice of proposed rule change for HAC. The FCC file to look up is named 01-309. This record reflects the stake holder's positions and issues that range from "not possible" to "completely possible." This public record is a hallmark for adopting rules and is replete with HAC information for interested parties.

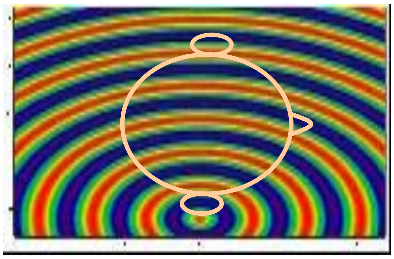
There are many contributors who played significant roles in identifying the need for regulatory change and who continuously and tirelessly pressured regulatory bodies for HAC compliance. These include AG Bell, Cochlear Americas, Hearing Industry Association, National Association for the Deaf, Self Help for Hard of Hearing People as well as many individuals who provided their personal insight and opinions on the subject.

The telecommunications industry claimed it wasn't technically possible to meet the HAC requirements. The industry was opposed to mandates and wanted the hearing aids made more compatible. HAC was stalled in a debate as to whether it was possible at all.

Three individual companies contributed separately to support closure of the HAC technology stalemate. Dr. Mead Killion, Chairman, Etymotic Research, Stephen Berger, President TEM (Traverse Electromagnetic) Consulting and James R. Johnson, President of Myers Johnson Inc. Etymotic Research conducted one of the first studies to review the issue (3) and provide feedback for possible solutions including a recommendation that hearing aid makers incorporate a clamping circuit in the hearing aid's amplifier that would sense the interference spikes and filter them out before they reach the audible range. Dr. Killion also conducted a study of T-Coil interference at a hearing conference to determine the most effective signal to noise requirements needed for developing the inductive T-Coil signal at the handset. Etymotic Research now has a T-coil signal driver as a potential solution for handset compliance.

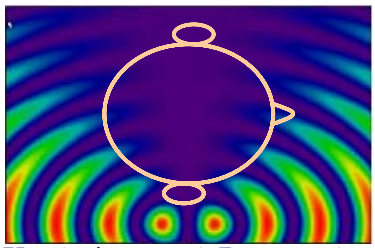
Stephen Berger, as co-chairman to the ANSI Standard that was adopted by the FCC, lead the 5 year 50 company consortium that developed the standard. Mr. Berger's knowledge and recommendations to the FCC provided the technical foundation for understanding the overall issue. Mr. Berger created the testing protocol for scanning handsets and hearing aids to the standard and is now making his testing equipment and protocols public to assist in testing for compliance.

James R. Johnson, a former antenna company's Director of Quality Assurance, saw the stalemate and sought to find the obvious solution in an advanced antenna design. He knew the technology did exist to reduce unwanted RF energy while at the same time providing a stable, efficient signal platform in order to meet the CTIA testing requirements and other tests without adding significant costs to the handset.



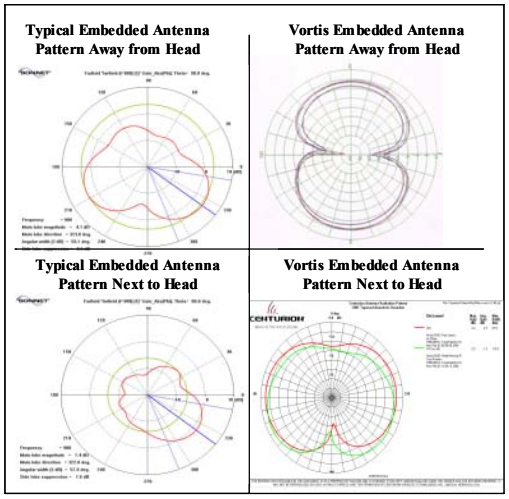
Typical Antenna Propagation

A prototype of the first near field array antenna called the Vortis demonstrated a significant reduction of energy toward the head and hearing aid while increasing handset performance. Efficiency tests, gain, nulls, bandwidths, drive, etc. all fall into a substantial competitive position. MJI conducted a test using a sampling of 47 units chosen for their relative popularity in order to 1) determine levels of immunity, 2) mitigation of interference by the Vortis and 3) market conditions for commercialization. MJI used three categories (BTE, ITE and ITC) of hearing aids and made an interesting discovery. By extrapolating market penetration with test findings, MJI interpolated (by formula from tests results) that up to 80% of all hearing aids in use today have a significant problem. Although this could be reduced to a



Vortis Approach Propagation

more conservative 60% to 70%, it pointed out that "the problem is more wide spread than originally thought and is not going away without a significant outreach program or motivation from a government body." MJI suggested that with over 18 million hearing aid users around the world and the majority experiencing RF interference (RFI) and when considering the differences in positions of industry toward HAC resolution, it was obvious that the HAC issue was not going to be resolved naturally by the invisible hand of the economy. Resolution to the HAC issue required a push for a technology change and a paradigm change to the way industry engineers and their managers look at designing handset antennas and hearing aids. ISO 9000 design standards can provide the means to effectively design new HAC solutions into future handsets. MJI initiated a HAC Consortium designed to review the regulatory and technological issues surrounding the use of new antenna technology. In its review, the HAC Consortium believed that highly directional antennas were not allowed by federal regulations. MJI filed a petition with the FCC requesting that isotropic terminology be changed to regulate power into the antenna rather than antenna patterns. In addition, MJI recommended regulations be harmonized with European antenna regulations because of potential misinterpretations. The FCC responded to MJI's petition stating there were no barriers in the regulations for directional antennas and that directional antennas should be sought after as a means for HAC solution and a means to improve mobile phone service. The FCC denied the petition, but they clarified the rules and regulations governing antennas thus allowing innovative solutions without concern for regulatory issues. Etymotic Research, TEM and MJI all shared information with the FCC and congress in an effort to support resolution to HAC.



Comparison above shows significant gain and coverage improvements over HAC related antenna call the Vortis. This dispelled the argument that it is not only technologically possible to meet HAC, in doing so, mobile phones improve for all.

During the HAC deliberations, there was consideration focused on whether technological advancements could be readily achievable. This included discussions on hearing aid immunity, telecoil signal generating capability and costs for removing unwanted RF emissions toward the hearing aid. The Cellular Telephone and Internet Association (CTIA) took the position that reducing emissions to the hearing aid was not readily achievable. If it was not readily achievable, the FCC, by law, could not compel compliance and remove the exemptions given to handset makers and carriers. At the economies of scale (ratio of hearing aid users with RFI problems to the total users of mobile phones), the concept of readily achievable was a tough obstacle to over come. If solutions were required across all handsets around the world, the cost would be inordinate to the value of serving 1% of the total user base. Some technology companies were concerned with the fact that T-coils may be an obsolete technology. The current telecoil signal frequency band is low and very susceptible to interference from minor sources. Many argue that new wireless protocols for local transmission of signals such as Blue

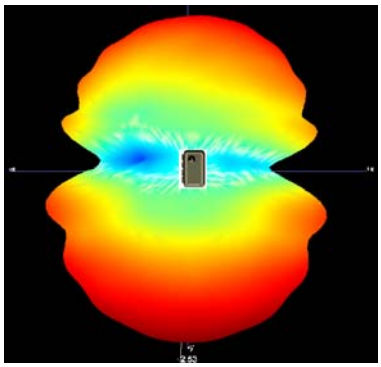
Tooth or 802.11 are more appropriate. However, this requires a vast change in technology that would not be readily achievable. As far as hearing aid immunity is concerned, hearing aid engineers believe that it's just a matter of time before all hearing aids will be made immune to RF interference once it becomes a major competitive advantage for sales. Dave Robb, the former Chief Engineer for GN Resound and an advisor for MJI, pointed out that at a cost of less than $13US, all hearing aids could be made immune.

In 1996, the U.S. Food and Drug Administration (FDA) representing hearing aid makers, and the FCC representing handset makers, along with their respective industries would strive to resolve the HAC issue by increasing immunity in hearing aids by 15 dB and decreasing RF emissions from mobile phones by 15 dB. The hearing industry declared success in their goals and stated that the wireless industry did not do enough to act on the issue.

In addition, a consortium of over 50 companies participated in the development of the ANSI Standard C63.19 in order to arrive at a point where measurements could be quantified. This was not easy since the variables of cellular phone emissions combined with the variables of hearing aid immunity caused concern as to whether or not such things could be quantified. How does one quantify "level of annoyance" of interference in the exacting world of engineers? The permutations seemed to be endless especially when considering the third major variable, the user.

The handsets above are a new look for handsets if adopting full array technology for HAC and improved performance.

In March of 2002, at a time when the final consideration by the FCC was underway, Jim Johnson opened discussions with representatives throughout industry and conducted both a technology and market review to determine status of solutions. MJI's commercial agenda was to determine whether it should move forward in support of a HAC solution and what obstacles might be forth coming. MJI's position was directed at the unique antenna's commercial value for all users. The "Vortis" antenna has the capability to reduce RF emissions by over 20 dBil (tested to as high as 25 or 30 dBil under certain frequency ranges and idealized conditions). MJI's mission was to support the HAC resolution with an attachable Vortis antenna and eventually provide a global solution for all handsets.



Actual test results of Vortis antenna in a 3D anechoic chamber test performed by Centurion Wireless Technologies Inc.. This figure shows the energy around the handset. Blue areas are least energy; red are highest. Notice the "sweet spot" of silence (low energy).

MJI discovered several key engineers echoing the public record stating that wireless phones require omni directional antennas. Only a handful of RF engineers and most Star Trek fans understand the dynamics and non-trivial nature of altering energy around handsets to accommodate the HAC requirement. A 1996 study by the International Electronics and Electrical Engineers (IEEE) pointed out that nearly half of the RF emissions of a cellular phone are absorbed by the head and hand and are thus wasted. This absorption causes the system, when used next to a head, to be directional so, in fact, since day one, all mobile phones have been directional after all. As end users, we all

understand the directionality of mobile phones intuitively and correct for this when talking. If a signal is poor, we just move or rotate our heads or position. Visits with engineering groups in America, China, SE Asia, Europe reflect wide spread support for new antenna technology. With T-Coil drivers likely to be installed in handsets as special HAC models in order to meet compliance, mitigating RFI to ensure a quiet, interference free conversation will come from new antennas.

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