Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of Improvements to Benchmarks and Related Requirements Governing Hearing Aid-Compatible Mobile Handsets	)	WT Docket No. 15-285

HEARING AID COMPATIBILITY TASK FORCE

FINAL REPORT AND RECOMMENDATION

December 16, 2022

TABLE OF CONTENTS

EXECUTIVE SUMMARY.

After years of hard work, independent research, and consensus-building, the Hearing Aid Compatibility Task Force ("HAC Task Force") presents its findings and recommendations to the Federal Communications Commission ("FCC" or "Commission") on whether 100% hearing aid compatibility ("HAC") is achievable, as set forth in Section 710(e) of the Communications Act of 1934, as amended (the "Act"). The HAC Task Force puts forward a path towards 100% HAC by incorporating new wireless connectivity technologies as well as accounting for intervening events over the last few years, including consumer adoption of Bluetooth connectivity, the addition of a "volume control" requirement to the HAC rules, and the transition to a new ANSI testing standard for both hearing devices and wireless handsets.

Informing the path to 100% hearing compatibility is the work of the HAC Task Force working groups, which researched and analyzed (i) available and evolving HAC technologies (Working Group 1), (ii) consumer usage of HAC technologies and alternatives (Working Group 2 – Consumer Survey), (iii) the behavior and experience of hearing health care professionals (Working Group 2 – Professional Survey), and (iv) the measurement of available handsets that achieved at least M3/T3 per the 2011 ANSI Standard against the testing methodology set forth in the 2019 ANSI Standard (Working Group 3).

The research demonstrated that consumers have access to and use numerous features on both their hearing devices and wireless phones to facilitate telecommunications on their wireless handsets. Comparing the data collected by the HAC Task Force to previous user surveys, consumers surveyed by the HAC Task Force in 2021 are increasingly using – and increasingly finding a satisfying listening experience – with Bluetooth connectivity. A new non-proprietary Bluetooth profile holds additional promise to improve the experiences of people aging into hearing loss, in particular, because many of these individuals will be familiar with pairing their wireless devices through Bluetooth, potentially lowering the barrier to adopting a compatibility method that works for them. The research also demonstrated that additional opportunities around education, including educating hearing health professionals, may improve consumer experiences. Keeping in mind the Commission's charge to consider how alternative technologies could improve consumer experiences and industry compliance, the HAC Task Force determined that consumer preferences and market conditions supported considering a more flexible way of looking at HAC for the purposes of the Commission's rules.

During the course of the HAC Task Force's work, the Commission adopted a transition to a new American National Standards Institute ("ANSI") C63.19 technical standard for the purposes of the HAC deployment benchmarks, the 2019 ANSI Standard. For the first time, the technical standard incorporated a "volume control" component, accomplished via the incorporation of ANSI/TIA-5050-2018 ("TIA 5050"), which was not developed with the Commission's traditional all air interface/frequency/codec approach in mind. Testing currently available wireless handsets, which achieved at least an M3/T3 per the 2011 ANSI Standard, identified significant and material problems with the testing approach and resulted in every handset failing to pass the 2019 ANSI Standard when following the guidance released by the FCC's Office of Engineering and Technology ("OET") to conform with the Commission's traditional testing approach. As a result, the HAC Task Force suggests the Commission alter its approach to volume control testing to ensure consumer and industry needs are met going forward.

The HAC Task Force recommends that the Commission take the following actions to forge a path to 100% HAC:

- Adopt a more flexible definition of HAC:

  > A hearing aid compatible wireless handset (a) has an internal means for compatibility (b) that meets established technical standards for hearing aid coupling or compatibility, and (c) is usable.

- Consider, along with a more flexible definition of HAC, factors such as ease-of-use, reliability, industry adoption, and consumer use and adoption when evaluating what technical standards meet the above proposed HAC definition.
- Adjust the technical standards in the HAC rules:
  - Short-term: Grant a limited, interim waiver of current transition to the 2019 ANSI Standard that allows wireless handsets to meet a modified volume control test that ensures increased amplification for hearing device users until the TIA 5050 standard has been revised and adopted into the FCC's rules.
  - Medium-term: Adjust the deployment benchmarks for manufacturers (four years from the effective date of an FCC order based on this report) and for service providers (five years from the effective date of an FCC order) to:
    - 100% of wireless handsets pass the RF Immunity Test in the 2019 ANSI Standard (successor to 2011 "M" rating); and
    - 100% magnetic/wireless coupling as follows:
      - At least 85% of handsets pass the telecoil ("T-Coil") Test in the 2019 ANSI Standard (successor to 2011 ANSI Standard "T" rating), while any handsets not passing the T-Coil Test include Bluetooth coupling capability; and
      - At least 15% of handsets include Bluetooth coupling capability, while any handsets not including Bluetooth pass the T-Coil Test.
  - Medium term: incorporate into the FCC's rules an adjusted volume control testing method that accomplishes the goal of increased amplification (i.e., need articulated by user advocates) with an updated testing methodology that better reflects modern wireless handset technologies and operation.
- Allow for additional exploration of increased reliance on Bluetooth and other alternatives with related decreasing reliance on magnetic coupling, based on future consumer and market trends, over the longer term.
- Permit service providers to legally rely on the information linked to in the Commission's Accessibility Clearinghouse in connection with meeting applicable benchmarks.
- Set a 90-day shot clock for the resolution of petitions for waiver of the HAC requirements, which would include a public notice comment cycle.

The members of the HAC Task Force stand ready as a resource to the Commission as it reexamines the Commission's HAC rules in light of this report and its recommendation.

1. History and Context.

The HAC Task Force formed in 2019, and is the result of the landmark Joint Consensus Proposal among organizations representing the interests of people with hearing loss, service providers, and handset manufacturers. Signatories to the Joint Consensus Proposal agreed to establish a multi-stakeholder task force to recommend to the Commission whether 100% hearing aid compatibility ("HAC") is achievable for wireless handsets.

1.1. Overview of the FCC's Hearing Aid Compatibility Rules and Their Formation.

Section 710 of the Communications Act of 1934 (the "Act"), as amended, requires the Commission to establish regulations "to ensure reasonable access to telephone service by persons with impaired hearing,"[1] and to "establish or approve such technical standards as are required" to do so.[2] In 2003, the Commission established wireless HAC rules to ensure that Americans with hearing loss have access to telephone service through a wide array of wireless handsets used for voice communications.[3] Since 2003, the rules have required both wireless handset manufacturers and terrestrial mobile service providers to make available to consumers a minimum number of handsets that meet specified HAC technical criteria.[4]

The Commission's rules use technical standards to measure whether wireless handsets are compatible with, or work together with, hearing aid devices (including cochlear implants). Technical standards allow the Commission, consumers, and wireless companies to objectively measure HAC and ensure compliance with the Commission's rules. As wireless handsets, hearing aids, and consumer preferences have evolved over time, the Commission in turn has updated its HAC definition and associated rules to reflect those changes. A discussion of the origin of HAC and the current definition of HAC are described below.

1.1.1. Congressional Mandate on the Commission.

The Commission established its "hearing aid compatibility" or "HAC" rules based on a direction from Congress in the 1988 HAC Act to require, to the extent possible by technology and medical science, that telephones work with hearing aids effectively via an internal means that meets a

[1] 47 U.S.C. § 610(a).
[2] *Id.* § 610(c).
[3] *Section 68.4(a) of the Commission's Rules Governing Hearing Aid-Compatible Telephones*, Report and Order, 18 FCC Rcd 16753, 16757 ¶ 8; Erratum, 18 FCC Rcd 18047 (2003) ("*2003 Hearing Aid Compatibility Order*").
[4] 47 C.F.R. § 20.19(c).

technical standard.[5] Indeed, Congress required the Commission "establish or approve such technical standards as are required to enforce [the statute]."[6]

Although wireless handsets were originally exempt from this requirement, the Commission narrowed the exemption over the years so that today, wireless handsets operating on the most used frequencies must be compatible with hearing aids. The Commission's *2003 Hearing Aid Compatibility Order*, which first required a minimum number of digital wireless phones be capable of being effectively used with hearing aids, explained Congress's directive to the Commission:

> [T]he HAC Act contemplates that phones subject to the requirements need only be capable of effective use with hearing aids designed for use with digital wireless phones. The statute requires telephones to "provide internal means for effective use with *hearing aids that are designed to be compatible with telephones which meet established technical standards* for hearing aid compatibility." We interpret this to mean that the statute does not require covered telephones to be compatible with all hearing aids, but rather only hearing aids with sufficient immunity to be intended for use with wireless devices and services.[7]

In other words, the Commission interpreted the directive from Congress to require, to the extent possible, that wireless handsets work with hearing aids through built-in functionality that is testable to a technical standard to help ensure that HAC can be objectively measured. The *2003 Hearing Aid Compatibility Order* also noted that Congress expressly avoided technology mandates so as to not "inhibit future development" of telephones, provided they are compatible with hearing aids.[8]

More recently, in 2017, the Commission explained that its legal authority to impose a volume control requirement rested on the fact that such a rule would require an "internal means for

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[5] Hearing Aid Compatibility Act of 1988, Pub. L. No. 100-394, § 3, 102 Stat. 976, 976 (1988), codified as amended at 47 U.S.C. § 610 (the "HAC Act"), (requiring the FCC to require, subject to exceptions, telephones "provide internal means for effective use with hearing aids that are designed to be compatible with telephones which meet established technical standards for hearing aid compatibility"); *id.* § 2 ("The Congress finds that – (1) to the fullest extent made possible by technology and medical science, hearing-impaired persons should have equal access to the national telecommunications network….").

[6] 47 U.S.C. §610(c). Congress first enacted this requirement as part of the Telecommunications for the Disabled Act of 1982, Pub. L. 97-410, §3, 96 Stat. 2043, and then expanded it in the Twenty-First Century Communications and Video Accessibility Act of 2010, Pub. L. 111–260, § 102, 124 Stat. 2751, 2753.

[7] *2003 Hearing Aid Compatibility Order*, 18 FCC Rcd at 16778 ¶ 60 (quoting the HAC Act).

[8] *Id.* at 16765 ¶ 28 ("In the legislative history of the HAC Act, Congress stated that the Act does not tie manufacturers to a particular technology and inhibit future development; instead, it sought only to require that telephones be compatible. Congress specifically noted that, in an effort to avoid mandating any particular type of technology, 'induction coupling and electromagnetic fields are not even mentioned' in the Act.") (quoting H.R. Rep. No. 100-674, at 8 (1988)).

[providing] effective use with hearing aids," and "because 'technologies other than the electro-magnetic coil are contemplated in the definition of hearing aid compatibility.'"[9]

1.1.2. HAC Incubator.

Several years after the adoption of the HAC rules in 2003, the Alliance for Telecommunications Industry Solutions ("ATIS") facilitated the HAC Incubator. That effort brought together nationwide service providers, wireless handset manufacturers, and several organizations representing the interests of people with hearing loss to submit a consensus plan to the Commission in 2007 to revise the HAC rules and, as part of this plan, adjust the acoustic and inductive coupling benchmarks.[10] In February 2008, the Commission adopted the consensus plan's revised benchmarks and minimum deployment standards.[11]

1.1.3. Joint Consensus Proposal.

Building upon the success of the HAC Incubator, in the fall of 2015 and spring of 2016, a diverse group of industry stakeholders explored further updates to the HAC rules. Participants in this effort included the Competitive Carriers Association ("CCA"), CTIA, the Hearing Loss Association of America ("HLAA"), the National Association of the Deaf ("NAD"), Telecommunications for the Deaf and Hard of Hearing ("TDI"), and the Telecommunications Industry Association ("TIA") (collectively, the "Consensus Proposal Participants"). The Consensus Proposal Participants agreed to several amendments to the HAC-rating system including: (1) increases in the required acoustic and telecoil coupling deployment percentages for HAC-compliant wireless phones; and (2) a process that would seek to explore and ultimately recommend to the FCC the achievability of a 100 percent FCC HAC compliance requirement ("Joint Consensus Proposal").[12] The Commission adopted the 2016 HAC Consensus Order adopting the proposals in the Joint Consensus Proposal and revising its HAC rules to create

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[9] *Access to Telecommunication Equipment and Services by Persons with Disabilities*, Report and Order and Order on Reconsideration, 32 FCC Rcd 9063, 9079 ¶ 32 (2017) ("*2017 Volume Control Order*") (footnotes omitted).

[10] *See* Supplemental Comments of ATIS, WT Docket No. 06-203 (filed June 25, 2007); *Amendment of the Commission's Rules Governing Hearing Aid-Compatible Mobile Handsets*, First Report and Order, 23 FCC Rcd 3406 (2008) ("*First Report and Order*").

[11] *See First Report and Order*, 23 FCC Rcd at 3418-19 ¶¶ 35-36.

[12] *See* Letter from James Reid, Senior Vice President, Government Affairs, TIA; Scott Bergmann, Vice President, Regulatory Affairs, CTIA; Rebecca Murphy Thompson, General Counsel, CCA; Anna Gilmore Hall, Executive Director, HLAA; Claude Stout, Executive Director, TDI; and Howard A. Rosenblum, Chief Executive Officer, NAD, to Marlene H. Dortch, Secretary, FCC, WT Docket Nos. 07-250 & 10-254 (filed Nov. 12, 2015), https://www.fcc.gov/ecfs/document/60001308803/1; Letter from James Reid, Senior Vice President, Government Affairs, TIA; Scott Bergmann, Vice President, CTIA; Rebecca Murphy Thompson, EVP & General Counsel, CCA; Barbara Kelley, Executive Director, HLAA; Claude Stout, Executive Director, TDI; and Howard A. Rosenblum, Chief Executive Officer, NAD, to Marlene H. Dortch, Secretary, FCC, WT Docket Nos. 15-285, 07-250 (filed Apr. 21, 2016), https://www.fcc.gov-/ecfs/document/60001641821/1, (collectively, the "Consensus Letters").

additional benchmarks to be met by wireless handset manufacturers and service providers to ensure greater access to wireless communication services for Americans with hearing loss.[13]

1.1.4. HAC for Wireless Handsets Today.

At present, the Commission's rules use compliance with specified technical standards to determine whether wireless handsets are compatible with, or work together with, hearing aid devices (including cochlear implants). As Congress and the Commission have recognized over the years, reliance on technical standards allows for uniform testing and reliable, reproducible measurements that permit direct comparisons among the devices being tested. So that the Commission, consumers, and wireless companies can objectively compare wireless handsets with respect to HAC, the Commission bases HAC on a technical standard, ANSI C63.19: American National Standard Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids, developed by the standards body, ANSI-accredited Committee on Electromagnetic Compatibility, C63®. The Commission applies ANSI C63.19 to wireless handsets; the same standard contains measurement methodology and performance criteria for testing the radiofrequency ("RF") immunity of hearing aids but the Commission does not regulate hearing aids. ANSI C63.19 is periodically reviewed and may be revised to reflect changing hearing aid and wireless handset technologies as well as changing consumer needs. The Commission, in turn, assesses and updates its rules to reflect these changes.

In May 2021, the Commission began transitioning from the 2011 version of the C63.19 standard adopted in 2011 ("2011 ANSI Standard") to one adopted in 2019 ("2019 ANSI Standard"). Companies may sell handsets that meet either the 2011 ANSI Standard or the 2019 ANSI Standard.[14] Starting June 5, 2023, new handsets coming on the market (and those that have had a change to their HAC capabilities) must meet the 2019 ANSI Standard. Handsets certified under older versions of the technical standard may still be sold beyond that point, though.

Wireless device manufacturers and service providers make available many handsets that meet the Commission's criteria for HAC. The 2011 ANSI Standard measured HAC based on two areas of performance: a handset's ability to reduce the likelihood of causing interference noise in the hearing aid and a handset's ability to work with a hearing aid's telecoil (or "Telecoil") via magnetic inductive coupling.[15] The 2019 ANSI Standard also measures HAC based on these areas of performance and additionally requires that the handset meet volume control

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[13] *See Improvements to Benchmarks and Related Requirements Governing Hearing Aid-Compatible Mobile Handsets*, Report and Order, 31 FCC Rcd 9336 (2016) ("*2016 HAC Consensus Order*").
[14] *Amendment of the Commission's Rules Governing Standards for Hearing Aid-Compatible Handsets*, Report and Order, 36 FCC Rcd 4566 (2021) ("*2021 HAC Standard Order*").
[15] *See* HLAA, *Hearing Aid Compatibility With Cell Phones*, https://www.hearingloss.org/wp-content/uploads/HearingAidCompatibility_with_CellPhones.pdf. Specifically, the standard measured the wireless handset's (1) level of radiofrequency emissions and (2) the telecoil coupling capability of the handset as determined by the handset's magnetic level, the magnetic frequency response, and the magnetic S-to-N ratio.

specifications.[16] The 2019 ANSI standard incorporates a separate standard, TIA 5050, to accomplish its volume control testing methodology.[17]

1.1.5. The Commission Currently Determines Whether a Wireless Handset is "HAC" (hearing aid compatible) Using an ANSI Standard.

Today, handsets that meet either the 2011 ANSI Standard or the 2019 ANSI Standard are HAC.[18]

For the 2011 ANSI Standard, the Commission uses a "HAC rating" to identify whether a handset meets the current definition of HAC. That means the handsets must achieve a minimum rating when tested according to the ANSI HAC standard. The 2011 ANSI Standard uses a combination of "M" and "T" ratings to identify handsets that work together with both the microphone (M) and telecoil (T) coupling modes available in hearing aid devices. Only handsets that meet the defined rating levels for both M and T are considered hearing aid compatible – HAC.

- An "M" rating refers to use of the hearing device's microphone during acoustic coupling with a wireless handset. All digital HAC-rated handsets have a rating for their ability to reduce interference with hearing aids operating in acoustic mode – from M1 to M4, with M4 being the best.[19]

- A "T" rating refers to the inductive coupling capability of the wireless handset to a hearing aid's telecoil. Handsets are also rated – from T1 to T4, with T4 being the best – for their ability to operate with hearing aids that contain a telecoil and operate in inductive coupling mode.[20]

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[16] Volume control is measured by the ability to achieve a specific nominal acoustic output level with a specified input along with the ability to achieve a specified amount of acoustic gain above that nominal level. The nominal acoustic output is the same level experienced during a typical face-to-face conversation when speakers are about 1 meter apart, with gain that permits increasing the level if needed.

[17] Accredited Standards Committee C63® - Electromagnetic Compatibility, *American National Standard Methods of Measurement of Compatibility Between Wireless Communications Devices and Hearing Aids*, ANSI C63.19-2019, 53 ("ANSI/TIA-5050-2018, *Telecommunications – Communications Products – Receive Volume Control Requirements for Wireless (Mobile) Devices*, provides acoustic volume requirements for WDs. For a WD to comply with this standard, ANSI C63.19, it shall also comply with ANSI/TIA-5050-2018.").

[18] Through June 4, 2023, wireless phones rated HAC pursuant to either the 2011 or 2019 ANSI Standard can be equipment authorized and then count towards HAC deployment benchmark requirements. Starting June 5, 2023, new phones offered for sale must be tested under the 2019 ANSI Standard in order to be HAC rated, although phones previously certified pursuant to the 2011 standard prior may continue to be offered for sale and count towards the HAC deployment benchmarks. The FCC provides more information at FCC, Hearing Aid Compatible Mobile Handsets (last updated Apr. 15, 2022), https://www.fcc.gov/hearing-aid-compatibility-wireless-telephones and in Section 20.19 of the FCC's rules ("FCC Compatible Mobile Handsets").

[19] *See* FCC Compatible Mobile Handsets, *supra* note 18.

[20] *See id.*

- If a handset is rated at least M3 for acoustic coupling and at least T3 for inductive coupling (for use with a telecoil), then the Commission considers it to be HAC or HAC-rated.

For the 2019 ANSI Standard, the M/T rating system is replaced by new requirements and thresholds that determine compatibility and rate a wireless handset as either passing or failing HAC. In other words, under the new standard, a handset is certified as HAC, and there is no rating level assigned. The Commission explained in its recent order adopting the new ANSI HAC standard into its rules that doing so would provide "a more consumer-friendly system."[21]

New for the 2019 ANSI Standard is a requirement that wireless handsets meet volume control specifications in order to pass.[22] The 2019 ANSI Standard also applies to a wider range of frequency bands[23] and technologies and harmonizes hearing aid testing methodologies with international hearing aid standards.[24]

Under this new system, a handset certified as hearing aid-compatible is considered to meet specifications for RF emissions, which can introduce interference noise in hearing aids during acoustic (microphone or "M") coupling or inductive (telecoil or "T") coupling. Among other changes, the 2019 ANSI Standard expanded the specification for coupling with the hearing aid T-Coil as well as added a new volume control specification that handsets must meet in order to be HAC-rated. The ANSI committee eliminated the M/T category rating system that was part of the 2011 ANSI Standard because hearing aid users found it to be confusing.[25]

1.1.6. Consumers Have Access to Various Resources to Determine Whether a Wireless Handset is HAC/HAC-rated and Where to Find the Devices to Meet Their Needs.

Consumers can look in several places to determine whether a wireless handset is HAC/HAC-rated. Packaging, package inserts/handset manuals, manufacturer websites, service provider websites, the Global Accessibility Reporting Initiative ("GARI") (www.gari.info), and the Commission's website all have information on whether a particular handset is HAC/HAC-rated.

For handsets tested under the 2019 ANSI Standard, consumers should look for HAC or "hearing aid compatible," as described below. For handsets tested under the 2011 ANSI Standard,

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[21] *2021 HAC Standard Order*, 36 FCC Rcd at 4571 ¶ 10.
[22] *Id.* ("Further, for the first time, the standard incorporates a volume control requirement that will provide significant benefits to persons with hearing loss, whether or not they use hearing aids.") (footnote omitted).
[23] The new standard covers new technologies and devices and expands the covered frequency range from the current frequency range of 698 MHz to 6 GHz to a new frequency range from 614 MHz to 6 GHz. This expanded frequency range means that handsets operating in the frequencies assigned in the Commission's Broadcast Incentive Auction can also be certified as hearing aid-compatible over those frequencies. *2021 HAC Standard Order*, 36 FCC Rcd at 4571 ¶ 10.
[24] *Id.*
[25] *Id*.

consumers should find a handset's HAC ratings (M and T ratings) to indicate a handset is HAC-rated. A handset rated M3/T3 or higher is HAC-rated.

There are many resources available for consumers to find HAC-rated devices. About 93 percent of wireless handsets are HAC-rated today, based on recent reports.[26] This *exceeds* the benchmarks required by the Commission's rules. Many of these handsets exceed the minimum HAC rating of M3/T3.[27] Below are examples of the resources available for consumers:

- **The Commission's Website.** The Commission publishes data on all mobile handsets offered in the United States,[28] including all handsets that are telecoil compatible (that is, are HAC-rated T3 or T4).[29] As seen in the "T-Rating" column of the report of June 2021, 248 telecoil coupling capable handsets were offered in the U.S. during the preceding year. Based on the latest data, telecoil-compatible handsets represent about 93 percent of all handsets in the U.S.

- **Wireless Provider and Handset Manufacturer Websites and Handset Packaging Labels.** Industry stakeholders make available information about their accessible products, including telecoil-compatible products, on their websites. The wireless industry also provides information about a handset's HAC capabilities and the Commission's HAC rating system on handset packaging and company websites. These disclosures use the Commission definition of HAC. By using a web search for "HAC <device brand>" or "HAC <wireless provider name>" consumers can find lists of products from those companies, including their HAC rating.

    - For example, Apple's Accessibility site offers consumers the ability to search for devices that meet a variety of accessibility needs. 100% of Apple smartphones are HAC-rated for both microphone and telecoil coupling. Likewise, all of the smartphones Samsung offers in the U.S. are HAC-rated for both microphone and telecoil coupling.

    - Wireless providers including AT&T, T-Mobile, and Verizon also offer a wide variety of handsets that are HAC-rated. In fact, all the phones offered by AT&T, T-Mobile, and Verizon were HAC compatible in 2020 (the most recent year for which data is available).

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[26] FCC, Device Manufacturers List of All Handsets Offered by Manufacturers, DOC 386342 (WTB Aug 18, 2022), https://docs.fcc.gov/public/attachments/DOC-386342A1.xls (93% of FCC IDs listed reported at least an M3/T3 rating) ("FCC Compatibility Report July 1, 2021 – June 30, 2022").
[27] Data is not publicly available for handsets tested under the new 2019 ANSI Standard.
[28] FCC, Hearing Aid Compatibility Reports: Device Manufacturers Summary (last updated Dec. 6, 2021), https://www.fcc.gov/wireless/systems-utilities/universal-licensing-system/hearing-aid-compatibility-status-reporting-1.
[29] FCC Compatibility Report July 1, 2020 – June 30, 2021, *supra* note 26 (see devices rated T3 or T4 in the "T-Rating" column).

- Handset manufacturers and major wireless providers also offer accessibility resource centers that help guide consumers to the products and services that meet their needs and describe other accessibility outreach and initiatives. For example:

  - **Handset manufacturers:**
    - https://www.apple.com/accessibility/
    - https://www.samsung.com/us/accessibility/

  - **Wireless Providers:**
    - https://www.att.com/accessibility/
    - https://www.t-mobile.com/accessibility
    - http://verizon.com/accessibility

- **The GARI Database.** GARI is an international resource for exploring accessibility features that supplements the Commission's HAC rules. GARI is updated as new technologies become commercially available, and retains historic data, as requested by consumer groups. GARI is used by consumers around the world; other countries may have compatibility requirements and terminology that differ from the Commission rules. GARI includes alternatives for international users – for example, incorporating commonly used terms in Europe – while referencing the U.S. HAC rating system.

- **AccessWireless.org.** AccessWireless.org provides people with disabilities, seniors, veterans, and their families and caregivers, information about accessible mobile products and services. AccessWireless.org includes a five-part video series to help consumers choose a hearing aid compatible wireless device that meets their needs. Each video, developed in partnership with the Wireless Rehabilitation Engineering Research Center, breaks down the information consumers need into easy-to-understand segments.

1.2. The 2016 HAC Consensus Order.

In 2016, the Commission accepted and adopted the Joint Consensus Proposal. Specifically, the Commission adopted the *2016 HAC Consensus Order* revising its HAC rules to create additional benchmarks to be met by wireless handset manufacturers and service providers to ensure greater access to wireless communication services for Americans with hearing loss, as noted above.[30] The *2016 HAC Consensus Order* additionally invited industry stakeholders and advocates for consumers with hearing loss to develop the HAC Task Force to determine whether a 100 percent HAC deployment benchmark is achievable considering both technical and market conditions.

1.2.1. HAC Task Force Action Items.

The *2016 HAC Consensus Order* encourages interested parties to address four issues, in particular: (1) whether 100 percent compatibility is "achievable," as defined by Section 710(e) of the Act; (2) how a 100 percent deployment benchmark could rely in part or in whole on alternative HAC technologies, bearing in mind the importance of ensuring interoperability between hearing aids and alternative technologies; (3) whether service providers should be able

[30] *See 2016 HAC Consensus Order*.

to legally rely on information in the Accessibility Clearinghouse in connection with meeting applicable benchmarks; and (4) whether the Commission should establish a fixed period of time or shot clock for the resolution of petitions for waiver of the HAC requirements.

Based on the Order, the HAC Task Force endeavored to consider the following questions:

1. *Whether 100% compatibility is achievable*, framed under Section 710(e), which requires the Commission to "consider costs and benefits to all telephone users, including persons with and without hearing loss," to "ensure that regulations adopted to implement [the HAC Act] encourage the use of currently available technology and do not discourage or impair the development of improved technology," and to "use appropriate timetables and benchmarks to the extent necessary due to technical feasibility or to ensure marketability or availability of new technologies to users."

   The HAC Task Force's Recommendation responding to these questions are discussed in Section 2.1.3.

2. *How a 100% deployment benchmark could rely in part or in whole on alternative HAC technologies*
   a. Bearing in mind the importance of ensuring interoperability between hearing aids and alternative technologies,
   b. Considering whether 100% should permit technologies other than the current M and T rating requirements,
   c. Considering whether Bluetooth can be used to meet the requirement,
   d. Considering whether personal sound amplification devices can be used to meet the requirement,
   e. Considering how would these be incorporated into future benchmark framework,
   f. Considering which data would be needed to determine if the existing definition of HAC is the most effective means for ensuring access while encouraging innovation,
   g. Considering the importance of broad interoperability between hearing aids and compatibility technologies, and
   h. Considering the costs consumers would face if certain technologies work only with select hearing aids.

   The HAC Task Force's Recommendation responding to these questions are discussed in Section 2.1.3.

3. *Whether service providers should be able to legally rely on information in the Accessibility Clearinghouse in connection with meeting applicable benchmarks*

   The HAC Task Force's Recommendation responding to these questions are discussed in Section 2.2

4. *Whether the FCC should establish a fixed period of time or shot clock for the resolution of petitions for waiver of the HAC requirements*
   a. Would 180 days be an appropriate amount of time?
   b. What would be the impact of this shot clock on small entities?

c. How would this deadline contribute to the achievability of 100%?
d. Ensuring HAC requirements don't hinder the development or deployment of new technologies

The HAC Task Force's Recommendation responding to these questions are discussed in Section 2.3.

5. *How transitioning to a 100% regime would work in practice*
   a. Considering compliance processes/waivers; legacy models;
   b. Could reporting, disclosure, labeling, and reporting requirements and other burden be reduced?
   c. What would be an appropriate transition period?
   d. How would the rules apply to other alternatives and implementation issues?
   e. How would the de minimis exception apply?
   f. What would a model rule look like?

   The HAC Task Force provides a model rule to address increased benchmarks in Section 2.1.4.

1.2.2. HAC Task Force Timeline.

The Commission recommended, consistent with the Consensus Letters, that the Consensus Proposal Participants and HAC Task Force should collaborate and convene over the course of a six-year period before making a recommendation for agency consideration and ultimate determination on the 100 percent goal. Specifically, the *2016 HAC Consensus Order* endorsed (but did not require) the following key dates:

- *By October 3, 2018 (two years after the effective date of the rules) but no later than January 1, 2020 (start of Year 4)* – HAC Task Force formation.

- *December 31, 2017 (end of Year 1) and December 31, 2018 (end of Year 2)* – suggested reports to the FCC on (i) outreach efforts by or to relevant stakeholders to gain commitments to participate in a consensus group, and (ii) HAC Task Force formation, including membership, leadership, and operations.

- *December 31, 2019 (end of Year 3)* – suggested report on (i) any Task Force meetings, operations, and accomplishments to date, (ii) the questions and scope of HAC issues to be evaluated by Task Force, (iii) any information and data planned to be collected by the Task Force, and (iv) updates to previous reports.

- *December 31, 2020 (end of Year 4) and December 31, 2021 (end of Year 5)* – suggested reports on (i) any Task Force meetings, operations, and accomplishments to date, and (ii) the information and data collected over the course of the respective years on those HAC issues being evaluated by the Task Force.

- *December 31, 2022 (end of Year 6)* – required report on (i) any Task Force meetings, operations, and accomplishments to date, (ii) the information and data collected over Years 4 and 5 on those HAC issues being evaluated by the Task Force, and (iii) final

recommendations on the achievability of a 100 percent HAC deployment benchmark and related other HAC issues.

1.3. HAC Task Force Actions to Date.

1.3.1. Formation of Task Force and Selection of ATIS as Administrator.

As explained in the discretionary reports to the Commission, in 2017 and 2018, industry stakeholders and advocates for consumers with hearing loss made significant progress toward implementation of the HAC Task Force.[31] Among other steps, industry representatives formed an *ad hoc* working group to discuss various issues relating to the stakeholder process, including potential participants, potential costs and time commitments, and whether an organizational entity may be needed to oversee the logistics of the group. Industry representatives, including the signatory associations, the *ad hoc* group, and broader participants, discussed these issues during at least a dozen substantive meetings and casual conversations throughout the year. Industry also provided consumer groups with three brief, informal, verbal updates and participation in one face-to-face meeting over the course of the year regarding these discussions.

The Consensus Participants then worked together to develop and release a Request for Information to solicit a partner, facilitator, and convener ("Administrator") for the HAC Task Force to help manage and lead the consensus-based HAC Task Force process. A Request for Information was released in August 2018 to solicit candidates with the technical, legal, and administrative expertise to help manage this consensus-based process, which would consider how to advance the goal of HAC for all wireless handsets and also encourage continued innovations that can benefit all consumers, including those who use hearing aid devices or cochlear implants. After rigorous and collaborative review by the Joint Consensus Proposal Signatories of the RFI responses, ATIS was selected as the HAC Task Force Administrator based on its expertise in managing and administrating key industry initiatives, including the ATIS HAC Incubator, which developed previous consensus-based industry recommendations for the Commission's HAC rating system for wireless handsets and hearing aid devices.[32]

ATIS convened two organizational meetings of the HAC Task Force, the first held in November 2019 and the second in January 2020. During these meetings, the mission, leadership, deliverables and operating procedures were discussed. The recruitment of additional stakeholders for this effort was also discussed. Finally, the group discussed initial research

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[31] *See* Letter from Rebecca Murphy Thompson, EVP & General Counsel, CCA; Scott Bergmann, Senior Vice President, Regulatory Affairs, CTIA; Cinnamon Rogers, Senior Vice President, Government Affairs, TIA; Barbara Kelley, Executive Director, HLAA; Claude Stout, Executive Director, TDI; and Howard A. Rosenblum, Chief Executive Director, NAD, to Marlene H. Dortch, Secretary, FCC, WT Docket No. 15-285 (filed Jan. 11, 2018), https://www.fcc.gov/ecfs/document/10111654521690/1; Letter from Courtney Neville, Associate General Counsel, CCA; Kara Graves, Director, Regulatory Affairs, CTIA; Savannah Schaefer, Policy Counsel, Government Affairs, TIA; Barbara Kelley, Executive Director, HLAA; Howard A. Rosenblum, Chief Executive Officer, NAD; and Claude Stout, Executive Director, TDI, to Marlene H. Dortch, Secretary, FCC, WT Docket No. 15-285 (filed Feb. 8, 2019), https://www.fcc.gov/ecfs/document/10208098455326/1.

[32] *See* Letter from Thomas Goode, General Counsel, ATIS, to Marlene H. Dortch, Secretary, FCC, WT Docket No. 15-285 (filed Feb. 6, 2020), https://www.fcc.gov/ecfs/document/1020696466926/1.

topics, including surveying HAC technologies, evaluating consumer use of HAC technologies, and examining the potential impact of the new 2019 ANSI Standard and related FCC rulemaking proceedings on the work of the HAC Task Force.

The HAC Task Force held its inaugural meeting on February 11, 2020, during which participants adopted a leadership structure and elected leaders, adopted operating procedures, established working groups, developed a work plan to complete initial research projects, and discussed other projects that the HAC Task Force should undertake.[33] The following participants were elected to the HAC Task Force leadership positions:[34]

- HAC Task Force Chair (Wireless Original Equipment Manufacturer): James Craig, Apple Inc.
- HAC Task Force Co-Vice Chair (Consumer): Lise Hamlin, HLAA
- HAC Task Force Co-Vice Chair (Wireless Service Provider): Shellie Blakeney, T-Mobile USA

During its February 23, 2021, meeting, the HAC Task Force nominated and elected members of the Executive Committee, which includes representatives from different industry sectors and was tasked with acting as a selection board for the research firm that ran the WG2 consumer and professional survey initiative, drafting the HAC Task Force Final Report to the Commission, and addressing other topics and questions related to the objectives of the Task Force.[35]

The HAC Task Force provided periodic discretionary updates to the Commission on various efforts undertaken toward formation of the consensus-based task force, election of leadership, launch of working groups, summaries of meetings, and status of the progress of the working groups and drafting committee toward the development of this report.

As of December 2022, the member organizations represented by the HAC Task Force were Apple Inc., AT&T, CCA, CTA, CTIA, Deaf/Hard of Hearing Technology Rehabilitation Engineering Research Center at Gallaudet University ("DHH-RERC"), Element, Google, HIA, HLAA, Julstrom Consulting and Development, Mobile & Wireless Forum, NAD, Nuheara Limited, Samsung Research America, T-Mobile USA, TDI, TIA, Union Telephone Company, UScellular, and Verizon.

1.3.2. HAC Task Force Working Groups and Workstreams.

The HAC Task Force agreed to form Working Group 1 ("WG1"), Working Group 2 ("WG2"), and Working Group 3 ("WG3"): WG1 to study available and evolving HAC technologies; WG2 to study consumer usage of HAC technologies and alternatives; and WG3 to analyze the potential impact of the new ANSI C-63.19 HAC standard on the work of the Task Force. All working groups were open to all Task Force participants.

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[33] *See* Letter from Thomas Goode, General Counsel, ATIS, to Marlene H. Dortch, Secretary, FCC, WT Docket No. 15-285 (filed Jan. 29, 2021), https://www.fcc.gov/ecfs/document/10129244034596/1.
[34] *Id.*
[35] Letter from Thomas Goode, General Counsel, ATIS, to Marlene H. Dortch, Secretary, FCC, WT Docket No. 15-285 (filed Jan. 24, 2022), https://www.fcc.gov/ecfs/document/101242886121216/1.

The HAC Task Force WG1 conducted research and gathered data on HAC technologies included in both wireless handsets and in hearing aid devices. WG2 conducted two surveys to understand the behavior and experiences of (1) consumers that use hearing aid devices, and (2) hearing health care professionals. WG3 facilitated the testing and analysis of currently available handsets that achieved at least M3/T3 per the 2011 ANSI Standard to predict the real-world effect of the current transition to the 2019 ANSI Standard.

2. Recommendations.

2.1. Recommendation on HAC Definition and Path to 100%.

The Commission requested that stakeholders consider whether 100% compatibility is achievable, framed under Section 710(e), which requires the Commission to "consider costs and benefits to all telephone users, including persons with and without hearing loss," to "ensure that regulations adopted to implement [the HAC Act] encourage the use of currently available technology and do not discourage or impair the development of improved technology," and to "use appropriate timetables and benchmarks to the extent necessary due to technical feasibility or to ensure marketability or availability of new technologies to users." In addition, the Commission requested that stakeholders consider how a 100% deployment benchmark could rely in part or in whole on alternative HAC technologies. These key questions framed the HAC Task Force's workstreams, research, and, ultimately, conclusions.

2.1.1. Background – New Bluetooth Technologies in Use.

As explained in Section 4 of this report, the HAC Task Force conducted surveys to understand how both consumers and hearing health care professionals approach hearing aid compatibility issues. The survey results demonstrated the popularity of Bluetooth for pairing hearing aid devices with wireless handsets, as compared to microphone and telecoil coupling methods where the handset is held at the ear. Bluetooth technology is an umbrella term for related technical standards that enable devices to communicate wirelessly. "Bluetooth Classic" has been used for decades in headphones and other peripheral devices such as keyboards and mice. Bluetooth Classic is used by some hearing aids to support headphone-like functionality, which reduces hearing aid battery life.

Bluetooth Low Energy ("Bluetooth LE"), standardized in 2010, greatly improves power consumption, resulting in longer battery life compared to Bluetooth Classic.[36] This improvement in the technology allows very small, lightweight devices, including wireless headphones, as well as hearing aids to reasonably manage the tradeoff between the power requirements of Bluetooth technology and a device's battery size and power capacity. Apple's Made-for-iPhone ("MFi") Hearing Aids (2013) and Google/Android's Audio Streaming for Hearing Aids ("ASHA") (2019) are proprietary coupling methods that both utilize Bluetooth LE. These coupling methods have become popular with both wireless handsets and hearing devices.

[36] *See* D. Murph, *Bluetooth 4.0 specification gets official, devices expected by Q4 2010*, Engadget (July 7, 2010) https://www.engadget.com/2010-07-07-bluetooth-4-0-specification-gets-official-devices-expected-by-q.html (including full text of Bluetooth SIG press release).

Bluetooth technology, available using either Bluetooth Classic and the Low Energy versions, is included in wireless handsets via internal chipsets and antennas found in smartphones and modern feature phones alike.[37] The more recent versions of Bluetooth technology that incorporate LE Audio are an industry standard and non-proprietary. Devices that implement these more recent versions of the standard are likely to be increasingly interoperable with hearing devices entering the marketplace. Consumers are already familiar with Bluetooth technology in common devices such as cars, computer mice, speakers, and other internet-connected devices. As a result, the concept of Bluetooth pairing is familiar to consumers, hearing health professionals, and retail workers.

Likely to increase Bluetooth technology's popularity as a coupling method for hearing devices and wireless handsets is the new Bluetooth Hearing Access Profile ("HAP"), which was adopted June 7, 2022.[38] The new profile builds on functionality first released in the proprietary Bluetooth LE hearing aid coupling methods (MFi/ASHA) along with input from other handset and hearing device manufacturers. Indeed, in 2014, the Bluetooth Special Interest Group (the Bluetooth technology standards body) and the European Hearing Instrument Manufacturers Association ("EHIMA") announced a memo of understanding with the goal of establishing a new standard for hearing aids with improved features.[39] HAP, which extends the Bluetooth LE Audio standard, will enhance the ability of individuals with hearing devices that implement the profile to interchangeably use wireless handsets from any manufacturer that also implements the profile. Both Bluetooth LE Audio and the HAP specification are recognized industry standards and non-proprietary and will therefore be interoperable across all numerous devices. The HAC Task Force anticipates that handset and hearing device manufacturers will widely adopt the Bluetooth LE Audio framework and HAP specification.[40]

Ongoing improvements to Bluetooth LE Audio add functionality that has the potential to greatly benefit hearing device users and enhance compatibility, namely standardized profiles for Bluetooth hearing aids, a modern codec (LC3), and multi-stream support and broadcast audio. Broadcast audio using the additional Bluetooth LE Audio – Public Broadcast Profile ("PBP")[41]

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[37] *See, e.g.*, Bluetooth, *2022 Bluetooth® Market Update* (2022), https://www.bluetooth.com/2022-market-update ("With Bluetooth LE and Bluetooth Classic in 100 percent of phones, tablets, and PCs, the number of dual-mode devices supported by Bluetooth technology is reaching complete market saturation...."). As noted above, Bluetooth is an umbrella term and both phones and hearing aids incorporate different Bluetooth specifications depending on when they are launched, battery size, software, costs, and other factors.

[38] Bluetooth, Specifications and Test Documents List, Hearing Access Profile (June 7, 2022), https://www.bluetooth.com/specifications/specs/hearing-access-profile ("Bluetooth HAP 1.0").

[39] *See, e.g.*, *Bluetooth SIG and EHIMA Partner to Advance Hearing Instrument Technology*, The Hearing Review (Mar. 21, 2014), https://hearingreview.com/inside-hearing/industry-news/bluetooth-sig-ehima-partner-advance-hearing-instrument-technology.

[40] *See, e.g.*, Bluetooth & ABI Research, *Market Research Note – LE Audio: The Future of Bluetooth® Audio*, at 9 (2022), https://www.bluetooth.com/wp-content/uploads/2022/10/MRN-LE_Audio.pdf ("ABI Research forecasts that annual LE Audio device shipments will reach three billion by 2027.") ("Bluetooth & ABI Research").

[41] Bluetooth, Specifications and Test Documents List, Public Broadcast Profile ("PBP") (July 5, 2022), https://www.bluetooth.com/specifications/specs/public-broadcast-profile-1-0/ ("Bluetooth PBP").

includes exciting opportunities for public and private infrastructure to support assistive listening scenarios in movie theaters, convention centers, public transit vehicles, and other venues.

The wireless industry is currently deploying 5G, which will include a mixture of low-, mid-, and high-band frequencies as well as existing and new air interfaces. The 2011 ANSI Standard or the 2019 ANSI Standard cover the most commonly used frequencies and air interfaces at present. The C63.19 ANSI standard addresses telecoil coupling methods with measurement methodology and performance criteria that assess the RF interference potential, acoustic volume control and telecoil coupling capability of wireless handsets. But it is possible that 5G and 6G will introduce voice functionality on frequencies and air interfaces not contemplated by either standard. The Bluetooth connection between a handset and hearing device runs parallel to the voice frequencies and air interfaces handsets use when connecting to wireless networks. Bluetooth coupling will be available to consumers, even if the handset and network are using frequencies and air interfaces that are not covered by the ANSI standards because Bluetooth always transmits on the 2.4 GHz band, a frequency band covered by the 2011 and 2019 ANSI Standards.

2.1.2. The HAC Task Force Recommends Consideration of a More Forward-Looking Definition of HAC.

As discussed in Section 1.1.1, the Hearing Aid Compatibility Act of 1988 required certain telephones "provide internal means for effective use with hearing aids that are designed to be compatible with telephones which meet established technical standards for hearing aid compatibility."[42] Congress "anticipated improvements in both telephone and hearing aid technologies promise greater access in the future,"[43] expecting that newer technologies would evolve into effective alternatives to the known methods of providing for "effective use" in 1988. Now, 34 years later, the HAC Task Force recommends that the Commission consider whether a transition to more consumer-friendly technologies, purposefully designed for audio transmission, is possible. The magnetic field telecoils created were a "by-product" of certain 1940s-era phone designs that later proved useful to couple to a similarly coiled piece of copper in a hearing aid.[44] Other phones of the time did not include telecoils and evolving phone designs greatly reduced "the magnetic flux leaked by the receiver,"[45] requiring regulatory mandates to hold onto equipment and technologies that could have been otherwise left out or significantly changed in evolving wireless handsets to match the greatly smaller or discarded telecoils in hearing aids.

Unlike telecoil, Bluetooth audio transmission methods are expressly designed to transmit and facilitate audio. The vast majority of wireless handsets now include at least some type of Bluetooth audio technology, without a regulatory mandate, and the HAC Task Force anticipates that operating system designers and manufacturers of handsets, headsets, earbuds, hearing aids, cochlear implants, personal sound amplification products, and other information and communications technology will incorporate the Bluetooth HAP going forward, providing a purpose-built, familiar, and effective means of using one's handset with hearing aids designed to

[42] HAC Act, Pub. L. No. 100-394, § 3, 102 Stat. at 976.
[43] *Id.* § 2(3) (setting forth findings of Congress).
[44] Linda Kozma-Spytek, *Hearing Aid Compatible Telephones: History and Current Status*, 24(1) Telephones and Telecoils: Past, Present and Future, Seminars in Hearing 17, 19 (2003).
[45] *Id*. at 21.

be compatible with telephones. In addition, Bluetooth-capable hearing devices increasingly support both MFi and ASHA.

While the HAC Task Force's survey points to greater use of Bluetooth for connectivity to phones, the survey also revealed a subset of the respondents reported using telecoil and found telecoil to be an important feature to the wireless handset. As noted in this report at Section 4.2.5, Hearing Device Features, "the top three most frequently mentioned features included in hearing devices were: (i) volume control (85%); (ii) direct Bluetooth audio streaming (64%); and (iii) a telecoil (45%). Of the 45% of respondents that used a telecoil for coupling their hearing device and phone, nearly half reported it as extremely important (48%) and were satisfied or very satisfied (47%) with its performance during wireless phone use, with another 18% reporting they were somewhat satisfied with telecoil coupling during wireless phone use.

As the HAC Task Force concluded in Section 4.2.6, "These results may indicate that the HAC Task Force should consider expanding the definition of HAC to include direct Bluetooth audio streaming capabilities or equivalent technologies, alongside the current handset requirements related to RF emissions and telecoil coupling capability, among handsets that may be counted towards the FCC's deployment benchmarks." The HAC Task Force therefore recommends that the Commission define HAC more flexibly than whether a handset merely meets a minimum rating for the 2011 ANSI Standard or the criteria in the 2019 ANSI Standard, which is the current definition.[46] In particular, the HAC Task Force encourages the Commission to adopt a forward-looking, flexible definition that reflects changing technologies while abiding by Congress's direction in the statute:

> A hearing aid compatible wireless handset (a) has an internal means for compatibility (b) that meets established technical standards for hearing aid coupling or compatibility, and (c) is usable.

Breaking down each component:

- An *internal means of compatibility* means that "the capability must be provided as an integral part of the phone, rather than through the use of add-on components that significantly enlarge or alter the shape or weight of the phone as compared to other phones offered by the manufacturer."[47]
- Any *established technical standard for hearing aid coupling* should be interoperable, non-proprietary, and adopted by industry and consumers alike. Some standards bodies require there to be two implementations by industry stakeholders before a final recommendation, to ensure interest and achievability from multiple vendors. Although relying on implementations may have caused delays in the adoption of technologies to enable access in the past, the HAC Task Force does not anticipate such concerns manifesting themselves here. In the case of the Bluetooth HAP, it is anticipated there will be at least two OS implementations (in Apple's iOS and Google's Android), as well as in multiple implementations from manufacturers of hearing aids and cochlear implants. To reflect that acoustic coupling – assured through an RF interference test (M-rating) –

[46] *See* 47 CFR § 20.19(b).
[47] *2003 Hearing Aid Compatibility Order*, 18 FCC Rcd at 16778 ¶ 61.

has been a traditional, effective means of achieving hearing aid compatibility, the HAC Task Force adds that a handset could also meet an established technical standard for hearing aid compatibility, such as the technical standards incorporated into the Commission's rules.

- Consistent with other FCC accessibility requirements, *usable* refers to ensuring that an individual has adequate information on how to operate a product[48] and access to the "full functionality and documentation for the product, including instructions, product information (including accessible feature information), documentation, bills and technical support which is provided to individuals without disabilities."[49]

The HAC Task Force also recommends that the Commission consider factors such as ease-of-use, reliability, industry adoption, and consumer use and adoption when evaluating what technical standards meet the above proposed HAC definition.

Importantly, the means of compatibility should be easy enough to use and have a reliable connection over time. Consumers must be able to couple and reconnect their hearing devices to a handset within a reasonable amount of time and in an equitable manner to those who do not use hearing devices, i.e., the connection time should be virtually the same between connecting a hearing device and connecting another accessory such as wireless earbuds. For both making and receiving calls, consumers expect that the device will remain coupled without the need to re-couple or adjust settings on their phone for the duration of a call and when making or receiving calls in succession. Consumers must also be able to disconnect their devices within a reasonable amount of time and in an equitable manner to those who do not use hearing devices, i.e., the disconnection time should be virtually the same between disconnecting a hearing device and disconnecting another accessory such as wireless earbuds.

The HAC Task Force recommends that by adopting the above HAC definition, the Commission will allow for the express incorporation of alterative and innovative technologies that can enable compatibility between wireless handsets and hearing aid devices.[50] Handsets complying with the 2019 ANSI Standard (and the 2011 ANSI Standard until that is phased out on June 5, 2023) would meet the HAC Task Force's proposed definition. In addition, recent advances with respect to Bluetooth also would meet the definition. The HAC Task Force also recommends that the Commission conduct periodic assessments of consumer usage of different coupling methods,

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[48] *See Implementation of Sections 255 and 251(a)(2) of the Communications Act of 1934, as Enacted by the Telecommunications Act of 1996*, Report and Order and Further Notice of Inquiry, 16 FCC Rcd 6417, 6429 ¶ 22 (1999).

[49] *See, e.g.*, 47 C.F.R. § 6.3(l). As part of this requirement to ensure products or services are usable, companies must provide functionally equivalent access to support services, such as technical support hotlines and databases, call centers, service centers, repair services and billing services.

[50] *2016 HAC Consensus Order*, 31 FCC Rcd at 9353 ¶ 42 ("We encourage interested parties to address four issues in particular: (1) whether 100 percent compatibility is achievable, with any analysis framed under the standard articulated in Section 710(e) of the Act, as appropriate; (2) how a 100 percent deployment benchmark could rely in part or in whole on alternative hearing aid compatibility technologies, bearing in mind the importance of ensuring interoperability between hearing aids and alternative technologies….").

to encourage innovation and further understand which standards are most relevant to a continually changing marketplace.

2.1.3. Proposal for Rules to Implement a More Forward-Looking Definition of HAC.

The HAC Task Force recommends the below revisions to the Commission's HAC rules. The recommendation is intended to incorporate the principles recommended above and to enable the Commission to adopt a more forward-looking definition of HAC, while also considering the need for wireless industry stakeholders to comply with the recommended definition. Therefore, the HAC Task Force recommends the Commission update the criteria for passing the HAC testing standard by moving toward a requirement of 100% HAC to enable two possible coupling methods: (i) acoustic and (ii) then using either telecoil or Bluetooth to enable magnetic or wireless coupling, respectively.

The HAC Task Force also recommends the Commission adopt a limited waiver of the HAC testing requirement before the June 5, 2023 compliance deadline in 47 C.F.R. § 20.19(b)(1) so that a handset compliant with the following testing would be counted towards the 85% deployment benchmark, as required by 47 C.F.R. § 20.19(c) with a modified volume control test that still ensures increased amplification for those with hearing devices.[51] The HAC Task Force recommends the Commission maintain a pass/fail system to simplify the process for consumers to identify the HAC-rating of devices.[52]

For ease of reference, the below tables show the current and proposed HAC compliance requirements:

Table 1: Current HAC Rules

OEM (Date of Compliance)	**Service Provider (Date of Compliance)**	**Technical Requirement for a Device to be Considered HAC**	**Deployment Benchmark (Percent of Handsets)**
Before June 5, 2023	Before June 5, 2023	M3/T3 Under C63.19-2011	85%
		C63.19-2019[53]	

[51] *See generally* Section 5.

[52] Likewise, the HAC Task Force recommends OET continue to issue the "HC" grant note with respect to certification grants that meet the requirements for HAC as described herein. *See* FCC, OET, *Equipment Authorization Guidance for Hearing Aid Compatibility*, KBD 285076 D01 HAC Guidance v06r02, at 4 (Sept. 19, 2022), 285076 D01 HAC Guidance v06r02.

[53] For purposes of the recommendation, the HAC Task Force intends "C63.19-2019" to include the M and T tests but not the volume control test as the HAC Task Force recommends that the Commission adopt a limited waiver of the volume control testing requirement until the Commission adopts the revised standard, as proposed below.

June 5, 2023 onward	June 5, 2023 onward	C63.19-2019	85%

Table 2: Proposed HAC Waiver and Ultimate Rules

OEM (Date of Compliance)	**Service Provider (Date of Compliance)**	**Technical Requirement for a Device to be Considered HAC**	**Deployment Benchmark (Percent of Handsets)**
June 2023	June 2023	C63.19-2019, but volume control bridge that includes increased amplification	At least 85%
4 years from effective date of FCC Order (~2028)	5 years from effective date of FCC Order (~2029)	RF Immunity Test C63.19-2019	100%
		Meet the T-Coil Compatibility Test C63.19-2019	At least 85% • Any non-T-Coil handsets must include Bluetooth
		Support Bluetooth	At least 15% • Any non-Bluetooth handsets must include T-Coil
		[[Volume Control]]	[[To be determined based on FCC adoption of an updated Volume Control standard]]

The 2019 ANSI Standard requires that wireless handsets meet three tests in addition to other "normative" and recordkeeping requirements: (1) RF Immunity Test (M – "clause 4"), (2) T-Coil Compatibility Test (T – "clause 6"), (3) Volume Requirements (Volume Control – "clause 7"). At present, handsets submit separate RF interference and T-Coil tests as part of the equipment certification process. It would be possible to assign a rating to the different test reports: M, T, V/C, and then add on B to reflect Bluetooth functionality.[54] At present, a Bluetooth test along these lines is not part of the equipment certification process, although a transmitter with Bluetooth must be certified. That is, there are different tests. The Task Force recommends having the manufacturer submit a Bluetooth attestation along with their application for FCC certification. This would provide the four separate ratings: M, T, V/C, and B.

The HAC Task Force has studied the role of each of these capabilities from the consumer and professional perspective, as well as by testing whether handsets on the market today meet the various ratings under the 2019 ANSI Standard. As discussed above, WG1 reports that M (or acoustic coupling via a microphone, reflected by the RF Immunity Test) is offered in all hearing

[54] Bluetooth LE Audio and its supported Bluetooth HAP were finalized in June 2022. *See* Section 2.1.1.

aid devices today, while hearing aid devices (as identified by WG1) appear to support Bluetooth coupling at a higher rate than for telecoil. Similarly, WG2 reports that the results of the consumer survey show that a larger percentage of consumers prefer coupling via Bluetooth than with telecoil.

Finally, WG3 conducted tests of a number of handsets for compliance with the 2019 ANSI Standard. The 2019 ANSI Standard tests telecoil differently than the 2011 ANSI Standard. The differences in the new standard appear to have resulted in handsets performing differently compared to the 2011 ANSI Standard. Specifically, over half of handsets failed the telecoil tests and all the handsets failed the V/C test. Among other things, it appears to be more difficult to maintain 85 percent T under the 2019 ANSI Standard.[55] Altogether, the results of the studies and testing completed by WG1, WG2, WG3 indicate that consumer and marketplace trends, as well as testing results, indicate that it is appropriate to develop a definition of HAC and benchmarks for compliance that continue to require handsets to meet the RF emissions test, move gradually away from requirements to offer handsets that provide the T-Coil compatibility rating, and toward handsets that provide the Bluetooth functionality.

To reflect these developments, the HAC Task Force recommends that the Commission update the HAC benchmarks to require that, four years from the effective date of its order considering this Report, OEMs offer 100 percent of wireless handsets that pass the RF Test (M) with at least 85 percent of those handsets continuing to pass the T-Coil Test (T) and at least 15 percent of those handsets support Bluetooth, and five years from the effective date of its order considering this Report, wireless providers offer 100 percent of wireless handsets that pass the RF Test (M) with at least 85 percent of those handsets continuing to pass the T-Coil Test (T) and at least 15 percent of those handsets support Bluetooth. To the extent a phone does not pass the T-Coil Test, it would have to support Bluetooth, and vice versa.

Incorporation of Bluetooth into the HAC Rules.

The HAC Task Force recommends that the Commission consider incorporating Bluetooth technology connection methods such as Bluetooth Classic and Bluetooth LE-based ASHA and MFi into its HAC rules for a period of transition. Given that newer forms of Bluetooth connectivity like Bluetooth LE Audio and Bluetooth HAP were finalized during the development of this Report, the Commission should evaluate whether these or other forms of Bluetooth technology are appropriate when adopting revised HAC rules. Bluetooth LE Audio and Bluetooth HAP – which are non-proprietary, interoperable wireless standards – represent a long-term goal. Current widespread use of other methods (e.g., Bluetooth Classic, ASHA, MFi) indicates that these methods should be considered to ensure a seamless transition toward full interoperability. The HAC Task Force recommends that the Commission assess whether the new, non-proprietary Bluetooth LE Audio and the Bluetooth HAP specifications have become more widespread and whether there are other Bluetooth technology developments to consider when incorporating Bluetooth into the HAC rules.

[55] *See* Section 5.2.2.2 explaining changes to the T-Coil test from the 2011 ANSI Standard to 2019 ANSI Standard that made passing the test more difficult.

The HAC Task Force also considers that smaller wireless providers and OEMs may be differently situated regarding Bluetooth technology in wireless devices than larger entities. In order to help ensure all covered entities can meet the proposed benchmarks, the HAC Task Force proposes an incremental step toward requiring Bluetooth technology in devices, as discussed above, particularly with respect to the introduction of Bluetooth LE Audio/Bluetooth HAP. The HAC Task Force also observes that the data collected by the HAC Task Force indicates that there is a strong trend toward devices supporting Bluetooth technology and, in the future, the Commission may wish to consider adjusting the benchmark accordingly.

Limited Waiver of Volume Control Testing.

As explained in more detail in the WG3 report in Section 5, the HAC Task Force also recommends the Commission adopt a limited waiver of the HAC testing requirement before the June 5, 2023 compliance deadline in 47 C.F.R. § 20.19(b)(1) so that a handset compliant with the following testing would be counted towards the 85% deployment benchmark, as required by 47 C.F.R. § 20.19(c):

- Meet the following clauses of the 2019 ANSI Standard:
    - RF Immunity Test (M – "clause 4") and
    - T-Coil Compatibility Test (T – "clause 6");
- Pass conversational gain for all available codecs and air interface combinations at the 2N level;
- Pass at least one of the device's available codecs for the distortion and frequency response requirements; and
- Test codecs are to be limited to those that are in scope for TIA 5050, which include narrowband and wideband codecs.

The HAC Task Force recommends that the waiver be in effect while the TIA 5050 volume control standard is revised as proposed in Section 5. The HAC Task Force recommends that the Commission consider the revised TIA standard for incorporation into its HAC rules. Therefore, the HAC Task Force does not presently recommend a benchmark deployment percentage with respect to "volume control."

Owing to the testing results under the 2019 ANSI Standard[56] and marketplace developments, the HAC Task Force recommends that the Commission adopt a limited waiver of the volume control testing requirement of the ANSI C63.19-2019 standard until the Commission has adopted a revised volume control requirement. The HAC Task Force supports revising the standard as quickly as possible. Specifically, the HAC Task Force recommends TIA to reopen the TIA 5050 standard for revision regarding: (i) receive distortion and noise performance; (ii) acoustic

[56] As the WG3 summary describes, WG3 received data from 18 mobile devices which were tested using the procedures of C63.19-2019. WG3 found that none of the devices were able to pass all testing. The key factor driving this observation is the inability of devices to pass volume control testing. After further analysis on the volume control data the WG3 members provided recommendations for TIA and the FCC, which informed the recommendations of the full HAC Task Force.

frequency response; and (iii) consideration of codecs with speech bandwidth exceeding 50-7000 Hz. If TIA cannot come to a resolution of testing of codecs with bandwidth exceeding 50-7000 Hz, the HAC Task Force recommends that the FCC exclude those from compliance testing.[57] OEM participants of the Task Force are committed to working with TIA, which housed the development of the volume control standard that was incorporated in ANSI C63.19-2019, to update the standard. The HAC Task Force participants plan to work collaboratively with Commission staff to help inform their work with TIA and other stakeholders to expediently revise the standard, and TIA plans to provide regular updates on the progress of the revision to the Commission.

Once the standard is revised, the HAC Task Force recommends allowing time for device testing and implementation to help ensure the standard can better achieve the goals of promoting volume control capabilities in HAC-rated wireless devices. Once stakeholders have completed this effort, the HAC Task Force recommends the Commission evaluate the standard and test results as it considers whether continue to the waiver of the volume control requirement and whether the Commission needs to consider revisions to the requirements regarding volume control testing.

Given the clear trends toward steadily increasing use of Bluetooth and the stagnant use of telecoil for coupling that the HAC Task Force observes in this Report, the Task Force recommends that four years from the effective date of its Order considering this Report, the Commission consider updates to the compliance benchmarks to reflect changes in the marketplace. The HAC Task Force recommends the Commission refresh the Task Force's research on available HAC technologies, consumer uses, and other relevant areas to seek to confirm that consumers increasingly use Bluetooth as this Report observes. In confirming the continuation of those trends, the HAC Task Force recommends that the Commission update the compliance benchmarks to reflect the consumer preferences by reducing the benchmark for telecoil and increasing the benchmark for Bluetooth, as appropriate. The Commission should also consider the status of the volume control standard update and incorporation of the revised standard into its rules in determining how to account for the volume control element in the compliance benchmarks. Considering changes in the marketplace, consumer trends, and technical standards development as part of its evaluation of compliance benchmarks will help the Commission achieve the balanced goals of hearing aid compatibility for all wireless handsets while incentivizing innovation to the benefit of consumers who use assistive hearing technologies.

2.1.4. Model Rule.

Incorporating the recommendations above, the HAC Task Force recommends that the Commission amend § 20.19 by revising paragraphs (b)(1), redesignating paragraph (b)(3)-(b)(5) as (b)(4)-(b)(7), redesignating paragraph (b)(3)(i)-(b)(3)(ii) as (b)(4)(ii)-(b)(4)(iii), and adding paragraphs (b)(3), (b)(4)(i), (c)(1)(iii), (c)(2)(iii), and (c)(3)(iii), as follows:

§ 20.19 Hearing aid-compatible mobile handsets.

[57] *See infra* Section 5.3 regarding recommendations from WG3 to address the issues with the volume control standard for more detailed proposals.

(a) * * *

(b) *Hearing aid compatibility; technical standards* -

(1) *Handset compatibility on or after June 5, 2023 and before [INSERT DATE FOUR YEARS AFTER EFFECTIVE DATE].* In order to satisfy a manufacturer or service provider's obligations under paragraphs (c) and (d) of this section, a handset submitted for equipment certification or for a permissive change relating to hearing aid compatibility on or after June 5, 2023 must meet the 2019 ANSI Standard.[58]

(2)[59] *Handset compatibility before June 5, 2023.* In order to satisfy a manufacturer or service provider's obligations under paragraphs (c) and (d) of this section, a handset submitted for equipment certification or for a permissive change relating to hearing aid compatibility before June 5, 2023 must meet either:

(i) At a minimum, the M3 and T3 ratings associated with the 2011 ANSI Standard; or

(ii) The 2019 ANSI Standard.

(3) *Handset compatibility after [INSERT DATE FOUR YEARS AFTER EFFECTIVE DATE].* In order to satisfy a manufacturer and service provider's obligations under paragraph (c) of this section, the following standards apply for a handset submitted for equipment certification or for a permissive change relating to hearing aid compatibility:

(i) RF Test - Clause 4 associated with the 2019 ANSI Standard;

(ii) T-coil Test – Clause 6 associated with the 2019 ANSI Standard; and

(iii) Bluetooth coupling capability means complying with a Bluetooth Standard.[60]

(4) *Handsets operating over multiple frequency bands or air interfaces.*

(i) Beginning [INSERT DATE FOUR YEARS AFTER EFFECTIVE DATE], a handset a handset is hearing aid-compatible if it meets:

(A) paragraph (b)(3)(i) and paragraph (3)(ii) for all frequency bands that are specified in the ANSI standard and all air interfaces over which it operates on those frequency bands for all frequency bands that are specified in the 2019 ANSI standard and all air interfaces over which it operates on those frequency bands, and the handset has been certified as compliant with the test requirements for the 2019 ANSI standard pursuant to § 2.1033(d) of this chapter with respect to Clauses 4 and 6 of the 2019 ANSI standard; or

(B) (1) paragraph (b)(3)(i) for all frequency bands that are specified in the ANSI standard and all air interfaces over which it operates on those frequency bands for all frequency bands that are specified in the 2019 ANSI standard and all air interfaces over which it operates on those frequency bands,

[58] For purposes of this Recommendation, we refer to the rules as written but intend for Section 20.19(b)(1) to require handsets to meet the 2019 ANSI Standard with a waiver of the V/C requirement.
[59] In a Final Rules Appendix, unmodified paragraphs would be shown by three stars including important, intervening but unchanged paragraphs here for clarity.
[60] *See* Section 2.1.3 (recommendation on incorporating Bluetooth into the HAC rules).

(2) the handset has been certified as compliant with the test requirements for the 2019 ANSI standard pursuant to § 2.1033(d) of this chapter with respect to Clauses 4 of the 2019 ANSI standard, and

(3) paragraph (b)(3)(iii).

(ii) Beginning on June 5, 2023 and before [INSERT DATE FOUR YEARS AFTER EFFECTIVE DATE], a handset is hearing aid-compatible if it meets the 2019 ANSI standard for all frequency bands that are specified in the ANSI standard and all air interfaces over which it operates on those frequency bands, and the handset has been certified as compliant with the test requirements for the 2019 ANSI standard pursuant to § 2.1033(d) of this chapter.

(ii) Before June 5, 2023, a handset that uses only the frequencies specified in the 2011 ANSI standard is hearing aid-compatible with regard to radio frequency interference and inductive coupling if it meets the 2011 ANSI standard for all frequency bands and air interfaces over which it operates, and the handset has been certified as compliant with the test requirements for the 2011 ANSI standard pursuant to § 2.1033(d) of this chapter. Before June 5, 2023, a handset that incorporates operations outside the frequencies specified in the 2011 ANSI standard is hearing aid-compatible if the handset otherwise satisfies the requirements of this paragraph (b).

* * * * *

(c) *Phase-in of hearing aid-compatibility requirements.* The following applies to each manufacturer and service provider that offers handsets used to deliver the services specified in paragraph (a) of this section and that does not fall within the *de minimis* exception set forth in paragraph (e) of this section.

(1) *Manufacturers - Number of hearing aid-compatible handset models offered.* For each digital air interface for which it offers handsets in the United States or imported for use in the United States, each manufacturer must offer hearing aid compatible handsets as follows:

***

(ii) Beginning October 4, 2021, at least eighty-five (85) percent of those handset models (rounded down to the nearest whole number) must be hearing aid-compatible under paragraph (b) of this section.

(iii) Beginning [*INSERT DATE FOUR YEARS AFTER EFFECTIVE DATE]:*

(A) All handset models must be hearing aid-compatible under paragraph (b)(3)(i) of this section.

(B) At least eighty-five (85) percent of those handset models (rounded down to the nearest whole number) must be hearing aid-compatible under paragraph (b)(3)(ii) of this section. Any handsets not compliant with paragraph (b)(3)(ii) must be hearing aid-compatible under paragraph (b)(3)(iii); and

(C) At least fifteen (15) percent of those handset models (rounded down to the nearest whole number) must be hearing aid-compatible under paragraph (b)(3)(iii) of this section.

Any handsets not compliant with paragraph (b)(3)(iii) must be hearing aid-compatible under paragraph (b)(3)(ii).

(D) Any handset model previously certified as hearing aid-compatible may be continued to be offered in the United States and counted as hearing aid-compatible.

(2) *Tier I carriers - Number of hearing aid-compatible handsets models offered.* For each digital air interface for which it offers handsets to customers, each Tier I carrier must:

(i) Beginning April 3, 2019, ensure that at least sixty-six (66) percent of the handset models it offers are hearing aid-compatible under paragraph (b) of this section, calculated based on the total number of unique handset models the carrier offers nationwide.

(ii) Beginning April 4, 2022, ensure that at least eighty-five (85) percent of the handset models it offers are hearing aid-compatible under paragraph (b) of this section, calculated based on the total number of unique handset models the carrier offers nationwide.

(iii) Beginning [*INSERT DATE FIVE YEARS AFTER EFFECTIVE DATE]:*

(A) All handset models must be hearing aid-compatible under paragraph (b)(3)(i) of this section.

(B) At least eighty-five (85) percent of those handset models (rounded down to the nearest whole number) must be hearing aid-compatible under paragraph (b)(3)(ii) of this section. Any handsets not compliant with paragraph (b)(3)(ii) must be hearing aid-compatible under paragraph (b)(3)(iii).

(C) At least fifteen (15) percent of those handset models (rounded down to the nearest whole number) must be hearing aid-compatible under paragraph (b)(3)(iii) of this section. Any handsets not compliant with paragraph (b)(3)(iii) must be hearing aid-compatible under paragraph (b)(3)(ii).

(D) Any handset model previously certified as hearing aid-compatible may be continued to be offered in the United States and counted as hearing aid-compatible.

(3) *Service providers other than Tier I carriers - Number of hearing aid-compatible handsets models offered.* For each digital air interface for which it offers handsets to customers, each service provider other than a Tier I carrier must:

(i) Beginning April 3, 2020, ensure that at least sixty-six (66) percent of the handset models it offers are hearing aid-compatible under paragraph (b) of this section, calculated based on the total number of unique handset models the carrier offers.

(ii) Beginning April 3, 2023, ensure that at least eighty-five (85) percent of the handset models it offers are hearing aid-compatible under paragraph (b) of this section, calculated based on the total number of unique handset models the carrier offers.

(iii) Beginning [*INSERT DATE FIVE YEARS AFTER EFFECTIVE DATE]:*

(A) All handset models must be hearing aid-compatible under paragraph (b)(3)(i) of this section.

(B) At least eighty-five (85) percent of those handset models (rounded down to the nearest whole number) must be hearing aid-compatible under paragraph (b)(3)(ii) of

this section. Any handsets not compliant with paragraph (b)(3)(ii) must be hearing aid-compatible under paragraph (b)(3)(iii).

(C) At least fifteen (15) percent of those handset models (rounded down to the nearest whole number) must be hearing aid-compatible under paragraph (b)(3)(iii) of this section. Any handsets not compliant with paragraph (b)(3)(iii) must be hearing aid-compatible under paragraph (b)(3)(ii).

(D) Any handset model previously certified as hearing aid-compatible may be continued to be offered in the United States and counted as hearing aid-compatible.

* * * * *

The HAC Task Force does not, at this time, address other possible modifications to the HAC rule to address how a transition to a 100% regime would work in practice or how the rule may change in response to an updated Volume Control standard.

2.2. Accessibility Clearinghouse.

2.2.1. Background.

The Commission created the Accessibility Clearinghouse as part of its CVAA implementation to provide information about accessible telecommunications and advanced communications products and service to the public.[61] HAC information is included in the Accessibility Clearinghouse and provides important data about the accessibility of wireless handsets that are available to consumers. The CVAA also requires the Commission to include within the Accessibility Clearinghouse "an annually updated list of products and services with access."[62] The Accessibility Clearinghouse can be accessed at https://www.fcc.gov/ach and contains links to information on the Commission's own website as well as the GARI database, www.gari.info, and AccessWireless.org, a website maintained by CTIA to be a "first stop" resource for learning about accessible cellphones and wireless devices. GARI is a project of the Mobile & Wireless Forum and its information is populated by device manufacturers and app developers.[63] The GARI database includes information about the accessibility features of more than 1,500 devices and are available for consumers today.[64]

The HAC Task Force understands that handset manufacturers are overwhelmingly responsible for the HAC certification of their wireless handsets and that handset manufacturers provide timely information to the GARI database. Given their responsibility for HAC testing as part of the Commission's equipment authorization process, manufacturers are in the best position to

[61] 47 U.S.C. § 618(d).
[62] *Id*.
[63] GARI, Home Page, https://www.gari.info (last visited Nov. 7, 2022).
[64] *See* FCC, Accessibility Clearinghouse, www.fcc.gov/ach (last updated Nov. 19, 2020); Mobile & Wireless Forum, *Over 70% of people find the accessible device they are looking for on GARI - just one stat from the latest Annual Report*, GARI Blog (May 20, 2021), http://blog.gari.info/2021/05/over-70-of-people-find-accessible.html. GARI also includes devices that are no longer offered for sale.

know the HAC status of their wireless handsets.[65] Further, the HAC Task Force understands that manufacturers often populate the GARI database when they bring a device to market, or shortly thereafter. This schedule results in a more current snapshot of HAC handset offerings than the annual FCC Form 655 cycle, which is the manufacturer report regarding how many wireless handsets are HAC and their characteristics including HAC ratings (as applicable), FCC IDs, air interfaces, and operating frequencies. Manufacturers are incentivized to populate the GARI website with only accurate information given that the HAC ratings of wireless handsets are publicly available in the manufacturer's FCC Form 655 report, the Commission's compilations of those reports, and the Commission's Equipment Authorization System database.[66] Compared to these sources, however, the GARI database has a user-friendly interface and search functionality – and is used by the public as a useful tool for understanding the accessibility of wireless handsets.[67]

2.2.2. The HAC Task Force Recommends that Service Providers Be Able to Legally Rely on the Information in the Accessibility Clearinghouse in Connection with Meeting Applicable Benchmarks.

The HAC Task Force recommends that service providers should be able to legally rely on information in the Accessibility Clearinghouse to determine a handset's HAC rating when calculating their deployment percentages for the purposes of meeting applicable benchmarks.[68] Specifically, service providers should be able to rely on the information reported in the GARI database, which is linked at the Accessibility Clearinghouse website. This approach is also better for consumers because information in the Accessibility Clearinghouse, which relies upon GARI, is the most up to date information about available HAC handsets, as well as providing historic data about handsets that may no longer be sold by service providers.

To the extent that the Commission may have been concerned about the reliance on third party websites, and GARI in particular in its *2016 HAC Consensus Order*,[69] recent evidence demonstrates that service providers are successfully relying on third-party websites, including

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[65] The HAC Task Force notes that should a service provider add functionality to a wireless handset that affects the hearing aid compatibility functionality of the handset, that service provider would know first-hand how the HAC status has changed and be able to incorporate that knowledge into their compliance with the HAC rules.

[66] The Commission determined that the information in the FCC Form 655 is reliable for the purposes of service providers' reporting requirements. *See, e.g.*, *2016 HAC Consensus Order*, 31 FCC Rcd at 9356-57 ¶ 49.

[67] *See* Mobile & Wireless Forum, *GARI Annual Report 2020*, at 5 (2020), https://www.mwfai.org/docs/eng/MWF_GARI%20Annual%20Report%202020.pdf ("Hearing features comprise two-thirds of the most searched for features on GARI.") ("GARI Annual Report 2020"); *Revisions to Reporting Requirements Governing Hearing Aid-Compatible Mobile Handsets*, Report and Order, 33 FCC Rcd 11549, 11565 Chart I (2018) ("*2018 Reporting Order*") (providing the average pageviews to the FCC Form 655 Website for service providers in non-filing months).

[68] *See 2016 HAC Consensus Order*, 31 FCC Rcd at 9356-57 ¶¶ 48-49.

[69] *Id.* at 9356 ¶ 48 (asserting that commenters expressing support for allowing service providers to rely on the Accessibility Clearinghouse as a compliance safe harbor did not address "whether the database reliably identifies devices that are in fact fully compliant with the hearing aid compatibility rule") (footnote omitted).

GARI, to meet HAC disclosure obligations. For example, in 2018, the Commission expressly allowed service providers to link to the GARI website to provide information about HAC-compliant handsets that service providers once, but no longer, offered.[70] This requirement became effective September 3, 2019.[71] The HAC Task Force is unaware of any reports, observations, or complaints regarding the information in GARI, since the Commission's disclosure rule went into effect.[72] In contrast, just as GARI has been a resource for consumers, GARI can be particularly useful for smaller and newer service providers, ultimately leading to an increase in information about HAC handset offerings by a wider variety of wireless service providers in the marketplace.

With respect to implementation, the HAC Task Force recommends that the Commission adopt a safe harbor that allows service providers to rely on information in the Accessibility Clearinghouse to the extent that it reflects compliance information submitted by manufacturers. The HAC Task Force further recommends that the Commission maintain the links to the GARI database at the Accessibility Clearinghouse website to facilitate this safe harbor. As noted above, the user interface and search functionalities at GARI are designed with ease of navigation and accessibility in mind, manufacturers are motivated to provide accurate information to the GARI database, and the Task Force is unaware of any issues with the data in the database.[73] As a fallback—for example, if a device is not in the GARI database—the HAC Task Force recommends that the Commission automatically and immediately upload manufacturers' FCC Form 655 to the Accessibility Clearinghouse after they are submitted to the Commission. The Commission determined that service provides may rely on the information in a manufacturer's FCC Form 655 for HAC compliance information.[74] Individual manufacturer forms, although less user-friendly than the GARI database, can provide further assurance to the Commission that service providers are relying on accurate information when determining their compliance with the HAC benchmarks.

2.3. Waivers and Shot Clocks.

2.3.1. Background.

Congress directed the Commission to ensure that the HAC requirements do not hinder the development or deployment of new technologies and handsets, especially when that innovation may present opportunities for a better experience for individuals with disabilities in the long run.

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[70] *2018 Reporting Order*, 33 FCC Rcd at 11556-57 ¶ 20.

[71] *Wireless Telecommunications Bureau Announces Opening of Filing Window for Hearing Aid Compatibility Certifications and Compliance Date for New Rules*, Public Notice, 34 FCC Rcd 7048 (2019).

[72] 47 C.F.R. § 20.19(h)(2) (requiring service providers to link to a third-party webpage designated by the Commission with information regarding hearing aid-compatible and non-hearing aid-compatible handset models, or include a list of handset models that are no longer offered if the calendar month/year that model was last offered is within 24 months of the current calendar month/year). The rule became effective August 1, 2019. *See* Revisions to Reporting Requirements Governing Hearing Aid-Compatible Handsets, 84 Fed. Reg. 37591 (Aug. 1, 2019).

[73] GARI Annual Report 2020.

[74] *See, e.g.*, *2016 HAC Consensus Order*, 31 FCC Rcd at 9356-57 ¶ 49.

Under Section 710(b)(3), Congress expressly permitted the Commission to entertain petitions to waive the HAC requirements provided:

> [T]he Commission determines, on the basis of evidence in the record of such proceeding, that such telephones, or such technology or service, are in the public interest, and that (A) compliance with the requirements of paragraph (1)(B) [the HAC requirements] is technologically infeasible, or (B) compliance with such requirements would increase the costs of the telephones, or of the technology or service, to such an extent that such telephones, technology, or service could not be successfully marketed. In any proceeding under this paragraph to grant a waiver from the requirements of paragraph (1)(B), the Commission shall consider the effect on hearing-impaired individuals of granting the waiver.[75]

In addition to the specific authority in Section 710(b)(3), the Commission has broad authority to waive its rules for good cause shown.[76] The Commission may exercise its discretion to waive a rule when the particular facts make strict compliance inconsistent with the public interest.[77] The Commission may take into account considerations of hardship, equity, or more effective implementation of overall policy on an individual basis.[78] In short, waivers may be justified when special circumstances warrant a deviation from general rules and such deviation will serve the public interest. Entities seek waivers for a variety of reasons, such as, when trying to bring to market a technology that can benefit a particular population,[79] a new technology that was not contemplated by the Commission's rules when they were adopted,[80] when a technology can be

[75] 47 U.S.C. § 6.10 (b)(3).
[76] 47 C.F.R. § 1.3.
[77] *Northeast Cellular Tel. Co. v. FCC*, 897 F.2d 1164, 1166 (D.C. Cir. 1990); *WAIT Radio v. FCC*, 418 F.2d 1153 (D.C. Cir. 1969).
[78] *WAIT Radio*, 418 F.2d at 1150; *Northeast Cellular*, 897 F.2d at 1166.
[79] *See, e.g.*, *Sorenson Communications, Inc. and CaptionCall, LLC Request For Waiver of Volume Control Reset, 47 C.F.R. § 68.317(f)*, Order, 29 FCC Rcd 14879 (CGB 2014) (granting waiver to permit certain telephone devices to include a volume control override switch).
[80] *See, e.g.,* News Release, FCC, *FCC PERMITS HOT-CAR SENSORS TO SAVE CHILDREN: Waivers Clear the Way for Automakers and Manufacturers to Use Radar Systems to Monitor for Children Left in Dangerous, Hot Vehicles* (Apr. 14, 2021) (announcing the grant of six waiver requests of the technical and services rules for the 57-71 GHz band, which would allow manufacturers and automakers to supply and operate in-cabin radars in the 60 GHz band to detect children left in hot cars); *Petition for Waiver of Rules Requiring Support of TTY Technology*, Order, 30 FCC Rcd 10855 (CGB, PSHSB, WTB & WCB 2015) (granting AT&T a waiver of certain TTY requirements while a proceeding related to a newer technology, real-time text (RTT) was underway); *Amendment of Part 90 of the Commission's Rules to Permit Terrestrial Trunked Radio (TETRA) Technology*, Notice of Proposed Rule Making and Order, 26 FCC Rcd 6503 (2011) (granting the TETRA Association a waiver, pending the outcome of a rulemaking to explore whether to amend the technical rules, to deploy new TETRA technology, which could have valuable benefits to land mobile radio users).

used for a new application not originally anticipated,[81] in anticipation of an expected, uncontroversial rule change,[82] or when they are seeking a ministerial fix.[83]

There are no established timelines—or shot clocks—for the Commission to act on either Section 710(b)(3) waivers or waivers granted pursuant to the Commission's general authority. Even so, the Commission asked the HAC Task Force to address whether the Commission should implement a shot clock on the resolution of hearing aid compatibility waiver requests pursuant to Section 710(b)(3) involving new technologies or other circumstances.[84]

Consistent with Congress's intent and the Commission's direction, the HAC Task Force wants to ensure that the HAC requirements do not hinder the development or deployment of new technologies and handsets, especially when that innovation may present opportunities for a better experience for individuals with disabilities in the long run. Further, the HAC Task Force recognizes that speed to market is often important to attracting investment that can, in turn, be used to increase accessibility beyond baselines.[85] Slower speed-to-market resulting from a drawn-out waiver process can diminish the benefits of newer technology or eliminate a newer and/or smaller firm's first-mover advantages. In addition, firms need timely finality in order to plan manufacturing and marketing strategies, or to change course—Section 710(b)(3) waiver requests that linger unresolved could hinder the development or deployment of new technologies.

2.3.2. The HAC Task Force Recommends that the Commission Establish a 90-Day Shot Clock for the Resolution of Petitions for Waiver of the HAC Requirements.

The HAC Task Force recommends that the Commission establish a fixed period of time or "shot clock" of 90 days for the resolution of petitions for waiver of the HAC requirements pursuant to Section 710(b)(3).[86] The HAC Task Force believes that 90 days properly balances (i) expected low number of expected petitions, and, relatedly, the burden on Commission staff, (ii) an

[81] *See, e.g.*, *Zebra Technologies*, Order, 36 FCC Rcd 14588 (OET 2021) (granting a waiver to allow Zebra to certify a version of its Dart positioning system for operation in the 7125-8500 MHz range; the technology would be used to track players in sports venues).
[82] *See, e.g.*, *EchoStar Technologies L.L.C. Funai Electric Co., Ltd.*, Memorandum Opinion and Order, 30 FCC Rcd 4562 (MB 2015) (granting EchoStar a waiver to import, market, and sell a new digital video recorder that does not include an analog tuner, as otherwise required under the rules, in order to "enhance consumer choice.").
[83] *See, e.g.*, *Telephone Number Portability*, Order, 19 FCC Rcd 23962 (WCB 2004) (granting Sprint a waiver to correct an inadvertent, computational error).
[84] *2016 HAC Consensus Order*, 31 FCC Rcd at 9357 ¶ 50.
[85] The HAC Task Force affirms that products and services should be designed with accessibility in mind from the earliest possible design stages and include consultation with individuals with disabilities. The HAC Task Force also recognizes that exceeding accessibility baselines and conducting above-and-beyond user testing may require more resources than a small or new firm may be able to dedicate before going to market.
[86] 47 U.S.C. § 610(b)(3).

opportunity for public notice and comment, with (iii) the need for timely resolution of petitions to ensure the deployment of new technologies is not unduly delayed.

As an initial matter, the statutory waiver standard laid out in Section 710(b)(3) is sufficiently tailored, and the need for HAC handsets is so important, that very few entities are likely to pursue Section 710(b)(3) waivers. This prediction is supported by the data to date. The Commission has not granted any waivers pursuant to Section 710(b)(3), and the HAC Task Force is unaware of any petitions for waiver in the past decade and a half.[87]

The HAC Task Force attributes the lack of waiver requests seen to date to the FCC's gradual increase in deployment benchmarks over the years, which were developed with input from the accessibility community and industry through the Joint Consensus Proposal. This "ramp-up" approach ensured that the overall market for wireless handsets had numerous HAC options while manufacturers and service providers could offer less than 100% HAC handsets. In addition, the *de minimis* exception has been important for firms just entering the U.S. market. These factors and the high bar for waivers set forth in the statute indicate to the HAC Task Force that any burden imposed on Commission staff in complying with a 90-day shot clock should be minimal.

A 90-day shot clock should also provide the Commission with sufficient time to seek comment on Section 710(b)(3) waiver requests. The HAC Task Force reads the phrase "on the basis of evidence in the record of such proceeding" in the statute as expecting the Commission to develop a public record. Therefore, the HAC Task Force recommends that waivers pursuant to Section 710(b)(3) be put on public notice for a comment period, such as 20 days for initial comments and an additional 15 days for reply comments. Any comment periods established should be encompassed in the 90-day shot clock timeline.

Finally, the HAC Task Force expects that a 90-day shot clock will allow the marketplace to increase the variety of HAC handsets, as defined in this report, while avoiding unintended harm that could be caused by firms seeking to develop or deploy new technologies and handsets having to wait an indefinite amount of time for the Commission to reach finality on Section 710(b)(3) waiver requests.

3. Working Group 1 Report.

3.1. Overview of Working Group 1.

WG1 was chartered by the HAC Task Force on February 11, 2020 with the following mission:

> Survey what currently available and emerging technologies (and the breadth and timing of their availability) enable those with hearing loss to connect to their devices. The focus of the WG is (1) hearing devices, (2) means of coupling, and (3) wireless handsets.

[87] A Lexis search identified a waiver granted pursuant to the Commission's general Rule 1.3 waiver authority in 2007. *See Section 68.4(a) of the Commission's Rules Governing Hearing Aid-Compatible Telephones*, Memorandum Opinion and Order, 22 FCC Rcd 7171 (2007). An ECFS search for "610(b)(3)" did not return any relevant results.

In March 2020, WG1 began to compile an overview of the handsets and hearing devices available to American consumers, including relevant connection methods, HAC ratings, and other detail such as alternative coupling methods using Bluetooth.

Participants in WG1 consisted of 37 representatives from industry and disability advocacy organizations. Due to challenges related to the COVID-19 pandemic, all WG1 activity leveraged remote collaboration tools such as email, phone, and video conference services. The group met eight times in 2020 to coordinate initial compilation of the data and presented its initial findings to the full HAC Task Force on June 2, 2020. WG1 then went on hiatus while the efforts of Working Group 2 and Working Group 3 of the HAC Task Force proceeded.

WG1 reconvened in March 2022, to verify the data originally collected in 2020, and to collect data on any new devices released after June 2020. WG1 participants sought additional voluntary data submissions from device manufacturers, including any known device testing results for the 2019 ANSI Standard, and more specific device support listings of alternative coupling methods, including:

- Apple's MFi[88]
- Google Android's ASHA[89]
- Bluetooth Classic
- Any planned support for the emerging Bluetooth LE Audio standard, which supports the Hearing Access Profile ("HAP 1.0").[90] This new standardized connection protocol is similar to those used in the proprietary MFi and ASHA coupling methods.

From March to June 2022, WG1 met another six times and coordinated additional data collection remotely.

3.2. Handset Overview.

Data sources for handsets included voluntary submissions by handset manufacturers, data gathered by service providers and trade organization resources, as well as public data sources including the FCC website, wireless service provider websites, and device manufacturer websites.

3.2.1. Handset HAC Ratings (2011 Version).

WG1 gathered data for 554 handsets from 36 manufacturers. 521 (94%) of the 554 handsets listed passing HAC results for RF and telecoil interference minimums (using the 2011 ANSI Standard), meeting an M3 or M4 rating for microphone coupling and either a T3 or T4 rating for telecoil coupling.

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[88] Apple, Use Made for iPhone hearing devices, (MFi) Hearing Aids and Cochlear Implants, https://support.apple.com/en-us/HT201466 (last visited Nov. 7, 2022) ("Apple MFi").
[89] Android, Hearing Aid Audio Support Using Bluetooth LE, https://source.android.com/devices/bluetooth/asha (last visited Nov. 7, 2022) ("Android ASHA").
[90] Bluetooth HAP 1.0, *supra* note 38.

Figure 1: Mobile Handset Models
Overall HAC Ratings for 554 models (ANSI C63.19-2011)

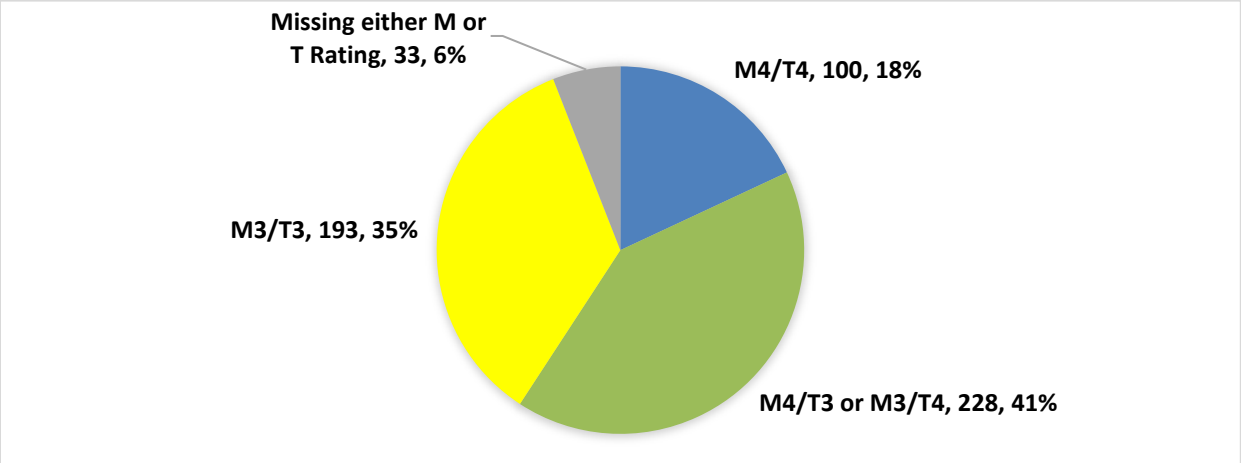
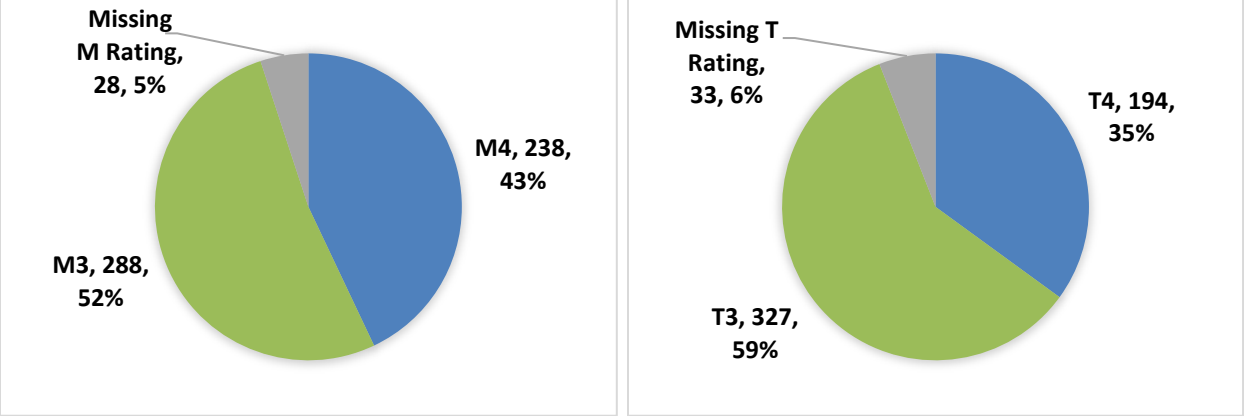


Figure 2: Mobile Handset Models
M and T Ratings for 554 models (ANSI C63.19-2011)



The rating data for 33 devices (6%) was not provided. The working group did not have a reliable means to determine if the remaining 6% of devices had been tested with failing ratings, or if they were untested, or if the data was missing for another reason.

3.2.2. Handset HAC Ratings (2019 Version).

Although included in the 2022 data collection update as an optional field, no handset manufacturers directly shared the 2019 ANSI Standard test results for specific devices. More information on the 2019 ANSI Standard testing is included in Section 5, where detailed but anonymized test data was provided by several handset manufacturers as part of WG3's efforts.

3.2.3. Handset Bluetooth Low Energy Based Coupling.

In addition to microphone and telecoil based coupling methods, many phone handsets also support Bluetooth Low Energy-based proprietary coupling methods: either Apple's "MFi" or Android's "ASHA" protocols.

313 (56%) devices support one of the proprietary Bluetooth methods, and support is increasing over time: All models of iPhone support Apple's MFi protocol (available since 2013), and most recent Android handsets support the Google ASHA protocol (available on handsets since 2018).

On June 7, 2022, the Bluetooth SIG finalized and adopted HAP 1.0. HAP 1.0 is a non-proprietary Bluetooth technology connection between handsets and hearing devices that is supported by the Bluetooth LE Audio standard and will offer much of the same functionality available in the proprietary hearing aid connection protocols. HAP 1.0 was released after WG1 completed its data collection, so an implementation timeline is difficult to predict, but a few manufacturers (Apple and Google) indicated that recent iOS and Android devices (2021 year releases, and possibly more) will likely be able to support the new Bluetooth coupling standard.[91] Older devices may require a chipset or firmware update, and therefore are less likely to support the new Bluetooth LE Audio/HAP specifications, even though they are likely to have access to Bluetooth Classic, MFi, and/or AHSA.

3.3. Mobile Service Provider HAC Overview.

Mobile Service Provider data was collected primarily from service provider submissions, service provider websites, and the FCC's service provider certification reports for 2019 and 2021.[92]

WG1 notes that these service provider HAC percentages and handset availability are based on the 2011 HAC standard: ANSI C63.19-2011. No comprehensive data is available for how currently available handsets fare against the more recent ANSI C63.19-2019.

Despite a decrease in total number of U.S. service provider HAC certification reports,[93] the percentage of devices with HAC certifications available from service providers improved overall. The number of service providers certifying HAC for 100% of their handset offerings increased from 74% in 2019 to 80% in 2021, and the underperforming listings (those below 85% HAC availability) decreased from 12% in 2019 to 7% in 2021.

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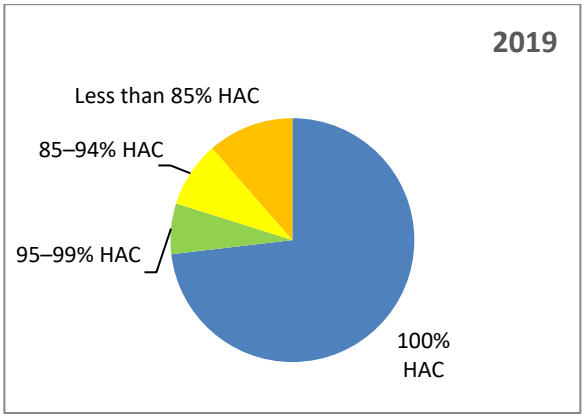
[91] Bluetooth SIG's market research forecasts nearly a half-billion LE Audio devices will ship in 2023, growing to three billion annually in 2027. *See* Bluetooth & ABI Research, *supra* note 40.

[92] FCC, Hearing Aid Compatibility Service Provider Certifications (last updated Aug. 8, 2019), https://www.fcc.gov/hearing-aid-compatibility-service-provider-certification (2021 reports); FCC, Hearing Aid Compatibility Status Reporting Archives: Service Providers (last updated Dec. 6, 2021), https://www.fcc.gov/wireless/systems-utilities/universal-licensing-system/hearing-aid-compatibility-status-reporting-2 (2019 reports) (collectively, "Compatibility Service Provider Certifications").

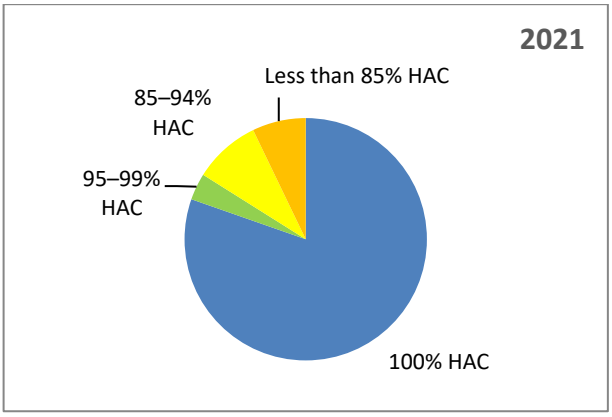
[93] In 2021, service providers filed 112 HAC compliance reports, down from 147 in 2019. WG1 identified no specific data to explain the drop in number of reports, WG1 notes that the time period includes a notable large acquisition (Sprint was acquired by T-Mobile) and the COVID-19 pandemic that affected most industries on a global scale.

Figure 3: Certification reports of available percentages of HAC-rated devices from Mobile Service Providers 2019 n=147; 2021 n=112

2019 Mobile Provider HAC Certifications



2021 Mobile Provider HAC Certifications



In 2021, the largest three U.S. mobile service providers (Verizon, AT&T, and T-Mobile) each reported HAC compliance rates of 99% or 100%. These HAC certification statistics seem to indicate that most Americans have the opportunity to choose between a variety of HAC-rated handsets, with different features and price levels.

3.4. Hearing Aid Data Collected by HAC Task Force WG1.

Data sources included voluntary submissions by hearing device manufacturers, either directly or through the Hearing Industries Association. Data was collected and compiled by WG1.

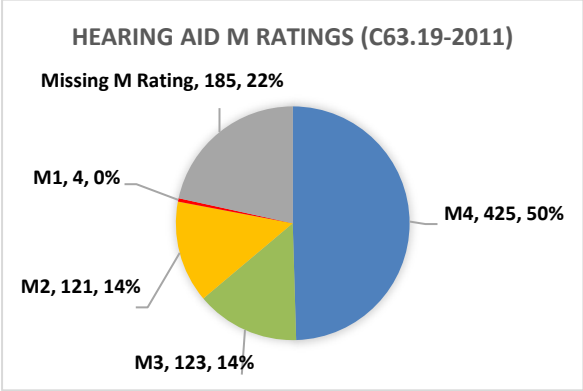
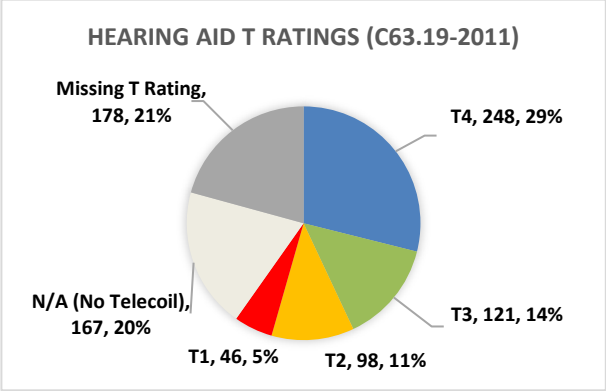
WG1 gathered data for 862 hearing devices from 27 manufacturers. These immediate sections do not include any findings from the data gathered independently by Hearing Tracker, as that data source was kept separate, and used only for secondary findings in a later section of this report.

3.4.1. Hearing Aid HAC Ratings (2011 Version).

Of the hearing device data collected, the majority of hearing aids (680 of 858) included compatibility ratings based on the 2011 HAC standard: ANSI C63.19-2011.

Figure 4: Hearing Device M and T Ratings (ANSI C63.19-2011) n=858

Microphone Coupling (M) Rating, C63.19-2011	Telecoil Coupling (T) Rating, C63.19-2011
• M4: 425 devices (50%) • M3: 123 devices (14%) • M2: 121 devices (14%) • M1: 4 devices (0.4%)	• T4: 248 devices (29%) • T3: 121 devices (14%) • T2: 98 devices (11%) • T1: 46 devices (5%)

• Missing M rating: 185 devices (22%)	• N/A (No Telecoil): 167 devices (20%) • Missing T rating: 178 devices (21%)
	

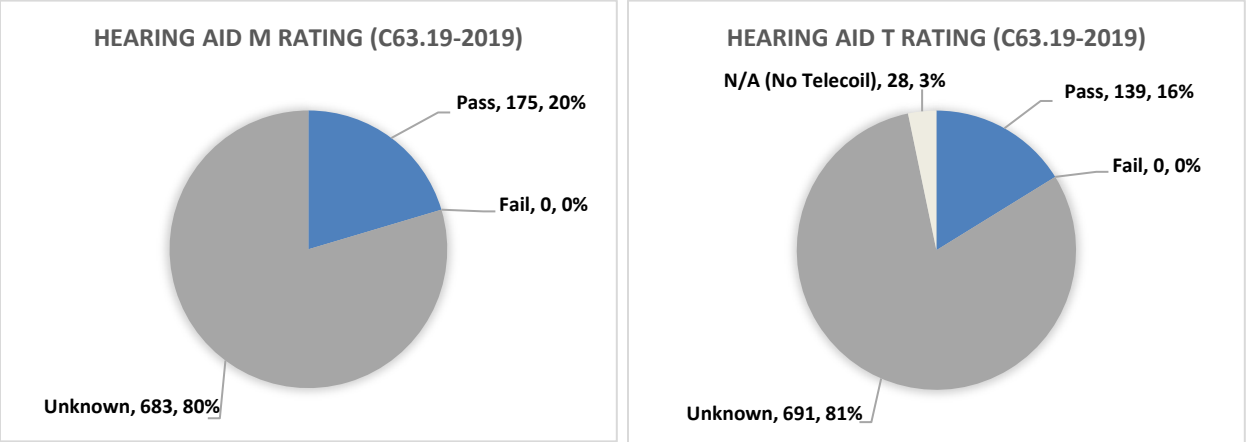
3.4.2. Hearing Aid HAC Ratings (2019 Version).

In addition to the 2011 HAC Ratings, approximately 20% of hearing aid data gathered also included test data against ANSI C63.19-2019, the current HAC standard. Only two manufacturers voluntarily shared C63.19-2019 HAC data for their hearing devices, and the data submissions listed either Unknown, Pass, or N/A. Note: N/A only applies to the T rating indicating the hearing device does not include a telecoil.

Manufacturers submitted that 175 hearing aids (20%) achieved a "Pass" rating for C63.19-2019 acoustic microphone coupling (M). All other 683 hearing aids were listed as "Unknown" for the M rating.

For C63.19-2019 telecoil coupling (T), 139 (16%) included a "Pass" rating. 28 devices (3%) included an "N/A" value for telecoil coupling, indicating the specific hearing aid does not contain a telecoil. All other 691 hearing aids were listed as "Unknown" for the T rating.

Figure 5: Hearing Device M and T Ratings (ANSI C63.19-2019)[94]
n=858



No failing ratings for C63.19-2019 were reported to WG1 for any hearing device.

3.4.3. Hearing Device Bluetooth Coupling Support.

In addition to Bluetooth Classic, there are three types of hearing aid coupling methods based on a modern "Low Energy" Bluetooth connection: two proprietary, and one recent non-proprietary method.

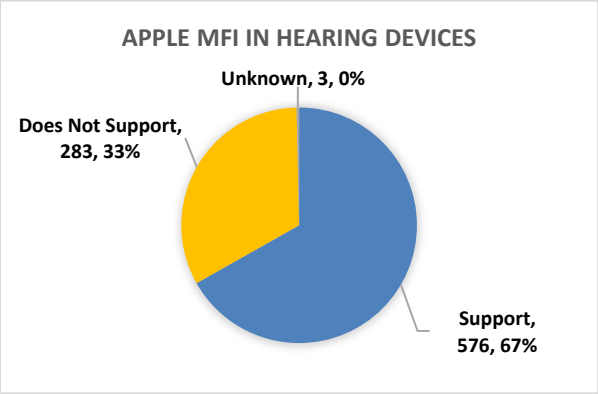
3.4.4. Existing Methods for Bluetooth Coupling (Bluetooth Classic, Apple MFi, and Android ASHA).

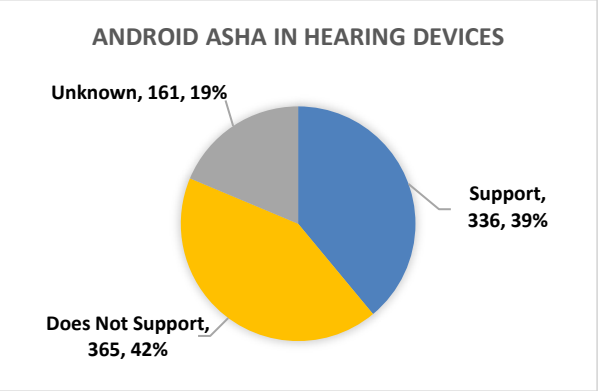
Apple's MFi[95] was first supported by hearing devices in 2013. Support for Bluetooth Classic was added by a major hearing aid vendor in 2017. Google Android's ASHA[96] was first supported by hearing devices in 2019.

Of the data gathered for 862 hearing aids and cochlear implants, 576 (67%) support Apple's MFi coupling method, 336 (39%) support Android's ASHA coupling method, and 86 (10%) support Bluetooth Classic. Of note, all 336 of the devices that support ASHA also support MFi, so the 336 ASHA devices are an enclosed subset the 576 that support MFi.

[94] Note: N/A rating only applies to hearing aids without telecoils.
[95] Apple MFi, *supra* note 88.
[96] Android ASHA, *supra* note 89.

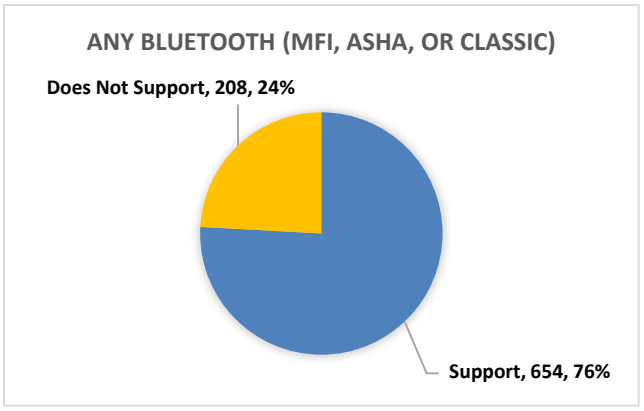
Figure 6: Support for Apple MFi and Google ASHA in hearing devices
n=862





One of the major hearing device manufacturers added support for Bluetooth Classic in 2017 for 86 (55%) of its devices (10% overall). Combined with the other Bluetooth LE connections, the percentage of all hearing devices that support some variant of Bluetooth coupling is 76% and rising.

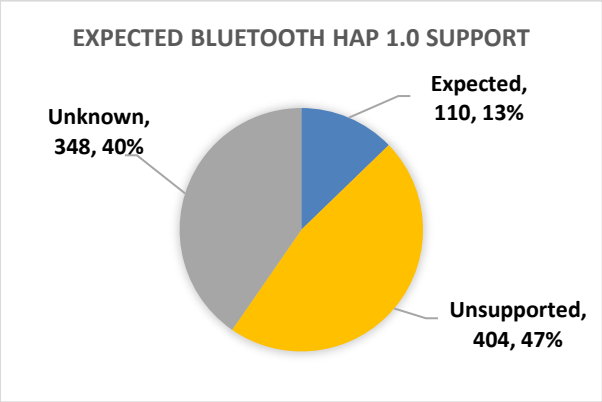
Figure 7: Hearing device support for any form of Bluetooth coupling
n=862



3.4.5. Non-Proprietary Method for Bluetooth Low Energy Coupling.

In June 2022, The Bluetooth SIG finalized its HAP 1.0, a non-proprietary coupling method that is supported by the Bluetooth LE Audio standard and offers many of the same features as the proprietary low energy connections. HAC Task Force members are not aware of any commercially released hearing devices that support HAP 1.0 yet, but two hearing device manufacturers shared that they expect to support the new profile for at least 110 hearing devices already available on the market. Two handset manufacturers also shared that they expect to support the new profile in recently released and future handsets.

Figure 8: Expected support for Bluetooth HAP 1.0 in currently released hearing devices n=862



Forty-seven percent (404 devices) were marked as "Unsupported." These devices often include an older Bluetooth chipset that does not support LE Audio or no Bluetooth support, so required hardware or firmware updates would be difficult to achieve.

The remaining 40% (348 devices) were marked as "Unknown" so they may or may not be able to support HAP. It seems likely that many new releases of Bluetooth-capable hearing aids will include a chipset capable of supporting the new Bluetooth coupling method.

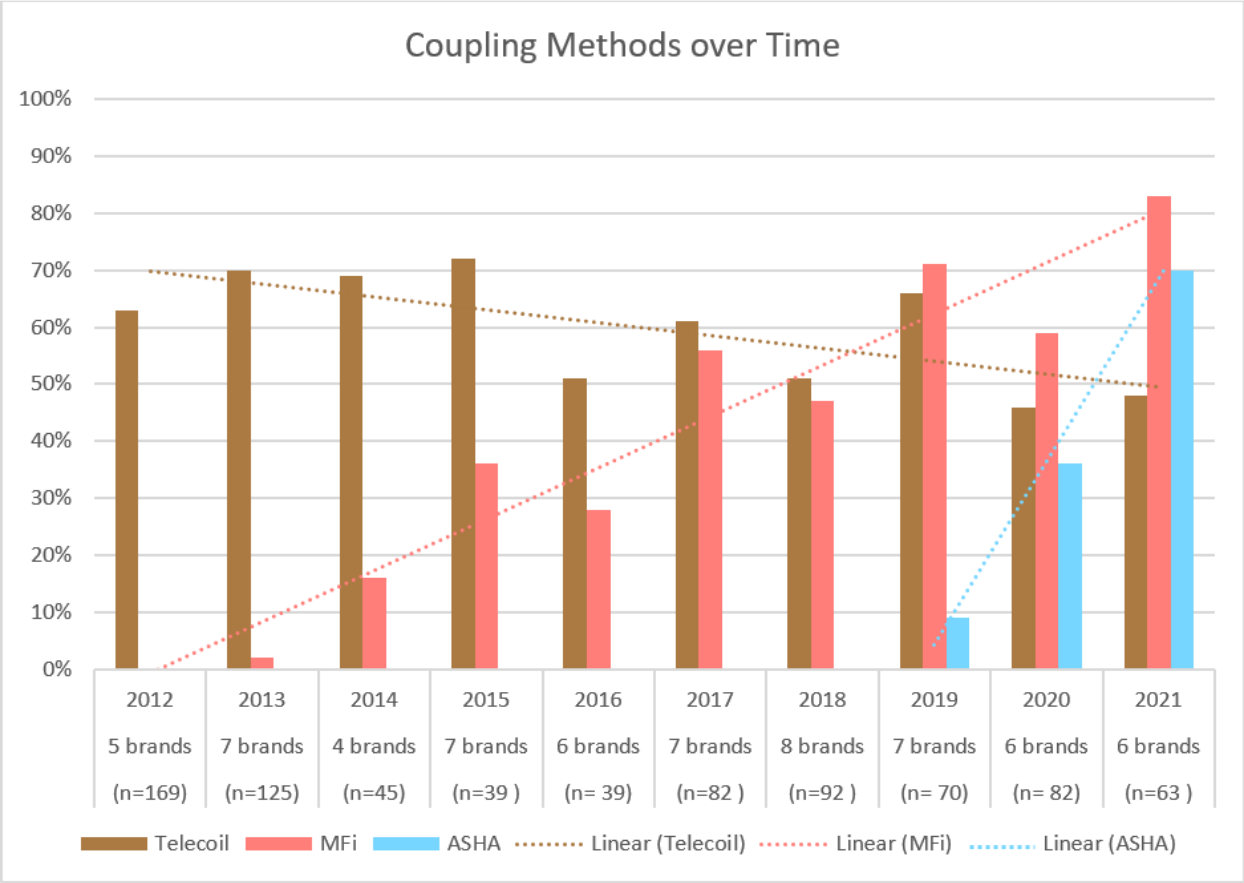
3.5. Additional Hearing Device Data from Hearing Tracker.

Another data source, collected and provided independently by Hearing Tracker, was analyzed[97] to determine additional hearing aid statistics. The Hearing Tracker database included device release dates, which provided trend insights for coupling methods: microphone, telecoil, as well as proprietary Bluetooth LE protocols (Apple's MFi and Google's ASHA) and Bluetooth Classic.

Among the major hearing aid manufacturers and their main brands found in the Hearing Tracker database, Low Energy-based Bluetooth as a direct audio coupling method for wireless phone calling has been steadily increasing in availability over the past 9 years since Apple's MFi was introduced. The wireless streaming technologies (telecoil, MFi, and ASHA) used in hearing aid brands included in this 10-year study (2012-2021) are shown in Figure 9.

[97] *See* Linda Kozma-Spytek, *Trends in Audio Streaming for Hearing Aids and Hearing Aid Compatibility for Wireless Phones*, Hearing Tracker (July 22, 2022), https://www.hearingtracker.com/news/trends-in-audio-streaming-for-hearing-aids.

Figure 9: Coupling Methods Over Time

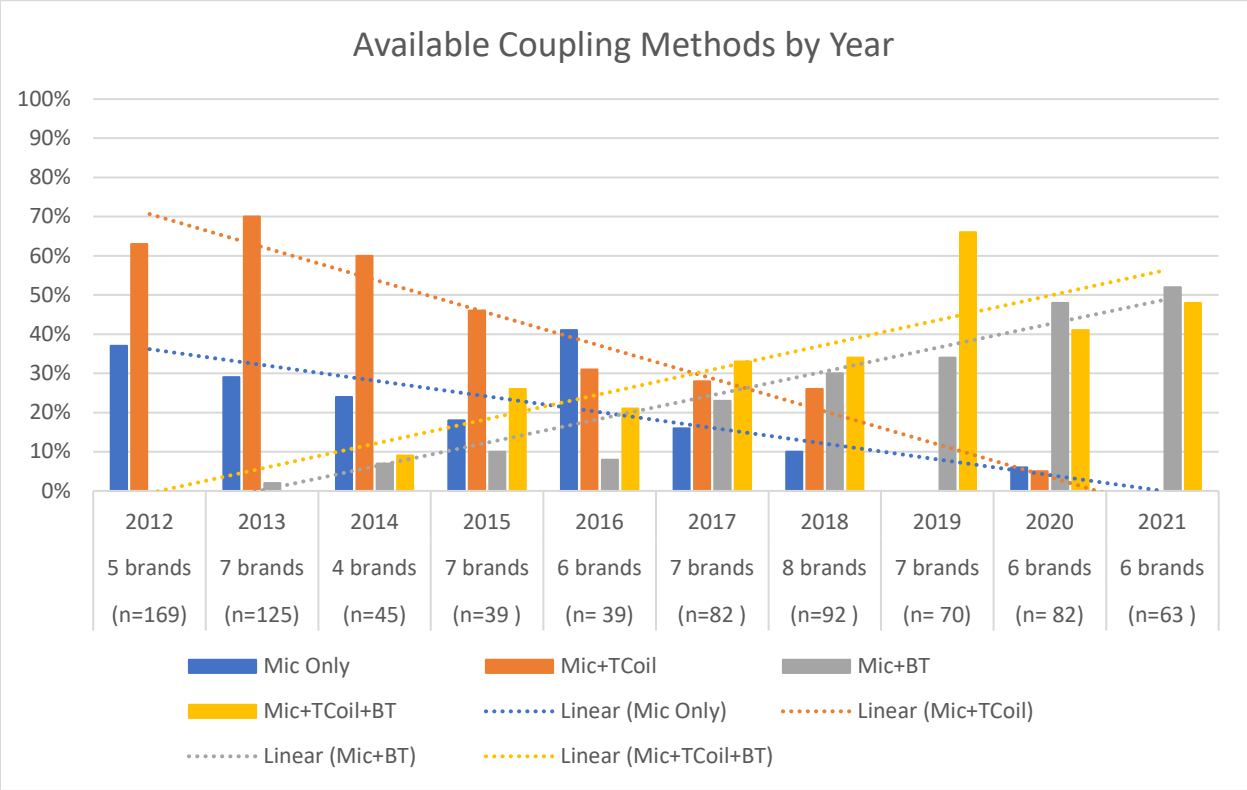


With the introduction of Android's ASHA capability, its availability has grown quickly over the last 3 years and is always implemented alongside MFi, which means the availability of *both* solutions in hearing devices has also grown quickly. The inclusion of a telecoil in hearing aids over the last 10 years has somewhat declined.

By also considering hearing aids found in the Hearing Tracker database that implement the Bluetooth Classic solution, we can look at how all direct audio coupling methods available to consumers for wireless phone calling have changed over time in this sample.

<u>Figure 10</u>: Available Coupling Methods by Year

Hearing Aid Coupling Options and Combinations (Mic Only, Mic+T-Coil, Mic+Bluetooth, and Mic+T-Coil+Bluetooth) have been available in hearing aid brands over the last 10 years. Bluetooth (BT) combines MFi, MFi plus ASHA, and Bluetooth Classic methods.



Hearing aids with only microphone coupling capabilities (Mic only) or microphone plus telecoil coupling capabilities (Mic+T-Coil) have been declining in favor of devices that also include some form of Bluetooth coupling (i.e., MFi, MFi plus ASHA, or Bluetooth Classic). The hearing aids in the database that utilized Bluetooth Classic did not support MFi or ASHA.

In the last two years (2020 and 2021), most hearing aids in the database included some form of Bluetooth coupling capability. About half of those also included telecoils.

Hearing aids generally remain on the market for approximately 5 years. Among hearing aids available in 2021 to consumers, the Hearing Tracker data from 2017 through 2021 suggests that:

1. A little more than half (54%) of available hearing aids included telecoils, and
2. More than three-quarters (80%) of available hearing aids were Bluetooth capable (i.e., either MFi, MFi plus ASHA or Bluetooth Classic).

Of those hearing aids that were Bluetooth capable:

1. Almost two-thirds (61%) were MFi capable.
2. Of the MFi capable hearing aids, about one-third (33%) were also ASHA capable.

3. Another 19% of hearing aids were Bluetooth Classic-only capable.

3.6. Over the Counter Hearing Aids.

On August 16, 2022, the Food and Drug Administration ("FDA") released a final rule allowing consumers with perceived mild to moderate hearing loss to purchase certain hearing aids over the counter ("OTC") without the assistance of a hearing professional.[98] This action by the FDA is intended to increase access to and affordability of hearing aid devices for the estimated 38 million Americans who have some degree of hearing loss. The final rule was effective October 17, 2022.

All OTC hearing aids must include a mark on the package stating "OTC." Outside package labeling is also required to indicate whether a mobile device or other non-included control platform is required, i.e., a smartphone, a remote sold separately, or a personal computer. The outside labeling will include details on the type of control platform and instructions on how the hearing aid connects to the control platform. Technical specifications define a limit on maximum power output but not a separate gain limit. All OTC hearing aids must have a user-adjustable volume control. However, the FDA does not require telecoil, Bluetooth, or other wireless technology nor does it require a list of these features, if present, be included on the outside of the package. However, if the OTC hearing aid requires a smartphone remote or other device to control the hearing aid and uses Bluetooth or other technology to connect to make the connection between the smartphone and the OTC hearing aid, that information must be provided on the outside package labeling of the OTC hearing aid. In addition, if telecoils are included, information about them would be necessary to provide adequate directions for use, so the information would have to appear in the labeling inside the package.

With current technology, the FDA expects that most hearing aids will incorporate wireless connectivity such as Bluetooth. The FDA also expects wireless technology will continue to evolve and that "specifying protocols or capabilities may unnecessarily constrain design and hinder innovation."[99]

4. Working Group 2 Report.

4.1. Overview of Working Group 2.

WG2: Consumer Usage of HAC Technologies and Alternatives was chartered by the HAC Task Force on February 11, 2020 with the following mission:

> Survey and understand what features are being utilized by consumers and how they are being utilized. WG2 is gathering data to determine whether the existing definition of hearing aid compatibility is the most effective means for ensuring access to wireless handsets for consumers who use hearing aids, while also encouraging technological innovation and advancement.

[98] Medical Devices; Ear, Nose, and Throat Devices; Establishing Over-the-Counter Hearing Aids, 87 Fed. Reg. 50698 (Aug. 16, 2022).
[99] *Id*. at 50729.

In May 2020, WG2 launched and began to identify subject matter experts to present to the WG2 participants on available and evolving HAC technologies and consumer trends in usage and began to discuss topics for its survey. WG2 agreed to conduct two surveys to understand the behavior and experiences of: (1) consumers who use hearing devices; and (2) hearing health care professionals. WG2 agreed that a third-party research firm should be engaged to conduct the two surveys. To inform the development of the surveys, WG2 has heard from experts including hearing health care professionals, market researchers, and survey usability experts. The hearing health care professionals provided background on how consumers use their hearing aids with wireless devices as well as how audiologists typically fit consumers with hearing aids and how they inform their clients about connectivity to wireless devices. WG2 also reviewed prior surveys that examined hearing aid use with wireless handsets. WG2 developed a request for proposals ("RFP") describing the research tasks agreed upon by WG2, which was approved by the full Task Force, and circulated to market research companies. The HAC Task Force Executive Committee evaluated the candidate companies and reached consensus on engaging a contractor, Northstar Hub ("Northstar"), to conduct the WG2 surveys and analyze and present the results to the HAC Task Force.

4.2. Consumer Survey.

4.2.1. Executive Summary.

WG2 of the HAC Task Force, in collaboration with a contractor, Northstar Hub ("Northstar"), conducted an online survey of 800 individuals with varying degrees of hearing loss who reported using wireless phones with their hearing devices.[100] WG2 summarized the results of the survey below. The results of the consumer survey showed that (1) many consumers with hearing loss were satisfied with the listening experience on their wireless phones; (2) the coupling methods evaluated by the 2011 ANSI HAC standard were used less than other coupling options; and (3) a majority of consumers with hearing loss reported using Bluetooth as their most frequently used coupling method. On a variety of topics, there were differences in the experiences and attitudes reported by these consumers across multiple areas as a function of age. These differences were most frequently noted when comparing responses from younger respondents 18-54 years of age with older respondents 55-84 years of age.

The HAC Task Force conducted the consumer survey to better understand consumers' real-world listening experience when using their wireless phones with hearing devices. Indeed, the FCC's *2016 HAC Consensus Order* directed the Task Force to "collect[] concrete data and information about the technical and market conditions involving wireless handsets and the landscape of hearing improvement technology."[101]

In particular, the HAC Task Force sought insight into how consumers' current use of their wireless phones with hearing devices to inform the Task Force's approach to the two threshold questions posed by the FCC in its *2016 HAC Consensus Order*: (1) whether 100 percent hearing aid compatibility is achievable; and (2) how a 100 percent deployment benchmark could rely in

[100] Hearing devices included prescription hearing aids, cochlear implants, and Personal Sound Amplification Products ("PSAPs").
[101] *2016 HAC Consensus Order*, 31 FCC Rcd at 9342 ¶ 17 (footnote omitted).

part or in whole on alternative HAC technologies.[102] These questions are related because the Task Force must decide on a definition for "hearing aid compatibility," both in light of the transition to the 2019 ANSI Standard and whether so-called alternative HAC technologies (such as Bluetooth or equivalents) should count towards the 100 percent deployment benchmark. The FCC's 2020 HAC Standard NPRM asked how the transition to the 2019 ANSI Standard might impact the Commission's ability to decide by 2024 whether to require 100 percent of covered handsets to be hearing-aid compatible: one of the core questions the Task Force aims to address.[103] In the related Report and Order, the Commission declined to adjust the 2024 timeframe and stated it would "continue to monitor the transition to the new ANSI standard."[104] As a result, the Task Force is considering the results of the survey as well as the transition to the new ANSI standard as key inputs into its discussion of the two key questions noted above.

If, as the survey results demonstrate, alternative technologies are being used by consumers and consumers report satisfaction with those technologies, then consumers would benefit from the incorporation of—and compatibility standards for—such alternatives into the definition of "hearing aid compatibility."[105] In addition, alternatives could be used to provide even more HAC-rated wireless phone options than are offered today. The FCC recently reported that 93 percent of the handset models offered in the U.S. by manufacturers during the 2021-2022 reporting period were HAC-rated—above the 85 percent benchmark required by the FCC's rules.[106] The non-HAC-rated devices listed in the Commission's most recent device report appear to include both non-HAC-rated wireless phones as well as devices that are not covered by the HAC rules such as tablets and at least one mobile hotspot without any voice/listening capabilities.[107] Already several wireless providers are exclusively offering HAC handsets.[108] However, some wireless providers may still find themselves offering a small percentage of non-HAC phones to offer a wider variety of wireless phones to consumers.[109]

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[102] *Id.* at 9343 ¶ 19 (directing the Task Force to consider the following issues: The definition of hearing aid compatibility "for purposes of a wireless handset's compliance with the Commission's rules;" Whether 100 percent compliance could be satisfied through "innovative approaches, including standards or technology that are not reflected in the current applicable ANSI standards;" How to ensure that the hearing aid compatibility rating system is effectively "helping consumers who use hearing aid devices;" and "The implementation process and extended compliance time frame for nationwide and non-nationwide service providers.") (footnote omitted).

[103] *See Amendment of the Commission's Rules Governing Standards for Hearing Aid-Compatible Handsets*, Notice of Proposed Rulemaking, 35 FCC Rcd 794, 799 ¶ 14 (2020).

[104] *See Amendment of the Commission's Rules Governing Standards for Hearing Aid-Compatible Handsets*, Report and Order, 36 FCC Rcd 4566, 4578 ¶ 28 (2021).

[105] As noted elsewhere in the Report and Order, the 2019 ANSI Standard tests frequencies between 614 MHz and 6 GHz. Bluetooth operates on 2.4 GHz irrespective of the frequencies a wireless handset uses to facilitate a call with the network.

[106] FCC Compatibility Report July 1, 2021 – June 30, 2022, *supra* note 26.

[107] *Id*.

[108] *See* Compatibility Service Provider Certifications, *supra* note 92 for information on service provider benchmark deployment percentages.

[109] *See id. supra* note 92 for information on service provider benchmark deployment percentages.

4.2.2. Survey Participants, Sampling, and Weighting.

The HAC Task Force consumer survey was completed by 800 U.S. adults 18+ having a personal hearing device and using a wireless phone. The survey sample was drawn from two healthcare-oriented panels (Quest Mindshare and M360 Research), and HLAA members, using Logit's sampling/quota management panel to ensure strict quality control and security. Both Quest Mindshare and m360 Research are companies that specialize in recruiting individuals for market, consumer, and health surveys.[110] Logit and its Zamplia proprietary panel/sample management program provide several processes and tools for validating data.[111] For consumers, a targeted sample was used for those profiled with hearing loss.

The consumer results were weighted to reach target age and gender weights consistent with HIA's October 2018 MarkeTrak study, which similarly screened for adults having a wireless phone and a hearing aid, and using the wireless phone and hearing aid together to make and receive calls.[112] HIA has been conducting MarkeTrak studies to learn about individuals with hearing loss since 1989.[113] The weighted sample had the following demographic characteristics:[114]

- On average were 64.5 years of age, with 11% identifying as 18-39 years of age, 10% identifying as 40-54 years of age, 27% identifying as 55-69 years of age, and 52% identifying as between 70-84 years of age.[115] Five-year population age ranges were limited to those under age 70, with ages 70-84 combined, to avoid over- or under-weighting specific age groups.
- 60% had severe or profound hearing loss (30% in each category), 36% report moderate-severe hearing loss, 27% had moderate hearing loss, and 14% had mild hearing loss.
- Among 18-39-year-olds, the proportion of those with mild hearing loss increased to 36%.
- 13% reported their hearing loss was related to military service.
- 61% were male and 88% self-described as Caucasian/white.
- Had an average household income of $80k/year.
- 41% had a graduate or professional degree and 26% had a Bachelor's degree.
- 61% were retired, while 25% were working either full- or part-time.

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[110] Quest Mindshare, Home Page, www.questmindshare.com (last visited Nov. 7, 2022); m360 Research, Home Page, https://www.m360research.com (last visited Nov. 7, 2022).
[111] Zamplia, Home Page, https://zamplia.com (last visited Nov. 7, 2022); Logit Group, Home Page, https://logitgroup.com/ (last visited Nov. 7, 2022).
[112] Thomas A. Powers & Carole M. Rogin, MarkeTrak 10: *Hearing Aids in an Era of Disruption and DTC/OTC Devices*, Hearing Review (Aug. 2019), https://betterhearing.org/HIA/assets/File/public/-marketrak/MT10%20Hearing%20Review%20Article.pdf.
[113] Better Hearing, Policy/Research, MarkeTrak, https://betterhearing.org/policy-research/marketrak/ (last visited Nov. 7, 2022).
[114] The demographics described herein are weighted to reflect known information about demographic characteristics of individuals with hearing loss and with hearing devices.
[115] As noted above, participants had to be at least eighteen years of age to participate in the survey.

- 57% lived in larger communities (more than 50,000), 28% in suburban areas of 2,500-50,000 and 13% in rural communities (fewer than 2,500).
- 75% lived with at least one additional individual.
- Were from around the country: South (29%), West (27%), Northeast (23%) and Midwest (19%).

The actual consumer sample skewed slightly younger, and more female compared to the population of individuals with hearing loss and hearing devices from the MarkeTrak studies. The respondent pool tended to be highly educated, generally higher income and white.[116] To some extent this may reflect differential adoption and use of hearing devices among minority and lower income populations among older individuals,[117] consistent with other areas of healthcare

[116] Respondents aged 18-39 included more individuals of color at lower incomes than the MarkeTrak studies used for weighting.

[117] While not suited for a direct comparison, a broad survey of an older slice of the population (55+) reported that "Among the participants, 40 percent of non-Hispanic white adults used a hearing aid, compared to 18.4 percent of non-Hispanic black and 21.1 percent of Hispanic adults." *See* The ASHA Leader, Study Reveals Disparities in Hearing Aid Use (Aug. 1, 2018), https://leader.pubs.asha.org/-doi/10.1044/leader.RIB2.23082018.15#:~:text=Researchers%20analyzed%20data%20from%20the,21.1%20percent%20of%20Hispanic%20adults; *see also* Michael M. McKee et al., *Determinants of Hearing Aid Use Among Older American With Hearing Loss*, 56(6) The Gerontologist 1171 (2019), https://academic.oup.com/gerontologist/article/-59/6/1171/5000029?login=false. Other sources report that "black and Hispanic adults were significantly less likely than white adults to use hearing technology," *see* Rene H. Gifford, *Hearing Health Care for All*, 71(7) The Hearing J. 6 (2018), https://journals.lww.com/thehearingjournal/Fulltext/2018/07000/Hearing_Health_Care_for_All.2.aspx. *See also* Thomas A. Powers & Kate Carr, *MarkeTrak 2022: Navigating the Changing Landscape of Hearing Healthcare*, The Hearing Review, May 3, 2022, https://hearingreview.com/inside-hearing/research/marketrak-2022-navigating-the-changing-landscape-hearing-healthcare ("When diving deeper into hearing difficulty by race, we see a disproportionately low rate of self-reported hearing difficulty for persons who are black as compared to other races….") ("Power/Carr MarkeTrak 2022").

and technology adoption in the U.S.[118] Other studies have identified that age and sex are significant risk factors for hearing loss,[119] and the HAC Task Force worked with Northstar to identify as representative sample as possible. Even so, the HAC Task Force notes that the sample has some shortcomings regarding representation of the consumer population that should be considered as the results are reviewed and analyzed.

4.2.3. Consumer Survey Results and Discussion.[120]

The survey asked consumers questions about a variety of topics in order to qualitatively assess and measure the following areas: what wireless phones and hearing devices consumers use today; what features of wireless phones and hearing devices are consumers using; how consumers are using hearing devices and wireless phones together; are consumers able to access the technologies and services they need; how do consumers find the devices, handsets, and technologies that work for them; are consumers able to learn about and adopt accessible devices, handsets and technologies; and are consumers satisfied with their experiences.

4.2.4. Wireless Phone Use.

Summary. Ninety percent of respondents owned smartphones, with those 55+ years old slightly more likely to own a smartphone than the younger survey respondents. A majority owned an iOS phone over an Android phone (64% iOS vs. 36% Android).[121]

Bluetooth Hearing Aid support for direct audio streaming of phone calls is available on almost all iPhones in use today, and on a growing number of Android phones.[122] However, iOS

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[118] The inequities that lead to lower rates of healthcare and technology adoption among minority populations may lead to similar results with respect to hearing loss and hearing technology. *See generally* Centers for Disease Control and Prevention, Racism and Health (last updated Nov. 24, 2021), https://www.cdc.gov/healthequity/racism-disparities/index.html; Pew Research Center, Internet/Broadband Fact Sheet (Apr. 7, 2021), https://www.pewresearch.org/internet/fact-sheet/internet-broadband (reporting that Black and Hispanic households are less likely to have home broadband connections than white households but Black and Hispanic adults are more reliant on their smartphones than white adults); Power/Carr MarkeTrak 2022 (a leading factor when buying hearing aids is having insurance that will cover some of more of the cost).

[119] *See, e.g.*, Power/Carr MarkeTrak 2022 (observing that "the rate of hearing difficulty steadily increases until age 55, when the rate develops a steeper upward slope" and that hearing loss continues to be more prevalent in males as compared to females); Howard J. Hoffman et al., *Declining Prevalence of Hearing Loss in US Adults Aged 20 to 69 Years*, 143(3) JAMA Otolaryngology 274 (2017), https://jamanetwork.com/journals/jamaotolaryngology/article-abstract/2592954 (finding that, among other things, age had the strongest association with hearing loss and men had nearly twice the prevalence of hearing loss as women).

[120] The results herein reflect weighted respondents, as described in the previous section.

[121] 40–54-year-olds were more evenly split between the two platforms (47% iOS and 54% Android, respectively).

[122] *See* I. Bonifacic, Android 10 transforms hearing aids into Bluetooth headsets, Engadget (Sept. 3, 2019), https://www.engadget.com/2019-09-03-android-10-transforms-hearing-aids-bluetooth-headsets.html; Jordan Golson, *ReSound LiNX Launches as World's First 'Made for iPhone' Hearing Aid*, MacRumors (Feb. 24, 2014), https://www.macrumors.com/2014/02/24/first-made-for-iphone-hearing-aid/.

(MFi)[123] and Android (ASHA)[124] implementations of this capability are not interoperable. Many Bluetooth capable hearing devices can connect to both iOS and Android phones, but this is not universal.

Discussion. The results regarding ownership of smartphones differs somewhat from what is currently seen in the general population. As of June 2021, iOS accounted for about 58% and Android accounted for approximately 42% of the mobile OS market in the U.S.[125] iOS/iPhone and Android each have other features related to hearing loss that may also be differentiating factors in a consumer's decision. As discussed elsewhere, survey participants reported higher incomes than the general population. It is possible that this also led to more iOS device use than Android device use among survey respondents.

4.2.5. Hearing Device Use.

Summary. Hearing aids were the most used hearing device type among respondents (86%). Among hearing aid users, more than three-quarters used a behind-the-ear hearing aid, driven by its higher usage among those 55+ years old. Younger respondents were more likely to use in-the-ear hearing aids. A quarter (25%) of all respondents had a cochlear implant in at least one ear and were most likely to report having a profound hearing loss. The 14% of respondents who reported using a Personal Sound Amplification Product (**"**PSAP") were most likely to report having mild, moderate, or moderately-severe hearing loss. Nearly 80 percent of respondents (79%) used a single hearing device type. The rest (21%) used a combination of devices with a majority of those respondents (57%) using a hearing aid in one ear and a cochlear implant in the other ear.

Most respondents (73%) were experienced hearing device users with 4 or more years of hearing device use, especially among those 55+ years of age. On average, respondents have been using a hearing device for about eight years, with younger respondents (18-39) averaging use of nearly four years (3.7), while older respondents (70-84) averaged nearly ten years (9.6) of use.

Further, most respondents (86%) used their hearing device for more than six hours daily. The exception was among younger users (<55 years), and PSAP users, who were also more likely to be younger (<55 years). Three-quarters of hearing aid users had devices that were at least two years old. Similarly, a majority of cochlear implant users received the most recent upgrade of

[123] MFi support in Apple phones was announced in Q3 of 2013 with the release of iOS 7. However, the first MFi hearing aid was not released until Q1 of 2014. Until Q2 of 2021 this was one-way audio streaming from the phone to the hearing device. In this case, the hearing device users voice is picked up by the phone or an intermediary device and not the hearing device microphones. *See, e.g.*, Golson, *supra* note 122.

[124] ASHA support in Android phones was announced in Q3 of 2019 (6 years later) with the release of Android 10. At that time, two hearing aids and Pixel 3 phone models were compatible with ASHA. As of Q4 2019, ASHA did not yet support bi-directional audio streaming. *See, e.g.*, Bonifacic, *supra* note 122.

[125] *See* Statcounter GlobalStats, Mobile Operating System Market Share United States of America, https://gs.statcounter.com/os-market-share/mobile/united-states-of-america (last visited Nov. 11, 2022).

their external components two or more years prior to completing the survey. On average, respondents reported using their current hearing device with their wireless device for three years.

Discussion. The type of hearing device is most often determined by the type of hearing loss an individual experiences. The fact that survey respondents were generally experienced users with four or more years of hearing device use, with a majority of users reporting on their experience with a device that is at least two years old, may demonstrate that respondents provide a generally reliable sample because they likely are set in the way they use their hearing devices. If the respondents were less experienced users, for example, the responses may not provide as strong a sample because they still may be learning their devices.

4.2.6. Hearing Device Features.

Summary. Hearing devices generally included multiple features respondents indicated were important for facilitating use of their wireless phone. On average, 67% reported that their hearing device had three or more different features, with younger respondents (<55 years old) being more likely to report their hearing devices had a greater number of features. The top three most frequently mentioned features included in hearing devices were: (i) volume control (85%); (ii) direct Bluetooth audio streaming (64%); and (iii) a telecoil (45%). Another 40% reported having feedback control, a preset programmed in their hearing device specifically for telephone listening, which was used more by younger respondents.[126] In addition, 30% of respondents also reported using a streamer, which is an accessory that supports audio streaming between a wireless and hearing device, when using their hearing device with their wireless phone.[127]

Direct Bluetooth audio streaming was an important feature with a high rate of satisfaction for those consumers who reported having it. This feature enables audio streaming directly between the hearing device and the wireless phone, without the use of an accessory.[128] Indeed, among those individuals who had this feature, 78% reported it as "extremely important" for successful use of their wireless phone and 70% were either satisfied or very satisfied with its performance

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[126] Feedback control is useful specifically for acoustic coupling to a wireless device, while a telephone program can be useful for any type of wireless device coupling method (i.e., acoustic, inductive via a telecoil, or Bluetooth via a preset or accessory).

[127] For example, Bluetooth coupling via a separate streamer device has existed for close to ten years.

[128] MFi support in Apple phones was announced in Q3 of 2013 with the release of iOS 7, and the first MFi hearing aid was released in Q1 of 2014. *See, e.g.*, Jordan Kahn, *CES 2014: First look at Resound Linx, the world's first MFi Bluetooth LE hearing aid launching this quarter*, 9to5Mac (Jan. 7, 2014), https://9to5mac.com/2014/01/07/ces-2014-first-look-at-resound-linx-the-worlds-first-mfi-bluetooth-hearing-aid-launching-this-quarter/. Until Q2 of 2021, MFi support in hearing devices enabled one-way, rather than bi-directional, audio streaming from the phone to the hearing device for telephone calls. In this case, the hearing device users voice is picked up by the phone or an intermediary device and not the hearing device's microphone.
ASHA support in Android phones was announced in Q3 of 2019 with the release of Android 10. At that time, two hearing aids and Pixel 3 phone models were compatible with ASHA. As of Q2 of 2021, ASHA support in hearing devices only enabled one-way audio streaming from the phone to the hearing device for telephone calls. The numbers of hearing aids and phones that are ASHA compatible has been steadily increasing. All hearing aids that are ASHA compatible are also MFi compatible. Some hearing aids are only MFi capable.

during wireless phone use, with another 16% reporting they were somewhat satisfied with direct Bluetooth audio streaming during wireless phone use. While younger respondents (<55 years old) were more likely to report having direct Bluetooth audio streaming, older respondents (55+ years old) were more likely to rate the feature as "extremely important" and report greater satisfaction with this feature.

Other features that were considered "extremely important" by at least half of those who have these features included: (i) volume control (69%); (ii) preset telephone programs (e.g., a general telephone listening program (63%) or binaural audio program (65%)); and (iii) feedback control (63%). Of the 45% of respondents that used a telecoil for coupling their hearing device and phone, nearly half reported it as extremely important (48%) and were satisfied or very satisfied (47%) with its performance during wireless phone use, with another 18% reporting they were somewhat satisfied with telecoil coupling during wireless phone use.

Discussion. The survey suggests that consumers have embraced direct Bluetooth audio streaming for wireless phone use and that Bluetooth as a means of coupling wireless phones and hearing devices is working for consumers. These results may indicate that the HAC Task Force should consider expanding the definition of HAC to include direct Bluetooth audio streaming capabilities or equivalent technologies, alongside the current handset requirements related to RF emissions and telecoil coupling capability, among handsets that may be counted towards the FCC's deployment benchmarks.

4.2.7. Knowledge of M/T (HAC) Ratings.

Summary. Few respondents reported knowing about the traditional microphone/acoustic ("M") rating or telecoil/magnetic ("T") rating for coupling methods tested for in the 2011 ANSI HAC standard for either their wireless phone or their hearing aid. Nearly three-quarters of respondents (73%) were unsure of the M/T rating for their personal wireless phone. Nearly eighty percent (79%) were unsure of the M/T rating for their hearing aid. Those respondents who did know the M/T rating of their wireless phone or their hearing aid were much more likely to be younger individuals (<55 years old).

Discussion. These results may demonstrate that additional education on available HAC technologies like the microphone and telecoil may be helpful to inform consumers and hearing health professionals about the M/T rating system, to the extent it is still in use. It would be helpful to educate consumers about M/T rating so that consumers are aware of the options available in their handsets. Further, the survey shows that the 2019 ANSI Standard is consumer friendly in that it abandons an M/T rating in favor of a meets/does not meet "rating."

4.2.8. Wireless Device and Hearing Device Coupling.

Summary. Few respondents reported using the traditional microphone/acoustic ("M") or telecoil/magnetic ("T") coupling methods tested for in the 2011 ANSI HAC standard. Although respondents on average reported using more than a single coupling method, less than half of respondents reported using traditional HAC coupling methods as the way they most often coupled their hearing device with their wireless phone where the phone is held to the ear (32% for microphone and 13% for telecoil). When comparing the methods consumers used most

often, about one fifth of consumers used their phones in ways that would take advantage of traditional HAC coupling methods: 16% reported they hold the phone to their ear and use their hearing device's microphone and 5% reported they hold their phone to their ear and use a telecoil. Regardless of coupling method, very few respondents (11%) chose to use an accessory most often for listening to their wireless phone, and even fewer (4%) reported removing their hearing device.

Bluetooth was the coupling method most likely to be used by respondents: 51% reported using direct Bluetooth audio streaming between their hearing device and wireless phone and 42% said this was the method they used most often. The other most frequently used methods when listening to their wireless phone were: (i) speakerphone on their wireless device (37% ever; 19% most often) and (ii) holding their phone up to their ear and using their hearing device's microphone (32% ever; 16% most often). Bluetooth was also the connection method used most often when respondents were holding their wireless phone to their ear (32%). On average, respondents made use of two coupling methods for wireless device listening, with younger respondents being far more likely to use a wider variety of methods, particularly when it came to using accessories (such as headsets).

Discussion. When the survey was conducted in the summer of 2021, there was limited ability for a hearing aid's microphone to pick up the voice of the hearing aid user during a phone call when using the proprietary Bluetooth Low Energy connection methods. Instead, the hearing aid user needed to hold the handset near their mouth to be heard by their calling partner. Hearing aid devices that support Bluetooth Classic and the Hands Free Profile are capable of bi-directional audio (i.e., audio that can be received by and sent from the hearing aid). Several MFi hearing aids supporting bi-directional audio were released in late 2021 and early 2022. As of Q4 2021, ASHA compatible hearing aids did not yet support bi-directional audio streaming. Holding the handset to the ear or near the mouth may fall out of practice when using Bluetooth coupling as it becomes unnecessary on more devices.

4.2.9. Volume Adjustments and Listening Comfort.

Summary. For speech during a voice call over a wireless device to be at a comfortable listening level, hearing device users may adjust the volume control of their hearing device and/or their wireless device. Among survey respondents, fewer individuals reported adjusting their hearing device's volume control from its usual (typical) setting (43%) compared with those who did not adjust their hearing device's volume control (52%). A small percentage (5%) reported that their hearing devices do not have a volume control. Correspondingly, on the wireless phone, about a third of respondents (35%) reported setting the volume control about halfway up, with a majority (56%) reporting that they set the volume control on their phone more than halfway or all the way up. Younger respondents (<55 years) were far more likely to adjust the volume (82%) of their hearing devices compared to older individuals (especially those 70-84 years) who were far less likely to make such adjustments (28%). On the other hand, older individuals, 55-69 years, were more likely (71%) to set the volume control on their wireless phones more than halfway to all the way up.

Overall, after making these adjustments to their hearing aid and/or wireless phone, 37% of respondents said speech over their wireless phone was always or almost always at a correct and

comfortable volume, with a further 28% of respondents saying speech was at a comfortable volume more than half the time. The other 35% of respondents reported that speech over their wireless phone was at a correct and comfortable volume only sometimes: about half the time (18%), occasionally (12%), or rarely (4%). Younger respondents (18-39) years were able to achieve a comfortable listening level less often than older respondents (55 years and above). Only 39% of 18-39 years old reported that speech was comfortable half the time or more compared with approximately 70% of older respondents 55 years and above.

There was also a difference in experience among respondents using various hearing device types: about two-thirds of those with hearing aids or cochlear implants reported speech over their wireless phone was at a comfortable level almost always, always, or more than half the time, while 44% of those who used a PSAP reported that speech over their wireless phone was at a comfortable level almost always, always, or more than half the time.

Discussion. About two-thirds of respondents were able to achieve a correct and comfortable volume with adjustments to their hearing device and/or wireless phone, while the other third of respondents were not. The difference between younger and older respondents may in part be due to younger individuals, particularly those under 40 years old, being more likely to use a lower volume control setting on their wireless phone, to make calls primarily in noisy environments, and to use PSAPs.

The difference between young and older respondents with respect to the device adjusted (hearing device for younger individuals; phones for older individuals) may reflect the comfort of the individuals with adjusting the relevant device. PSAP users were significantly more likely than hearing aid or cochlear implant users to adjust the volume control on their hearing device from its usual (typical) setting, and they were also significantly less likely to be able to achieve a comfortable volume for voice conversations over their wireless phone more than half the time.

However, it is difficult to know how PSAPs affect respondents' experience in part because it is a vaguely defined category; consumers using PSAPs likely self-diagnose their needs, may not have received a hearing evaluation, or been educated on what their hearing loss is; and may not be fully aware of what the right device is for their hearing loss and hearing needs.

4.2.10. Wireless Phone Speech Understanding.

Summary. Nearly 85% of respondents reported being able to understand most, almost all, or all of what the other person on the call was saying during a voice conversation. About half of respondents (47%) said they can understand most of what the other person was saying when having a voice conversation; an additional 37% say they can understand all or almost all of what the other person is saying. Over half (55%) of the respondents reported only using audio for voice calling on their wireless phone, even though other features such as video and text captions, are generally available. These respondents were primarily older individuals (55+ years old). Younger individuals (<55 years old) were much more likely to report having supplemented their listening experience on voice calls over their wireless phone with video or text captions, with 94% of those 18-39 years old and 87% of those 40-54 years old reporting using video and/or text captions when having a conversation on their wireless phone compared with over 30% for those

over 55 years old. This is consistent with younger individuals (~60%) also reporting a higher use of apps during voice conversations compared to older individuals (~40%).

Discussion. Consumers with hearing loss, who regularly use a wireless handset for voice telecommunications, appear able to achieve the high levels of speech understanding these respondents reported. It was also not surprising that younger individuals were more likely than older adults to supplement their listening experience with other means. Additionally, this may explain in part the use of speakerphone as the second most used coupling method reported by the survey respondents. Accessing the call's audio using the phone's receiver with the handset held to the ear would not allow someone to see the video of their calling partner or text captions during a phone call and may not allow someone who is just using the audio to make use of both ears.

4.2.11. Interference.

Summary. About half of respondents (51%) reported very rarely or never experiencing interfering noise when listening to their wireless phone, while the other half (49%) reported experiencing at least occasional interfering noises when holding the wireless phone to their ear. Among those who were experiencing interfering noises, while it was occasional, it was seen as disruptive (about 90% said that the level of interference was at least mildly disruptive). Older consumers (those 55 years and older) were much less likely to report hearing interfering noises compared with younger individuals. PSAP users were more likely to report hearing interfering noises compared with either hearing aid or cochlear implant users.

Discussion. The HAC Task Force considered these levels of reported interference when considering its recommendations.

4.2.12. Listening Satisfaction.

Summary. Most survey respondents were satisfied with their wireless phone listening experience as well as the performance of their hearing device with their wireless phone. Among respondents, 60% were either satisfied or very satisfied with the listening experience on their wireless phone, and another 20% were somewhat satisfied. Of those surveyed, 8% were neutral on the question of satisfaction, 6% indicated they were somewhat dissatisfied, and only 5% reported being dissatisfied or very dissatisfied.

Younger respondents were generally more satisfied with their wireless phone listening experience compared to older respondents: For those 18-39, 68% were either satisfied or very satisfied with the listening experience on their wireless phone (and 16% were somewhat satisfied); and for those 40-54 years of age, 74% were either satisfied or very satisfied with the listening experience on their wireless phone, and another 20% were somewhat satisfied. For individuals 55-69 years of age, 58% were either satisfied or very satisfied with the listening experience on their wireless phone, and another 20% were somewhat satisfied; and for individual 70-84, 56% were either satisfied or very satisfied with the listening experience on their wireless phone, and another 22% were somewhat satisfied.

Younger respondents (<55 years of age) were also more satisfied with the performance of their hearing device with their wireless phone (78% satisfied or very satisfied, 16% somewhat satisfied) compared to older hearing device users (60% satisfied or very satisfied, 20% satisfied).

PSAP users reported being less satisfied (49% satisfied or very satisfied, 22% somewhat satisfied) compared to hearing aid (66% satisfied or very satisfied, 20% somewhat satisfied) or cochlear implant users (73% satisfied or very satisfied, 15% somewhat satisfied) with the overall performance of their hearing device when used with their wireless phone. Regarding their listening experience specifically on their wireless phone, PSAP users also were less satisfied (53% satisfied or very satisfied, 29% somewhat satisfied) compared to hearing aid (60% satisfied or very satisfied, 21% somewhat satisfied) and cochlear implant (65% satisfied or very satisfied, 11% somewhat satisfied) users.

Discussion. As discussed in Section 4.2.15 below, consumers reported a much higher level of satisfaction with their listening experience when using their wireless phones with hearing devices than they have reported in past surveys. The HAC Task Force considered this higher level of satisfaction when determining what recommendations would continue to drive consumer satisfaction with their listening experience.

4.2.13. Barriers to Satisfactory Wireless Phone Communication.

Summary. Fewer than half (45%) of respondents reported experiencing barriers to satisfactory wireless phone communications. Using a phone in a noisy environment was the top barrier to satisfactory wireless phone communication (reported by 59% of those who experience barriers). This was followed by poor sound quality from the wireless device (42%) and the other person's speech not being loud enough (32%). The top barrier (noisy environment) was far more likely to be problematic among older respondents and those respondents who use hearing aids (63% vs 49% of cochlear implant users). Among those with a cochlear implant, poor wireless call sound quality was more likely to be mentioned as a top barrier (57% vs. 38% of hearing aid users). While PSAP users reported the same three top barriers that hearing aid and cochlear implant users reported, PSAP users (43%) also most often reported the high cost of equipment as a barrier, whereas cost was reported as a barrier much less often (19%) by hearing aid and cochlear implant users.

The survey offered several factors to help facilitate successful wireless phone communication. Respondents reported that the most important factors to help achieve satisfactory wireless phone communication were:

- Seamless use of my hearing device with a wireless phone (39%);
- Better wireless phone sound quality (39%);
- More or better information about wireless phone communication options for people with hearing loss (34%);
- More training on strategies I can use to improve my wireless phone communication (32%);

- More affordable prices for accessories and other special wireless phone equipment (32%);
- Improved wireless phone captions, which are more accurate, less delayed or both (31%); and
- Better ways to test wireless phone products to find ones that work for me (31%).

Compared to older groups, 18-39-year-olds were more likely to say the following were important:

- More or better information about hearing aid compatibility for wireless phones (34%); and
- Improved ability to hear and monitor my own voice when I'm talking (28%).

Discussion. The top barrier to a satisfactory experience was a noisy environment. Providing alternatives (such as Bluetooth and telecoil) to microphone coupling between hearing aid devices and wireless devices is very important for addressing noisy environments. In these cases, the pickup of acoustic noise in the environment can be reduced if the hearing aid device's microphones can be set to provide little to no input to the device from outside acoustic noise sources, while permitting the hearing device user to hear their calling partner's voice directly via Bluetooth coupling or telecoil. Another top barrier, seamless use of a hearing aid device with a wireless phone, is addressed directly in the recommendations: the means of compatibility should be easy enough to use and have a reliable connection over time.

4.2.14. Information Sources.

Summary. The survey asked where consumers acquired information about wireless phone products and services. Overall, consumers relied most on hearing health care providers (57%) and internet searches (44%) for information about using their wireless phone products and services**.** Younger individuals were more likely to rely on online resources while older respondents were more likely to rely on their hearing health care provider for information about wireless phone products/services. Internet searches, manufacturers' websites, hearing health care providers, and word-of-mouth from family, friends, or social media were each nearly equally important among those 19-39 years old (~35-42%), while only 22% or those younger respondents reported going to consumer organization websites, meetings, conferences or events.

Three-quarters (75%) of respondents reported receiving information/services related to the usage of their wireless phone and hearing device when they first received their hearing device; and fewer respondents (48%) received this information during their most recent check-up. Nearly 60% received this information without requesting it, while 46% actively asked for assistance from their hearing health care provider. Males and hearing aid users were more likely to have received this information without asking for it, while younger respondents (those under 55 years of age) were the most likely to have actively requested this information from or report a problem to their hearing health care provider.

The primary ways information was provided by respondents' audiologist/hearing specialist included: verbal information about wireless use with their hearing device (60%) and in-office instruction (56%). Written materials (39%) and in office testing (31%) were mentioned less frequently. There were differences in how information was conveyed based on age. Older individuals were more likely to report receiving in-office instruction than younger individuals, while younger individuals were more likely than older individuals to report receiving written material they could take home and read.

The most common topics covered in these conversations included how to pair/connect their hearing device with their phone (58%) and how to use Bluetooth with a wireless phone listening preset or program (50%). These topics were primarily driven by older consumers – younger individuals were more likely to receive a wider range of advice, especially compared to those older individuals 70-84 years old. These additional topics included accessory/assistive device options, how to position the phone next to their hearing device, how to use a telecoil, an explanation of HAC rules, and strategies for wireless phone communication.

Among those who received information from their audiologist/hearing specialist, 68% were either satisfied or very satisfied with the information provided; another 14% were somewhat satisfied. Younger individuals were more likely to be satisfied or very satisfied with the services received. Although a small number overall, older individuals were more likely than younger individuals to be neutral or somewhat dissatisfied with the services received.

Discussion. The survey seems to indicate that additional sources of information from a variety of resources would benefit consumers, especially older consumers. Approximately one-third of respondents indicated that more or better information about wireless phone communication options for people with hearing loss, more training on strategies to improve wireless phone communication, and better ways to test wireless phone products to find ones that work for consumers may be areas to focus on.

In addition, the fact that respondents reported rarely visiting government websites, such as the Accessibility Clearinghouse, or other websites such as AccessWireless.org, may indicate that further awareness about those resources would help enhance consumers' ability to access information about HAC-rated devices.

4.2.15. Resources for Comparison and Prior Research.

Gallaudet Study. The RERC on Telecommunications Access ("RERC-TA") conducted a survey in 2014-2015 to learn about the experiences of adults who are hard of hearing, deaf, or have hearing loss, in their use of voice telecommunications technology.[129] This survey's questions and their related response options were provided to WG2 by the RERC-TA (NIDILRR grant number 90RE5003) to help inform the development of the consumer survey.

To take the RERC-TA survey, respondents were screened for age and hearing status. For the purposes of this survey, voice telecommunications was defined for respondents in the following

[129] *See* Linda Kozma-Spytek and Christian Vogler, *Factors Affecting the Accessibility of Voice Telephony for People with Hearing Loss: Audio Encoding, Network Impairments, Video and Environmental Noise*, ACM Trans. Access. Comput. 14, 4, Article 21 (Dec. 2021), https://doi.org/10.1145/3479160.

way: "you both listen and talk for yourself during telephone calls, even if you also supplement your listening experience by using text (for example, relay or captioning) to read what the other person on the call is saying while you listen."

This anonymous, web-based survey was open for approximately one year closing in Q1 of 2015. A total of 439 adult respondents with hearing loss completed the survey and met all the survey inclusion criteria. While this RERC-TA survey covered more topics than the HAC Task Force Consumer Survey, this broader survey contained questions focused on wireless HAC. For this report, those results relevant to the topic of wireless HAC have been selected for discussion.

Most of the RERC-TA survey respondents (86%) owned a cell phone and for nearly half of them (48%), their cell phone was the phone they used most often for voice telecommunications. Many of these cell phone owners (75%) used a smartphone. This high rate of cell phone ownership was consistent with the rate of cell phone ownership found more generally in the United States at the time of the survey. Smartphone ownership was somewhat higher.[130]

Cell phones were clearly important to the survey respondents, and for those who owned a cell phone, it was most often the phone of choice for making personal phone calls. Despite the high rate of cell phone usage, only a little more than a third (37%) were either satisfied or very satisfied with the calling experience on their personal cell phones. This may in part be due to difficulties in adjusting the volume control of hearing devices and cell phones for speech to sound comfortably loud. Among those who used a cell phone most often for voice telecommunications, 82.1% generally set the volume control on their cell phones more than halfway to all the way up, but only a quarter (25.1%) of those were almost always or always able to achieve the correct volume for speech to be comfortably loud.

Cell phone owners generally did not know if their hearing aids or cell phones had HAC ratings. A little more than two-thirds (67.8%) were either unaware of whether their cell phone had M/T ratings, or they did not know what the ratings were. An even higher percentage of cell phone owners who wore hearing aids (80.8%) were either unaware of whether their hearing aids had M/T ratings or did not know what the ratings were.

Approximately two-thirds (66.5%) of all cell phone owners reported ever holding their cell phone to their ear and using either their hearing device's microphone or telecoil to couple to their cell phone's audio, even if this was not their most common coupling method. A little more than half (53.2%) of these respondents reported never or very rarely experiencing interference when using their cell phone this way. Another 30.7% experienced interference occasionally. Far fewer (16.1%) reported experiencing interference half the time or more when holding their cellphone to their ear for voice telephone communication.

Among cell phone owners who used their cell phone as their primary means for voice telecommunications, microphone coupling with the cell phone held at the ear and next to the

[130] According to the Pew Research Center's survey of mobile phone ownership, 89% of US adults reported owning a cell phone in December of 2014, with 59% reporting smartphone ownership. Pew Research Center, Mobile Fact Sheet (Apr. 7, 2021), https://www.pewresearch.org/internet/fact-sheet/mobile/ (Mobile phone ownership over time).

hearing device was the most common coupling method (36%) for listening to their calling partners. Other coupling methods, such as using a telecoil (8%), a telecoil or microphone accessory (8%), the speakerphone (11%) or a Bluetooth streamer (14%), were used much less often. During the survey's 2014 deployment, Apple's MFi proprietary technology for direct Bluetooth coupling was introduced in a limited number of hearing aid models by three hearing aid manufacturers, though none of the survey respondents reported utilizing this new coupling capability.

Because a noisy environment can be a barrier to satisfactory wireless phone communication and mobile environments can be noisy, the relatively high usage of microphone coupling (with the cell phone held at the ear and next to the hearing device was the most common coupling method (36%) and the speakerphone (11%)) may also contribute to the observed levels of satisfaction. While hearing aid devices do implement signal processing strategies to address noisy acoustic environments, microphones are the input device that transmits acoustic noise in the environment to the hearing aid device. Both Bluetooth coupling and telecoil permit bypassing the hearing aid device's microphone and thereby eliminating the input of acoustic noise in the consumer's environment to that hearing aid device

MarkeTrak Study. In late 2021, HIA fielded its eleventh consumer study of hearing aid users and non-users. The national sample was balanced and weighted to key U.S. census characteristics and reached 15,138 households and 43,957 individuals. The study was introduced as being about health and inquired about a variety of conditions and products, not just hearing loss and hearing aids. This allowed for a measurement of self-reported hearing difficulty across the entire study population of 10.2%.[131]

Hearing difficulty rates continued to increase with age ranging from 2.7% for those under the age of 18 up to 13.1% for those 55-64, 21.25% for those 65-74, 34.1% for those 75-84 and 55.7% for those 85 and older. There is a lower self-reported hearing difficulty rate among BIPOC populations (7%) compared to white individuals (12%).

The study revealed that 38.4% of individuals with hearing difficulty have a hearing aid. When individuals with implants are included, the rate increased to 39.1%. The majority of hearing aid owners (63%) wear their devices daily with 23% reporting weekly use. Hearing aid owners were more likely to get information from other persons with hearings aids, hearing aid manufacturer and hearing care professional websites and print advertisements. Each owner was asked where they got their most recent hearing aid and 81% reported that it was fit in-person with a hearing care professional; 12% had it fit remotely by a hearing care professional; and 7% reported self-fitting. Overall, the average age of all current hearing aids was 3-5 years, and the median age was 2 years. Most owners (64%) have a hearing aid that sits behind the ear, either a Receiver in the Canal or Behind the Ear style, with the remainder (35%) inside the ear.

The hearing aid features reported by owners in current devices included volume control (72%); program button (53%); rechargeable hearing aid (52%), directional, dual, twin or multiple microphones (39%); telecoil (33%); and tinnitus masker (29%). This study revealed an increase in hearing aid owners with wireless capability, increasing from 43% in MarkeTrak 2015 to 63%

[131] This rate is within the range of 10-11% that has been seen across all studies going back to 1989.

in MarkeTrak 2022. Another increase was seen in the number of current owners with a downloadable app increasing from 17% in MarkeTrak 2019 to 44% in MarkeTrak 2022.

Table 3: MarkeTrak Hearing Aid Features

Question: Below are some different hearing aid features, capabilities or accessories/apps. Please indicate whether your current hearing aid has each one, as far as you know.	**Hearing Aid Owners who got Hearing Aid(s) in last 5 years** [% "Yes"]		
	MT2022 (n=815)	MT2019 (n=702)	MT2015 (n=782)
Set-1: Features			
• Volume control	72%	67%	65%
• Program button	53%	41%	49%
• Rechargeable hearing aid	52%	15%	16%
• Directional, dual, twin, or multiple microphones	39%	28%	35%
• Rechargeable batteries	35%	14%	18%
• Telecoil	33%	20%	23%
• Tinnitus masker	29%	14%	16%
Set-2: Capabilities			
• The ability to "link" volume or program changes	47%	43%	36%
• The ability to stream sound from a smartphone directly	44%	13%	2%
• The ability to stream sound using an additional accessory	38%	26%	20%
• NET: Wireless hearing aid (calculated)	63%	54%	43%
Set-3: Accessories/Apps			
• Downloadable "app" for smartphones	44%	17%	6%
• Hearing aid remote control	39%	21%	22%
• Body-worn Bluetooth device	31%	15%	12%
• TV streamer	27%	11%	12%
• Companion microphone	25%	7%	9%

Satisfaction with the app was very high with eight in ten giving a top-3 box rating and about half (48%) reporting being very satisfied. However, among current owners who do not have an app to control hearing aid settings, awareness of the technology is very low. Eight in ten hearing aid owners feel that their hearing aid was better than expected or about as expected. The satisfaction rate for current owners is 83% as measured by a top-3 box score.[132]

Cell phone ownership has increased from 85% in MarkeTrak 2015 to 93% in MarkeTrak 2022 with 91% being smart phone users. Almost two-thirds of hearing aid owners (65%) use their

[132] The survey used a 7-box score ranging from very satisfied, satisfied, somewhat satisfied, neutral, somewhat dissatisfied, dissatisfied, very dissatisfied. The top three are highlighted.

hearing device when placing or receiving calls on a cell phone. Four in ten hearing devices owners who use a cell phone experience noise interference at least occasionally, and a little more than half experience problems with speech clarity/volume at least occasionally.

4.3. Professional Survey.

4.3.1. Executive Summary.

In addition to the Consumer Survey, the HAC Task Force conducted a survey of Hearing Health Care Professionals ("HCPs" or "professionals") comprised of audiologists and hearing instrument specialists. The HAC Task Force believes it is important to collect certain data about today's hearing health care professionals, including information about professional/patient interactions to better understand potential influences over consumer preferences and purchasing decisions. The Professional Survey sought to delve into professional observations and information exchanges with consumers and use that information to better understand how these may help drive/direct consumer choices in handsets. This additional material helped inform the HAC Task Force's assessment of the feasibility of a 100% HAC handset outcome at this time and how a 100 percent deployment benchmark may rely in part or in whole on alternative HAC technologies

Participating HCPs met the following criteria: 1) must treat adults who use hearing devices; 2) must provide direct clinical hearing healthcare services; and 3) must provide hearing aid and/or cochlear implant services. Furthermore, the Professional Survey focused on three areas: 1) the characteristics of the hearing aid devices and hearing improvement technologies dispensed in the 12 months prior to survey completion; 2) the interplay of characteristics of hearing aid devices and hearing improvement technologies with wireless handsets; and 3) the screening/fitting/counseling protocol for hearing aid devices and hearing improvement technologies with wireless handsets.

4.3.2. Survey Participants.

The HAC Task Force partnered with four organizations to recruit respondents for the professional survey: American Academy of Audiologists; Association of VA Audiologists; Academy of Doctors of Audiology; and International Hearing Society. In addition to these organizations, survey respondents were sourced by Northstar, who organized an online professional panel. In total, 193 hearing health care professionals completed the study. Of the professionals who completed the study, 83% were audiologists and 17% were hearing instrument professionals.[133]

The HAC Task Force understands the importance of obtaining multiple perspectives for this type of assessment and, as with the Consumer Survey, endeavored to collect information from

[133] Audiologists assess and treat persons with hearing and related disorders. They may fit and provide auditory training and may perform research related to hearing problems. *See* https://www.bls.gov/oes/current/oes291181.htm. Not all audiologists select and fit hearing aids with adults. Hearing aid dispensers or specialists only work with adults and their primary role is to select and fit hearing aids. They also conduct hearing tests, but this is primarily to aid in the selection and fitting of hearing aids. *See* https://www.bls.gov/oes/current/oes292092.htm).

participants serving various communities across the country. On average, survey participants were 47 years of age with 19 years of experience. More than half (56%) of audiologists were female, while a majority of hearing instrument specialists (58%) were male. Respondents from states in each of the four regions of the United States were represented in the survey (32% from southern states, 25% from western states, 24% from states in the Midwest, and 18% from states in the northeast). Two-thirds of the survey respondents were from communities with more than 50,000 residents (68%) and the remaining one-third of the respondents were from locations of less than 50,000 residents.

4.3.3. Professional Survey Results and Discussion.

The main objectives of the professional survey were to quantitatively assess and measure the following: (i) the characteristics of the hearing aid devices and hearing improvement technologies recently dispensed; (ii) the interplay of characteristics of hearing aid devices and hearing improvement technologies with wireless handsets; and (iii) the screening/fitting/ counseling protocol for hearing aid devices and hearing improvement technologies with wireless handsets.[134]

4.3.4. Patient Base and Hearing Device Services.

Summary. Most professionals reported seeing on average about 1,000 patients in the 12 months prior to the survey, which equates to 4-5 patients per day. The top "regular" work settings for professionals were: Independent Private Practice (41%); followed by ENT Clinic (22%), Hospital Clinic (15%), and University Clinic (10%).

A majority of professionals reported that at least half of their patient base had moderate (54%) or moderately-severe hearing loss (61%). A third (33%) reported that at least half their patient base

[134] Survey questions and their related response options were provided to WG2 from previous survey work completed by the RERC on Telecommunications Access (NIDRR grant number 90RE5003) to help inform the development of the professional survey. L. Jackson-Machmer and Linda Kozma-Spytek, Telecommunications-Related Audiologic (Re)habilitation Services, Research poster presentation at the American Academy of Audiology's annual meeting, AudiologyNOW! (April 3-6, 2013).

had severe hearing loss. Fewer reported having patients with mild hearing loss, and fewer still reported having patients with profound hearing loss.

Seventy-three percent of all professionals provided hearing aid services and 20% provided both cochlear implant and hearing aid services. Professionals who provided hearing aid services, reported dispensing on average 320 hearing aid devices in the prior 12 months, which is approximately one per day. They reported fitting hearing aids across all price ranges (budget 27%, mid-range 35% and premium, high-end hearing aids 38%), with a slight skew to the higher end price ranges. Most professionals (92%) also offered hearing aids from more than a single manufacturer, with 57% selling aids from 2-4 manufacturers and another 25% selling aids from 5 or more manufacturers. Seventy percent of professionals report that they assessed patients' telecommunications needs more than half the time in the prior 12 months.

Discussion. The majority of the professionals surveyed were in private practice and rendered services to patients who were experiencing more severe cases of hearing loss and in need of a hearing device. It is worth noting that most of the professionals offered hearing aids from more than a single hearing device manufacturer and purchasing patterns skewed somewhat toward the higher-end models, which typically support more advanced technological feature sets. Individuals with mild hearing loss made up a small proportion of these professional's patient base even though the prevalence of mild hearing loss is greater than other degrees of hearing loss,[135] suggesting that individuals are less likely to receive professional hearing health services in those cases.

4.3.5. Patient Inquiries about Wireless Phone Use.

Summary. About half of the professionals (55%) reported that most of their patients have inquired about topics related to wireless phone usage with their hearing device for voice communications, and almost all (99%) said that at least some patients have made such inquiries. The top inquiries were about how to use a Bluetooth-enabled wireless phone (72%), related app usage (71%) and information about hearing aid compatible wireless phones (60%). Other aspects of wireless phone and hearing device use for voice communication, such as information about assistive devices (38%), telecoils (27%) and the reduction of acoustic feedback (24%), received fewer inquiries.

Discussion. Professionals are discussing wireless phone usage with their patients. Professionals received more questions about Bluetooth-enabled wireless phones and related app usage than questions about other and related aspects of HAC wireless phones with hearing device usage (e.g., telecoils and acoustic feedback reduction).[136]

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[135] Adele M. Goman & Frank R. Lin, *Prevalence of Hearing Loss by Severity in the United States*, 106(10) Am. J. of Public Health 1820 (2016), https://doi.org/10.2105/AJPH.2016.303299.

[136] *See* note 131 and Section 4.3.9 Professional HHCP Services. Most important wireless phone-related counseling topic involved wireless phone-related positioning, which may be a contributing factor to the substantial number of inquiries/interest around Bluetooth-enabled technology options.

4.3.6. Familiarity with Wireless Hearing Aid Compatibility Topics.

Summary. When asked about their general familiarity with various aspects of wireless hearing aid compatibility, hearing health care professionals were most likely to say they are familiar with how to identify wireless phones that are hearing aid compatible – 77% are familiar of which 35% indicated "complete familiarity" and an additional 42% are "mostly familiar."[137] However, when further examining the more granular aspects of hearing aid compatibility, familiarity was more modest. For example, only slightly over half of the respondents (57%) indicated familiarity with the M and T ratings for HAC wireless phones. About half (51%) of survey participants were familiar with a hearing device user's right to try hearing aid compatible wireless phones prior to purchase in a service provider's store. Regarding hearing aid compatibility requirements for wireless phones, including telecoil, magnetic noise, and RF emissions, only some (41%) indicated having familiarity with these factors. As for hearing aids, only some (44%) professionals reported familiarity with the RF immunity (M/T) ratings for hearing aids.

Discussion. While professionals are generally familiar with how to identify hearing aid compatible wireless devices, they reported less familiarity with the more detailed aspects of hearing aid compatibility, such as M/T ratings and those aspects of a wireless phone's performance that are assessed in determining the ratings (e.g., magnetic field strength and noise, as well as RF emissions). This suggests there are opportunities for more robust education in these areas for professionals.

4.3.7. Sources of Professional Education/Information.

Summary. Professionals reported using on average two sources of information to stay apprised of technological changes and updates. The top way professionals reported staying apprised of technology topics is through hearing device manufacturers and their representatives (55%). All other means of staying up to date were reported far less often. For example, 21% reported reading articles, journals, or industry literature, 17% used online resources, and 13% made use of information from professional organizations.

Discussion. The leading way professionals are staying apprised of technological topics (including changes and updates) is through hearing device manufacturers and their representatives.

[137] Based on hearing health care professionals' responses, the most important wireless phone-related counseling topic involved wireless phone positioning aural rehabilitation service for hearing device users with 80% saying it is at least very important. Note that 45% of professionals rate this topic as 'extremely important' and an additional 35% say it is 'very important.' Furthermore, activating the phone preset/program/memory is also rated as very important among professionals (73%). Of slightly lesser importance are the following topics: Challenges with wireless phone communication (68%); how to avoid acoustic feedback with wireless use (68%); assistive devices for wireless phone use (72% extremely/very important, with 26% saying this is 'extremely important'); and alternative to spoken wireless phone communication (61%).

4.3.8. Patient Usage of Wireless Phones for Voice Telecommunications and Coupling Methods.

Summary. Some professionals (41%) reported that most of their patients use a wireless phone with their hearing device for voice conversations, and many more (95%) said that at least some patients have voice conversations on their wireless phone while using their hearing device. Well over half of the hearing health care professionals (70%) reported that in the prior 12 months at least half of their patients accessed voice conversations by streaming the audio directly from a wireless phone to their hearing device.

Audiologists also reported that few patients utilized a telecoil in their hearing device for wireless phone communication (on average 24%), with 20% of audiologists saying none of their patients use a telecoil for voice conversations.

Discussion. The information here suggests general patterns of coupling methods with wireless phones when used for voice communications and a growing adoption and use of Bluetooth-enabled technologies.

4.3.9. Patient Challenges with Wireless Phone Use for Voice Telecommunications.

Summary. Most professionals (82%) reported that at least some of their patients expressed difficulty using their wireless device with their hearing device for voice calls. Among professionals whose patients expressed difficulties, the most frequent challenge reported was wireless phone connectivity, where their hearing device did not connect correctly with their wireless phone (59%). Other challenges when using wireless phones with hearing devices included general usability (44%), unclear speech/difficulty understanding (36%), excessive battery drain (34%), wireless phone volume (32%), interfering noises (27%) and acoustic feedback (17%).

Discussion. Note that most professionals reported that at least some of their patients having experienced some form of challenge with wireless phone use, mainly centered around connectivity with the hearing device and usability.

4.3.10. Professional HHCP Services.

Background on Hearing Device Consultation and Programming. Hearing device consultation includes an assessment of a patient's needs. Well over half of the hearing health care professionals (70%) reported that in the prior 12 months, they assessed their patients' telecommunications needs more than half the time when selecting appropriate hearing devices, with 36% indicating that they always assess their patients' telecommunications needs.

Hearing device programming and program verification is the most time-consuming service performed as part of dispensing protocol. Professionals reported spending on average 32 minutes on these activities. Part of hearing device programming may include providing the patient with a phone preset/program/memory that can be engaged during a voice call on their wireless phone. When asked about providing a program specifically for use during telephone conversations as part of the hearing device fittings, about half of professionals (48%) reported always or most of the time providing this service.

The top configuration for such a program was a dedicated streaming program (52%). Mentioned less often were wireless phone programs for telecoil coupling (32%) and microphone coupling (22%). Other types of program configurations included automatic wireless phone programs[138] (48%), which were provided more often than manual programs (28%) that the patient would need to actively engage. A little more than a third of professionals reported providing a binaural wireless phone program, which permits the patient to listen to the phone conversation with both ears and provides an advantage in terms of sound quality, ease of listening and comprehension.

One reason for providing a phone preset/program/memory as part of a hearing device's fitting was to address a particular patient need or complaint. For example, professionals reported providing a phone program to improve speech understanding during wireless phone communications (49%), to reduce background noise during wireless phone communication (36%) or to avoid acoustic feedback (26%). In other cases, the phone program was provided at the patient's request (41%), as a standard procedure for most patients (34%) or because the patient stated that the patient used a wireless phone (33%). Professionals also reported a variety of reasons for not providing a phone preset/program/memory – including if a patient already used their wireless phone successfully (46%); the patient did not want a specific phone program (44%) or it was not important to the patient (42%), if it was not indicated due to the patient's cognitive state (44%), or the patient did not use a wireless phone (43%).

4.3.11. Support Services.

Summary. Many professionals reported providing a range of support services related to wireless phone use, including counseling on topics related to hearing aid compatibility. Considerations in purchasing wireless phones was the top counseling service provided regarding hearing aid compatibility. Hearing health care professionals also offered overviews of hearing aid compatibility requirements and help with identifying wireless phones that are compatible.

In addition, professionals reported determining the patient's ability to use their wireless phone with their hearing device (69%). This took a variety of forms from having the patient conduct a wireless phone conversation while wearing their hearing device (70%) to having the patient demonstrate certain skills such as activating their wireless phone program in their hearing device (61%), positioning the wireless phone next to their hearing device (57%) or demonstrating connecting an assistive device for wireless phone use (54%). These three skills along with how to avoid acoustic feedback were considered extremely to very important counseling topics. Professionals also verified the function of the hearing device for telephone use by conducting real-ear measurements (58%) or by performing listening checks of the telecoil (42%) or wireless phone program (58%).

Many professionals (72%) also asked their patients to return for a follow-up appointment if they needed troubleshooting assistance with their hearing device and its programming; a further 65% helped troubleshoot over the phone. On average, 31 minutes was spent on these follow up

[138] The hearing device switches automatically to a telephone program when a handset is held to the ear, or an incoming phone call is detected.

activities. Additionally, half of professionals referred their patients to the manufacturer's technical support if they needed help troubleshooting.

Finally, almost all hearing health care professionals (97%) ordered and sold hearing devices directly to consumers for communication when using a hearing device with a wireless phone in the prior 12 months. The top hearing device sold by 74% of professional respondents, are hearing aids with wireless connectivity to a smart phone. A streamer with wireless coupling to the hearing device is the top assistive device *recommended*, with 68% of professionals having recommended this device in the past 12 months. Focusing on counseling services, 78% of professionals provide in-office instruction for assistive devices or specialty wireless phone equipment. Seven in ten provide written instructions such as pamphlets and 56% direct their patients to a website or phone support line.

Discussion. Results here convey that conversations are taking place between professionals and their patients around telecommunications needs. These conversations include identifying wireless phones that are hearing aid compatible and participating in activities to assess patient skillset in using a wireless phone with a hearing device. In addition, the information here suggests that these discussions include considerations in selecting a hearing device. The top device sold by professional respondents (74%), are hearing aids with wireless connectivity to a smart phone. Professional knowledge base and recommendations are quite influential in a patient's overall experience with wireless phones.

4.4. Discussion of Key Observations from the Consumer and Professional Survey Results.

4.4.1. Key Observations – Consumer Survey.

Consumer Satisfaction. Most consumers reported that they are satisfied with their wireless phone listening experience as well as the performance of their hearing device with their wireless phone.

Feature Choice and Selection. Respondents identified that their hearing devices generally included a selection of features that they used when listening on their wireless phone. Many consumers also adjusted both their hearing device and wireless handset to facilitate their listening experience. The traditional acoustic and telecoil coupling methods with the phone held at the ear were less used than other coupling methods.

Bluetooth and direct audio streaming. About half (51%) of consumers with hearing loss reported using Bluetooth as a method of coupling their wireless device to their hearing aid devices, with most of those consumers reporting that Bluetooth was their top coupling method of choice. In addition, Bluetooth audio streaming was an important feature with a high rate of satisfaction for those consumers who reported having it.

Age matters. On a variety of topics, there were differences in the experiences and attitudes reported by these consumers across multiple areas as a function of age. These differences were most frequently noted when comparing responses from younger respondents (18-54 years of age) with older respondents (55-84 years of age).

4.4.2. Key Observations – Professional Survey.

Interaction with Patients about Hearing Aids and Wireless Phone Use: Professionals and patients are having dialogues about hearing devices, compatibility, and wireless phone user experience, with 55% of the professionals surveyed reporting that most of their patients have inquired about topics related to wireless phone usage with hearing devices for voice communications. Top inquiries were about topics related to how to use a Bluetooth-enabled wireless phone and related app usage (72% and 71%, respectively) as well as information about hearing aid compatible wireless phones (60%). Considerations in purchasing wireless phones was the leading counseling service provided regarding hearing aid compatibility.

With regard to the hearing device consultations, many professionals (70%) reported that in the prior 12 months, they assessed their patients' telecommunications needs (including wireless phone use) more than half the time when selecting appropriate hearing devices. And, the top device sold as reported by the professional respondents (74%), are hearing aids with wireless connectivity to a smart phone.

Familiarity with Hearing Aid Compatibility: While most professionals expressed a general familiarity about how to identify hearing aid compatible phones, knowledge of more granular aspects of hearing aid compatibility familiarity was more modest, with slightly over half of professionals (57%) surveyed indicating familiarity with the M and T ratings. About half of the professionals (51%) understood hearing device user options in trying a wireless phone prior to purchase and fewer than half indicated familiarity with telecoil, magnetic noise and RF emissions. Likewise, less than half (44%) of the professionals reported familiarity with RF immunity (M/T ratings) for hearing aids.

Professionals' Main Source of Information: Professionals reported that the top way of staying apprised of technology topics is through hearing device manufacturers and their representatives.

Patients' Experience: Well over half of the professionals (70%) reported that in the prior 12 months at least half of the patients accessed voice conversations by streaming the audio directly from a wireless phone to their hearing device. In addition, audiologists reported that fewer patients utilized a telecoil in their hearing device for wireless phone communications (on average 24%).

Most professionals (82%) reported that at least some of their patients expressed difficulty using their wireless device with their hearing device for voice calls, where wireless phone connectivity with the hearing devices was cited as a leading challenge.

4.4.3. Overall Discussion.

The consumer and hearing professional surveys provide a window into real-world hearing device/wireless handset use and related professional care in 2021. Wireless phone use for voice calling is clearly important to consumers with hearing loss. Like most Americans, most consumers with hearing loss own a wireless phone, and that wireless phone is most likely to be a smartphone. High rates of wireless phone and smartphone ownership among hearing device users were reported in the previous RERC-TA Study, the present consumer study, and the MarkeTrak studies.

Both consumers and professionals also reported significant use of and interest in direct audio streaming from the wireless phone to the hearing device(s)—capability not captured in the traditional M/T ratings but made possible by Bluetooth's evolution. Compared to the previous RERC-TA Study, conducted before direct audio streaming was readily available, consumer respondents in 2021 reported greater satisfaction with their calling experience. In the RERC-TA Study, only a little more than a third (37%) of respondents were either satisfied or very satisfied with the calling experience on their personal cell phones. Whereas in the current study, 60% of consumer respondents were either satisfied or very satisfied with the listening experience on their wireless phone, and another 20% were somewhat satisfied.

Along with this increase in listening satisfaction, there has been a change in the coupling method that was used most often between the hearing device and wireless device over time. The RERC-TA Study found that microphone coupling with the cell phone held at the ear and next to the hearing device was the most common coupling method (36%) for listening to a calling partner, with other coupling methods, such as telecoil coupling at the ear (8%), being used far less often. The present study showed a shift in the preferred coupling method toward Bluetooth, with 42% reporting it was the most common coupling method used. Microphone coupling at the ear was used most often by 16% of the respondents and 5% used telecoil coupling at the ear most often.

The professional survey results were consistent with this finding of preferences for coupling methods. Additionally, the MarkeTrak study revealed a 20% increase from 2015 to 2022 in hearing aid owners with some type of wireless capability. In the 2022 MarkeTrak study, 63% of hearing aid owners reported some type of wireless capability, which means at least a third of hearing aid owners did not have access to direct audio streaming between their cell phone and hearing aid. While this will likely continue to change over time, the traditional forms of coupling, microphone and telecoil, remain very important. This is especially true when we also consider that on average, respondents made use of two coupling methods for wireless device listening.

While consumers reported general satisfaction with their wireless phone listening experience as well as the performance of their hearing device with their wireless phone, most professionals reported that at least some of their patients having experienced some form of challenge with wireless phone use, mainly centered around connectivity with the hearing device and usability. Likewise, consumers reported that one of the most important factors to help achieve satisfactory wireless phone communication included seamless use of their hearing device with a wireless phone. Other areas consumers identified were better wireless phone sound quality and more or better educational aspects that centered on information about hearing aid compatibility, training to improve wireless phone use and better ways to test wireless phone products. The Consumer Survey identified age-related differences regarding the range of advice received, the method for conveying information, and satisfaction with the services received. This may in part be due to younger respondents being most likely to have actively requested information from or report a problem to their hearing health care provider. Accordingly, there may be additional opportunities for education for both consumers and hearing health professionals.

The role of the professional's knowledge base on patient/consumer decisions about wireless phones is important since consumers, especially older consumers, relied most on hearing health care providers for information about using their wireless phone products and services.

Considerations in purchasing wireless phones was reported to be the leading counseling service provided by hearing health professionals. With most professionals expressing a general familiarity about how to identify hearing aid compatible phones, knowledge of more granular aspects of hearing aid compatibility familiarity was more modest – with slightly over half of the professionals indicating familiarity with the M and T ratings. A notable number of hearing health professional/patient conversations are centered around Bluetooth-enabled wireless phones and direct audio streaming from a wireless phone to their hearing device. These professionals are likely influencing patient/consumer decisions concerning hearing aid use with wireless devices (e.g., compatibility, coupling, etc.).

5. Working Group 3 Report.

5.1. Overview of Working Group 3.

The HAC Task Force noted that little testing data was available for review to understand how current devices perform relative to the 2019 ANSI Standard, which the Commission incorporated into its HAC rule during the course of the HAC Task Force's work. Accordingly, the HAC Task Force formed WG3 to examine the impact of changes of the 2019 ANSI Standard and related Commission rulemaking on the HAC Task Force charter and work (i.e., achievability of 100% hearing aid compliance).[139]

Handset manufacturers participating in WG3 agreed to perform testing and submit that data for evaluation. The working group received data about eighteen mobile handsets, which were tested using the 2019 ANSI Standard procedures. WG3 found that none of the handsets were able to pass all testing, primarily because none of the handsets were able to pass the volume control clause of the standard.

After analyzing the probable reasons for the handsets not to pass the volume control clause, WG3 recommends that TIA reopen the TIA 5050[140] standard for revision regarding (i) receive distortion and noise performance (ii) acoustic frequency response and (iii) consideration of codecs with speech bandwidth exceeding 50-7000 Hz.

WG3 estimates that revising the volume control standard can be done relatively quickly, but recognizes that the ANSI C63.19 committee would then need to accept the standard and petition for a rulemaking, and the Commission would update the technical standard in the rules.[141] In order to enable handsets to pass the Commission's requirements for near-term testing to the 2019 ANSI Standard, WG3 recommends that the Commission modify requirements associated with volume control testing until TIA can complete the revisions to the standard.[142] If TIA cannot

[139] *See 2021 HAC Standard Order*, 36 FCC Rcd 4566 (incorporating the 2019 ANSI Standard into the Commission's rules and transition the HAC testing standard to the 2019 ANSI Standard).
[140] ANSI/TIA-5050-2018, *Receive Volume Control Requirements for Wireless (Mobile) Devices* (Jan. 2018).
[141] The Chief of the Wireless Telecommunications Bureau and the Chief of the Office of Engineering and Technology may also update the incorporated ANSI standard. 47 C.F.R. § 20.19(k)(2).
[142] *See* Section 5.6.

come to a resolution of testing of codecs with bandwidth exceeding 50-7000 Hz, WG3 recommends the Commission exclude those from compliance testing.

5.2. The 2019 ANSI Standard.

The purpose of C63.19 is to establish test requirements for hearing aids and for wireless handsets that allow a hearing aid user to effectively use a wireless handset when both the hearing aid and wireless handset meet the requirements of the standard. In order to provide for the usability of a hearing aid with a wireless handset, several factors are coordinated, as follows:

- The field strength emitted by a wireless handset must not exceed the RF immunity of the hearing aid.
- The T-Coil[143] baseband magnetic field (H-field) transmission of the wireless device must be compatible with the T-Coil mode of the hearing aid.
- The magnetic noise from the wireless handset in the T-Coil audio band must not degrade the reception quality to unacceptable levels.
- Both the wireless handset's RF and audio-band emissions are measured. Hence, the following measurements are made for the wireless handsets:
    - RF amplitude modulation characteristics and power level, or optionally, near-field E-field emissions
    - T-Coil mode, magnetic signal strength in the audio band
    - T-Coil mode, magnetic noise in the audio band
    - T-Coil mode, magnetic signal frequency response in the audio band

Corresponding to these quantities, the hearing aid is measured for the following:

- RF immunity in microphone mode
- RF immunity in T-Coil mode

In 2015, the ANSI Group C63.19 undertook a revision of the C63.19-2011 standard, resulting in a new standard C63.19-2019. The standard revised the testing and requirements for both hearing aids and mobile handsets. The project was authorized to prepare a new revision of ANSI C63.19 addressing the following issues:

- Growing importance of Voice Over IP and Voice Over LTE for telephony services
- Hearing aid user satisfaction with HAC
- Adequacy of volume control
- Adequacy of T-Coil reception

[143] An inductive coil used in some hearing aids to allow reception of an audio band magnetic field signal, instead of an acoustic signal.

- Harmonization of hearing aid testing with corresponding IEC 60118-13[144]
- Cover new technologies, particularly at TV White Space and cellular at 600 MHz, 3.5 GHz, and 5.0 GHz, which may include extending the lower boundary of the frequency range covered
- Use of software defined radio and other new instrumentation in HAC measurements
- Simultaneous transmissions, particularly in smartphones

Table and section references in the next section are from the respective standards (C63.19-2019 or ANSI/TIA-5050-2018). This Report does not fully replicate the standards, and details can be found in the text of referenced standards.

5.2.1. Hearing Aid.

In order to harmonize the testing of the hearing aid with IEC 60118-13, the 2019 ANSI Standard prescribes the measurement method to be used in determining a hearing aid's immunity to radiated electromagnetic fields originating from a wireless handset. Because the positional relationship of the wireless handset's field and its polarization relative to the hearing aid is not predictable or limited to a small range of possibilities, the goal of the test is the determination of the RF immunity at the worst-case hearing aid orientation relative to the applied field strength. While this approach has the potential to overestimate the interference in actual use, it does establish an upper bound and will exhibit more predictive consistency overall than would an arbitrary single orientation or a more limited range of orientations.

5.2.2. Mobile Handset.

5.2.2.1. Performance Criteria for Mobile Handsets – RF Emissions.

5.2.2.1.1. Major Modifications to the 2011 ANSI Standard for RF Emissions Testing.

As with the newer 2019 ANSI Standard, the 2011 ANSI Standard evaluates a mobile handset's RF interference potential through evaluation of its RF audio interference level ("RF_{AIL}") or RF audio interference power level ("RF_{AIPL}"), which are functions of both (i) the field strength or power level and (ii) the subjective characteristic of the induced audio frequency interference, as perceived by hearing aid users.

In both versions, RF field scans are taken over a 50mm x 50mm grid centered on the acoustic output of the mobile handset. In the 2011 ANSI Standard, this grid is subdivided into nine subgrids, of which three contiguous, non-center subgrids may be excluded from the measurement. This procedure assumed that an area near the base of an antenna could be a hotspot that could be avoided in use. Extensive subsequent testing including somewhat more modern handsets revealed that this assumption did not hold in the presence of a hand and a head. This "exclusion area" procedure did not improve the correlation to in-use RF interference

[144] IEC 60118-13 – Electroacoustics – Hearing Aids – Part 13: Electromagnetic Compatibility.

coupling in comparison to a simpler overall area average, which was incorporated into the 2019 ANSI Standard.

The 2011 ANSI Standard includes a low-power exemption from RF emissions testing based on very conservative limits for RF_{AIPL} or peak power. Extensive subsequent testing found that comparable correlations to in-use RF interference coupling could be achieved with either RF_{AIL} or RF_{AIPL} procedures, along with a conservative view of peak power or peak field strength evaluations. This result led to a more straightforward and consistent RF emissions test routine.

Based on a handset's measured test results, the 2011 ANSI Standard classifies the handset as one of category M1-M4, as it does for hearing aid RF immunity. This classification system proved confusing to consumers. In practice, M3 became the required minimum category for mobile handsets. The 2019 ANSI Standard dispenses with the M-ratings and establishes a single threshold for each qualification method.

5.2.2.1.2. RF Emissions Testing for Mobile Handsets.

A handset may by qualified for RF emissions by any of four related tests:

- Measure peak conducted power; compare to the associated qualification level.
- Measure RF audio interference power level (RF_{AIPL}); compare to the associated qualification level.
- Measure peak E-field strength, averaged over the designated scan area; compare to the associated qualification level.
- Measure RF audio interference level (RF_{AIL}), averaged over the designated scan area; compare to the associated qualification level.

If the handset incorporates multiple transmitters expected to be operated when the wireless handset is in voice mode operation positioned at a user's ear, each transmitter is tested individually.

The wireless handset's conducted power must be at or below either a specified RF_{AIPL} or the specified peak power level, or the average near-field emissions over the measurement area must be at or below the stated RF_{AIL}, or the stated peak field strength. The wireless handset may demonstrate compliance by meeting any of these four requirements, but it must do so in each of its operating bands at its established worst-case normal speech-mode operating condition.

5.2.2.2. Performance Criteria for Mobile Handsets – Inductive Coupling.

Responding to subjective testing performed in 2018 where three test subjects used ten GSM cellphones paired with two behind-the-ear hearing aids, it was viewed that the 2011 ANSI Standard development erred in not putting a maximum limit on excessive magnetic noise ("ABM2") and in not specifying an adequate size for an "area of goodness," rather than just single measurement points for transverse and perpendicular orientations. The new standard maintains the desired ABM signal minimum level at -18 dB(A/m), establishes a maximum for undesired ABM level of -38 dB(A/m), establishes a minimum area over which these two criteria

should be met, but sets this only for the transverse orientation, which is more relevant for modern hearing aid trends.

These new requirements may be more difficult for many phones to meet compared to the 2011 ANSI Standard requirements, particularly for those using strong pulsed modulation protocols such as GSM.

5.2.2.3. Performance Criteria for Mobile Handsets – Volume Control.

5.2.2.3.1. Commission History.

The Commission explained in its *2017 Volume Control Order*:[145]

> For well over a decade, the Commission has explored the need for volume control in wireless handsets. When the Commission first considered this issue in 2003, it refrained from adopting a volume control requirement because it expected that newly adopted performance standards for inductive coupling and reduced RF interference would be sufficient to improve wireless handset audio quality for people with hearing loss. The Commission next initiated a review of this issue in a notice of proposed rulemaking in 2007, but in 2010, again determined that it was premature to take action because the Alliance for Telecommunications Industry Solutions (ATIS) had formed a working group to investigate the interaction between the audio output from wireless phones and modern digital hearing aids. The Commission expected that "the findings of this investigation, including recommendations for achieving adequate listening levels for consumers who wear hearing aids while using wireless phones. [would] be shared with the Commission upon the completion of this group's efforts." Later that year, in December 2010, and again in 2012, the Commission's Wireless Telecommunications Bureau (WTB) once again raised questions about the need for and feasibility of rules requiring acoustic coupling of wireless handsets for people with hearing loss. At some point in time between these two notices, the ATIS working group ceased activities without producing recommendations on this matter.

5.2.2.3.2. ANSI/TIA.

Volume control standard TIA 5050 was developed by Working Group TR-41.3.14 of Committee TR-41 and published in January 2018. This standard for wireless devices is based on the measurement methods established in ANSI/TIA-4965[146] for wireline handsets. ANSI/TIA-4965 specifies a measurement method based on the concept of "Conversational Gain" whereby the acoustic output level of a handset with volume control gain applied is measured with modern, updated methods, and referenced to an acoustic level of 70 dBSPL. The acoustic related measurement methods are identical to ANSI/TIA-4965 except that two force levels are specified for placing the handset against the ear pinna of the Head and Torso Simulator ("HATS"). The 8N force is similar to the 10 N force used in ANSI/TIA-4965 and is meant to be representative of a handset held to an ear without a hearing device (e.g., hearing aid, cochlear implant). The 2N

[145] *2017 Volume Control Order*, 32 FCC Rcd at 9072-73 ¶ 21 (footnotes omitted).
[146] ANSI/TIA-4965-2012 (r2017), Telecommunications – Telephone Terminal Equipment – Receive Volume Control Requirements for Digital and Analog Wireline Handset Terminals.

force is meant to simulate the handset being loosely coupled to the microphone of a hearing device. The Conversational Gain requirements differ for these two usage conditions.

Table 4: ANSI/TIA-5050-2018 Requirements

<table>
<tr><th>Section</th><th>Title</th><th>Requirement</th></tr>
<tr><td>5.1</td><td>Receive Volume Control Performance</td><td>The following requirements shall be met for at least one volume control setting for the narrowband transmission mode (if supported) and the wideband transmission mode (if supported).
1. With a mounting force of 8N, the DUT shall have at least one volume control setting that will produce a conversational gain of ≥ 18 dB with the output distortion and the frequency response meeting the requirements in clause 5.2.1 & 5.3.1 respectively.
2. With a mounting force of 2N, the DUT shall have at least one volume control setting that will produce a conversational gain of ≥ 6 dB with the output distortion and the frequency response meeting the requirements in clause 5.2.1 & 5.3.1 respectively.</td></tr>
<tr><td>5.2</td><td>Receive Distortion and Noise Performance (PN-SDNR)</td><td>Receive distortion is specified in terms of Signal-to-Distortion-and-Noise Ratio (SDNR) using a Pulsed Noise (PN) test signal. PN-SDNR is the ratio of the signal power to the total A-weighted distortion and noise power of the signal output expressed in dB. It is measured using a pulsed 1/3 octave pink noise input signal.
With a mounting force of 8N and 2N, the ratio of the stimulus signal power to the 100 Hz to 8000 Hz total A-weighted distortion and noise power shall be ≥ 20 dB when tested over the range of 1/3 octave band center frequencies:
1. Narrowband transmission mode: Each 1/3 octave band center frequency from 400 Hz to 3150 Hz.
2. Wideband transmission mode: Each 1/3 octave band center frequency from 250 Hz to 5000 Hz.</td></tr>
<tr><td>5.3</td><td>Receive Acoustic Frequency Response Performance</td><td>The receive acoustic frequency response is required to be met when tested with a handset mounting force of 2N and 8N.
For the volume control settings determined in 5.1.1 with a mounting force of 8N and 2N, the receive frequency response shall be measured at the drum reference point (DRP) in 1/12 octave bands. After translation to the free field (FF) or diffuse filed (DF), it shall fall between the below applicable upper and lower limits.
Table 1 – Narrowband Receive Frequency Response Limits
<table>
<tr><th>Lower Limit Frequency (Hz)</th><th>Lower Limit (dB)</th><th>Upper Limit Frequency (Hz)</th><th>Upper Limit (dB)</th></tr>
<tr><td>300</td><td>-6</td><td>100</td><td>+6</td></tr>
</table>
</td></tr>
</table>

Section	Title	Requirement

3400	-6	4000	+6

Table 2 – Wideband Receive Frequency Response Limits

Lower Limit Frequency (Hz)	Lower Limit (dB)	Upper Limit Frequency (Hz)	Upper Limit (dB)
200	-10	100	+6
300	-6	1000	+6
5000	-6	2000	+8
6300	-12	8000	+8

5.3. Testing Under the 2019 ANSI Standard.

After significant delay due to the unavailability of adequate testing equipment and software, WG3 received results from eighteen mobile handsets which were tested using the procedures of the 2019 ANSI Standard.[147] WG3 found that none of the devices were able to pass all testing.

RF emissions testing found all handsets devices passed testing. WG3 found during the testing process that the Commission should clarify the testing so that it is performed in accordance with the 2019 ANSI Standard.

T-Coil testing found 7/18 devices meeting the 2019 ANSI Standard testing. While this is a low pass value, WG3 recommends Commission continued review of T-Coil testing as more experience is gained and devices are tuned to improve performance.

Volume control testing found none of the devices passed testing.

WG3 recommends that TIA reopen the TIA 5050 standard for revision regarding (i) receive distortion and noise performance (ii) acoustic frequency response and (iii) consideration of codecs with speech bandwidth exceeding 50-7000 Hz.

In order to enable devices to pass the Commission requirements for near term testing to the 2019 ANSI Standard, WG3 recommends that the Commission modify requirements associated with volume control testing until TIA can complete the revisions to the standard. Finally, if TIA cannot come to a resolution of testing of codecs with bandwidth exceeding 50-7000 Hz, WG3 recommends that the Commission exclude those from compliance testing.

The performance of hearing aids through immunity measurements is evaluated alongside the performance of handsets in the 2019 ANSI Standard to determine how compatible a hearing aid is with a particular handset. For the objective of WG3, the scope of the measurement effort was limited to evaluation of handsets alone.

[147] The OEMs submitting the results represented that the handsets achieved a minimum of M3/T3 when tested pursuant to the 2011 ANSI Standard.

5.3.1. Data Collection Process.

Testing for Commission compliance can be quite time-consuming and costly because compliance requires testing on all air-interfaces, bands, and codecs used in the handset. To maximize obtaining a broad set of data from a variety of handsets within a reasonable timeframe, WG3 recommended testing for a handset device be limited to:

- All Air-interfaces
- Only one band for each air-interface
- For RF emissions testing consider one of the 4 testing options

The group recommended that handset manufacturers selected handsets for testing that were representative of the range of products they currently offered in the marketplace. The handset manufacturers confirmed that they tested handsets offered at a range of price points, with multiple form factors as well as with multiple chip set providers. In order to provide a common format for the submission of data a template was developed and agreed.

To encourage collection of data, WG3 used an external accounting firm as a collection point that would remove any company identification data associated with the participating handset manufacturers. All handset manufacturers and test labs submitted test data directly to the external accounting firm, the accounting firm reviewed and removed any identifying company information and then returned a sanitized set of test data back to WG3. The data collection effort did not seek information about any interaction between the design of devices and the version of C63.19 that was the target for regulatory compliance under the design phase.

5.3.1.1. Test Equipment.

All test equipment used by participant labs were confirmed to meet the requirements of the 2019 ANSI Standard and TIA 5050. Commercially available test systems, such as the DASY system by SPEAG, are software and hardware packages designed to meet the equipment requirements of the 2019 ANSI Standard. A necessary software module for WG3's testing was not released until 2022, and this significantly delayed testing.[148] Other test equipment is also commercially available or developed in-house by test labs used to perform testing for HAC-RF and HAC-T-Coil. Any test equipment used for testing meets the requirements of the 2011 ANSI Standard and 2019 ANSI Standard.

TIA 5050 specifies the use of an ITU-T P.58 compliant HATS equipped with an ITU-T P.57 type 3.3 ear simulator for Volume Control testing. All equipment used for Volume Control testing meets the requirements of TIA 5050 standard and the 2019 ANSI Standard.

[148] DASY is a robot-based high precision electromagnetic near-field scanning platform that is commonly utilized IN Specific Absorption Rate testing and HAC testing. A recent software module was released in 2022 to enable the DASY system to test handsets for HAC-RF and HAC-T-Coil according to the 2019 ANSI Standard. WG3 notes that acoustic measurements according to ANSI/TIA-5050-2018 are not planned for DASY.

5.3.1.2. Definition Of Metrics.

An air-interface in a handset is considered to pass the 2019 ANSI Standard testing if all bands tested for that air-interface pass all RF emissions testing, T-Coil testing and volume control testing.

A handset is considered to pass 2019 ANSI Standard testing if the handset passes all RF emissions testing, T-Coil testing and volume control testing.

5.3.1.3. Summary of Collected Data.

Data was submitted for consideration covering eighteen handsets. Data on the Commission approval date indicated all handsets in this evaluation received Commission certification after August 19, 2019 (the date ANSI C63 approved the 2019 ANSI Standard standard).

All of the handsets tested passed RF emissions testing, 38.9% passed T-Coil testing and none passed Volume Control testing. Since no handsets passed Volume Control testing, this also meant that none of the handsets would pass overall 2019 ANSI Standard testing. Viewing the data by air-interface the following statistics can be found in Table 5.

Table 5: Count of Overall Pass/Fail by Air-interface
(Pass if all bands tested for Air-interface pass in a single device)

Air-interface	RF Emissions		T-Coil		Volume Control		Overall*	
	pass	fail	pass	fail	pass	fail	pass	fail
CDMA	10	0	4	6	0	10	0	9
GSM	18	0	11	7	0	18	0	17
LTE (FDD)	18	0	14	4	0	13	0	12
LTE (TDD)	14	0	7	11	0	11	0	11
NR (FDD)	5	0	2	3	0	0	0	0
NR (TDD)	5	0	2	3	0	0	0	0
UMTS	18	0	14	4	0	11	0	11
WiFi	18	0	9	5	3	9	3	9

* To be counted in the overall column, all air-interfaces must have been tested in all bands for each of the three testing criteria, devices which undergo partial testing would not be counted in the overall statistic.

RF_{AIL} is passed by all devices in all bands. For Volume Control few devices pass the receiver distortion criteria specified in TIA 5050.

5.3.1.3.1. RF Testing.

All tests pass RF_{AIL} and subsequently pass the RF testing. WG3 noted that some discrepancies in RF_{AIPL} and Average Power were observed and further comment is provided below. The

distribution of the RF testing is shown in Figure 11 and Figure 12. The legend in each figure corresponds to the band tested with the value in the square brackets the pass/fail criteria as found in the 2019 ANSI Standard.

Figure 11: RF_{AIPL} distribution across all devices and air-interfaces

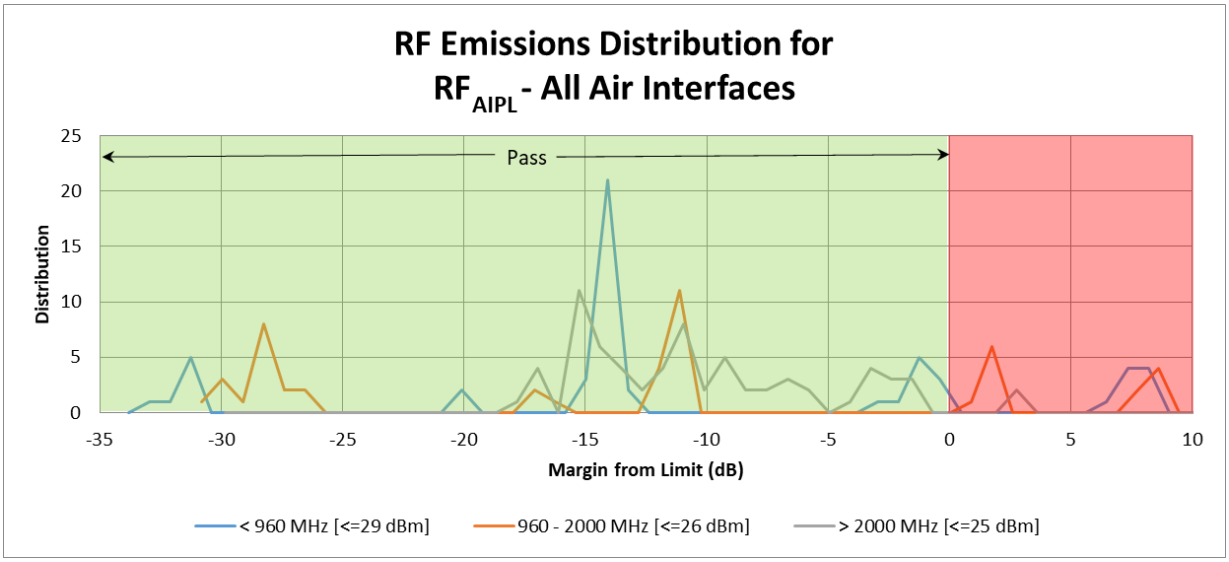
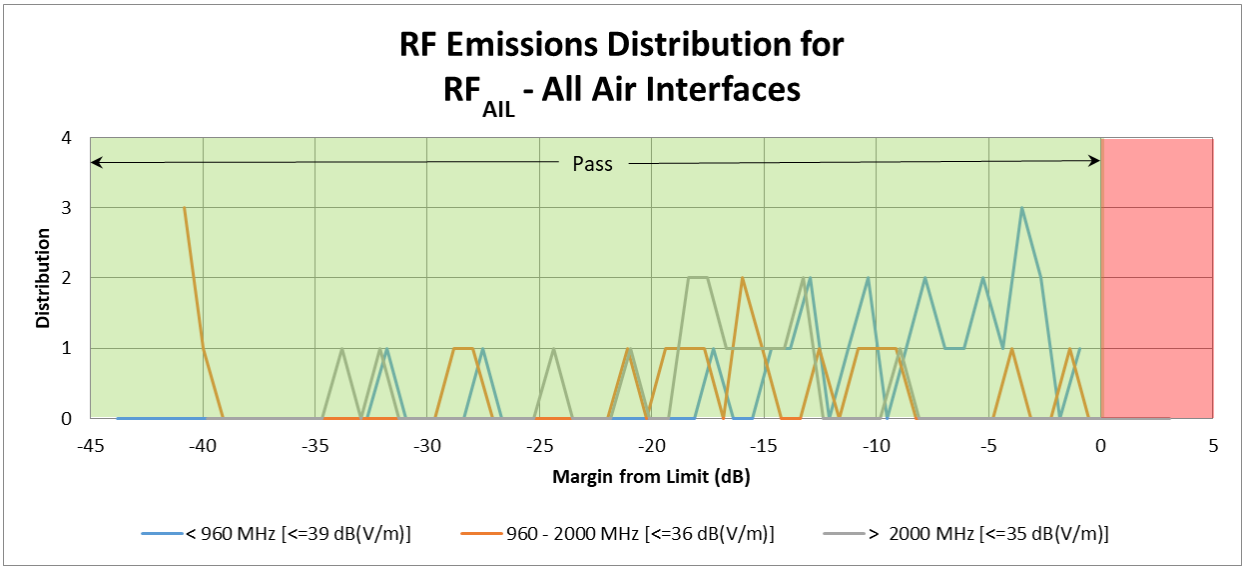


Figure 12: RF_{AIL} distribution across all devices and air-interfaces



As can be seen in the RF_{AIPL} plot above, there are several apparent failures. These are associated with air-interfaces having a pulsing characteristic capable of inducing higher levels of audio frequency interference. However, these handsets still should not have been classified as failures for this test.

The test results are to be based on a measurement of the average conducted power added to the measured Modulation Index Factor ("MIF"). In the standard's appendix, the MIF is shown to be

derived from a comparison of a measured RF_{AIPL} to the average power. All the three quantities – RF_{AIPL}, MIF, and average power – are taken as long-term averages. The body of the standard's reference to "average power" left open a possible interpretation as a very short-term average – what the standard's authors intended to define as "peak" power. The reported RF_{AIPL} failures appear to have been produced by adding the target peak or burst powers for the air-interface to a nominal MIF value for the air-interface, yielding results 9-10 dB higher than the expected measured values.

The intended interpretation of "average power" in this context will be solidified as an interpretation for future application of the standard. It should be noted that the problematic ambiguity did not reveal itself in the parallel RF_{AIL} field strength measurements, as the field probes used are inherently slow-averaging.

It is further noted that the standard specifies that the RF_{AIPL} should be calculated from measured MIF and conducted power rather than target values (ANSI C63.19-2019 Sec 4.4). The Commission testing guidance[149] allows use of predetermined values for MIF from the test equipment manufacturer for Commission certification.

According, WG3 concludes that the measured RF_{AIPL} results from the ATIS test data are not failures to meet the standard values but possible misinterpretation of average power measurements from the 2019 version of the standard, and corrected results are within expectation.

5.3.1.3.2. T-Coil Testing.

As shown by data in section 5.0, seven of eighteen handsets pass T-Coil testing. Reviewing the data on an air-interface/band perspective we find:

- 67% of air-interface/bands pass all T-Coil testing (210/313)
- All air-interface/bands pass the contiguous longitudinal and traverse tests
- 85.9% of air-interface/bands pass frequency response testing (269/313)
- 78.9% of air-interface/bands pass primary point testing (247/313)
- 90.4% of air-interface/bands pass secondary points testing (283/313)

[149] FCC, OET, KDB 285076 – HAC Guidance v06r01 Section 3.c (Oct. 25, 2022), https://bit.ly/3hDX1yZ.

Figure 13: Primary points for non-2G GSM modes

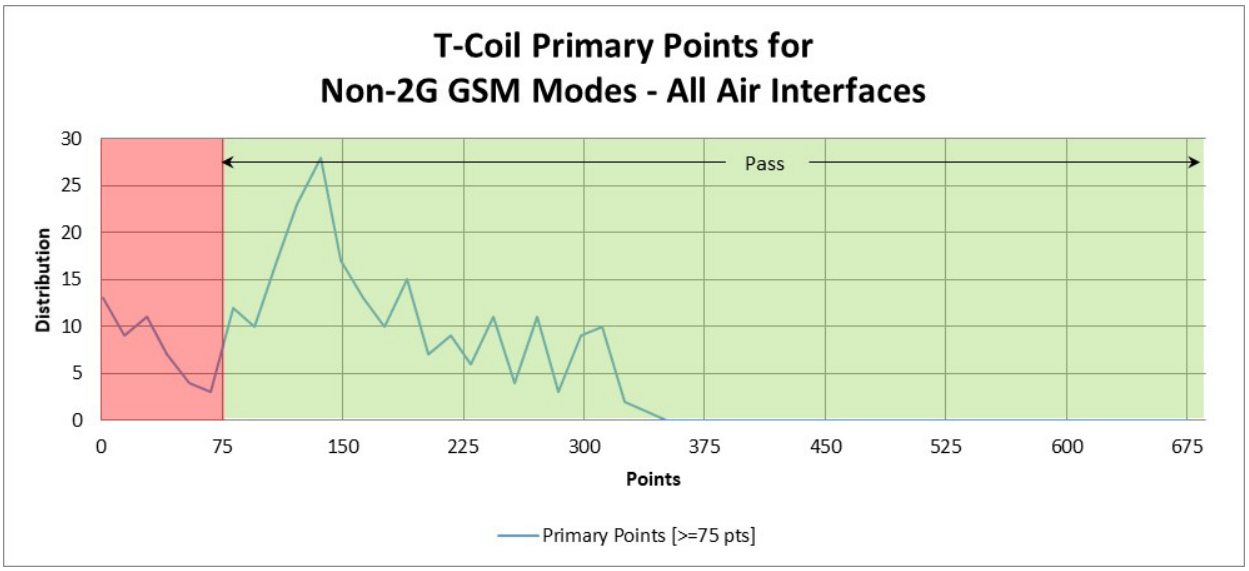


Figure 14: Secondary points for non-2G GSM modes

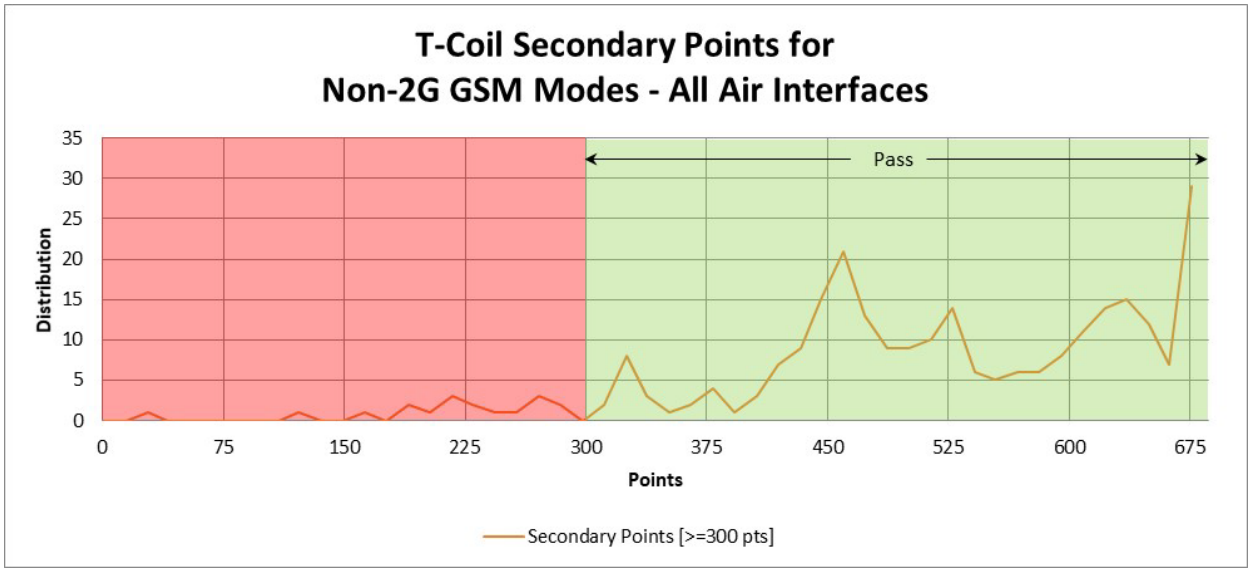


Figure 15: Primary points for 2G GSM modes

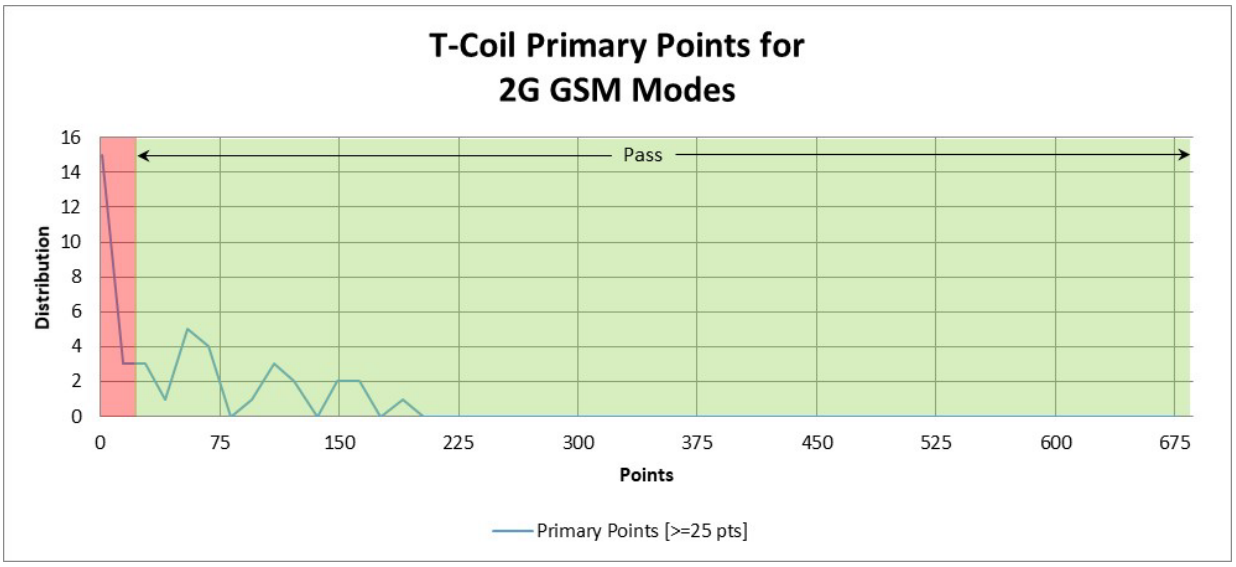
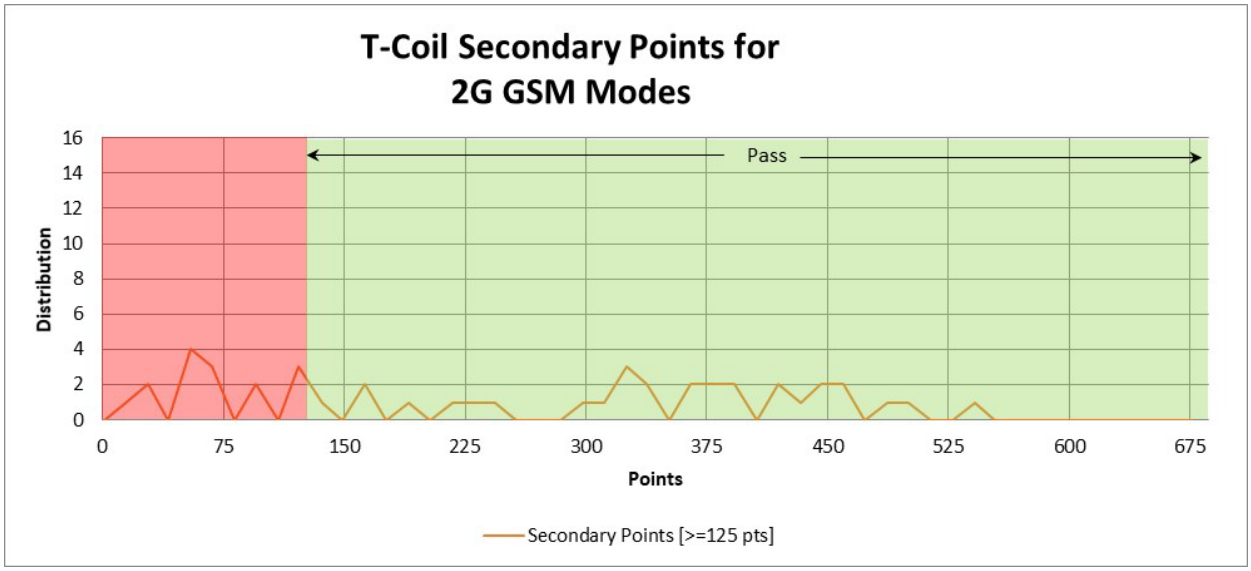


Figure 16: Secondary points for 2G GSM modes



5.3.1.3.3. Volume Control Testing.

None of the handsets pass Volume Control testing. The only air-interface to pass volume control was over the WiFi air-interface. Reviewing the data on an air-interface/band perspective, WG3 finds:

- Receive volume control – At 2N force 98.8% pass (79/80) and at 8N force 66.3% pass (53/80).
- Receive acoustic frequency response – At 2N and 8N force 53.8% pass (43/80).

- Receive distortion ratio (PN-SDNR) – At 2N force 15.0% pass (12/80) and at 8N force 16.3% pass (13/80).

The overall distribution of conversational gain is found in Figure 18, the pass/fail criteria is shown in square brackets in the legend. There was little variance in the conversation gain when higher forces are measured. Figure 17 shows the conversational gain normalized to the criteria, we observe a high pass rate for 2N measurement and low pass rate for 8N measurements.

Figure 17: Distribution of Conversational Gain

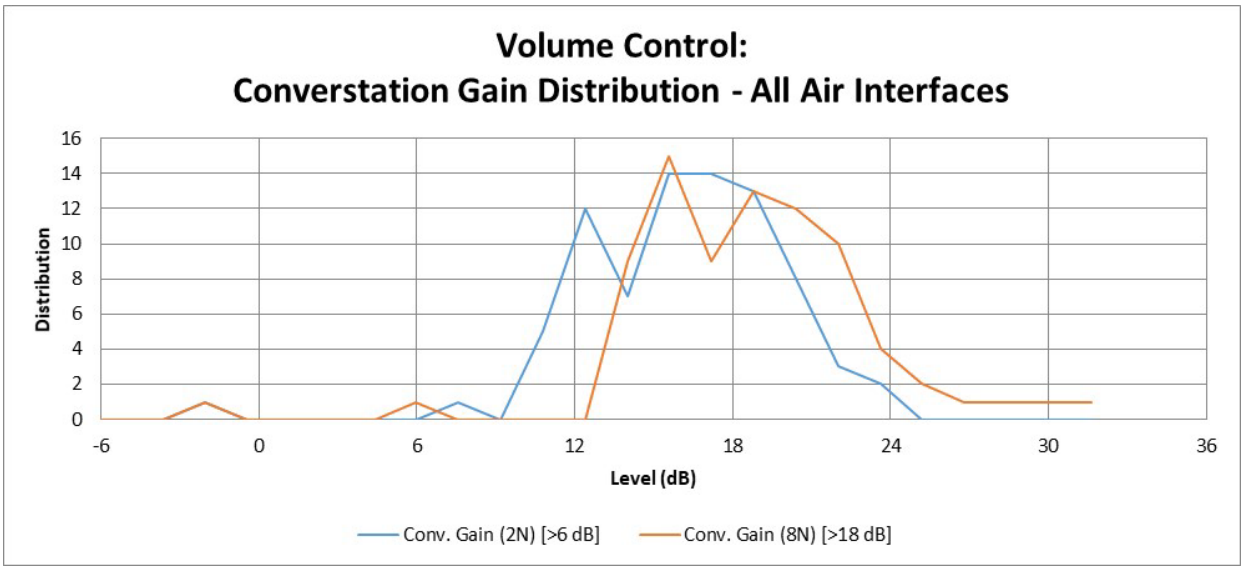
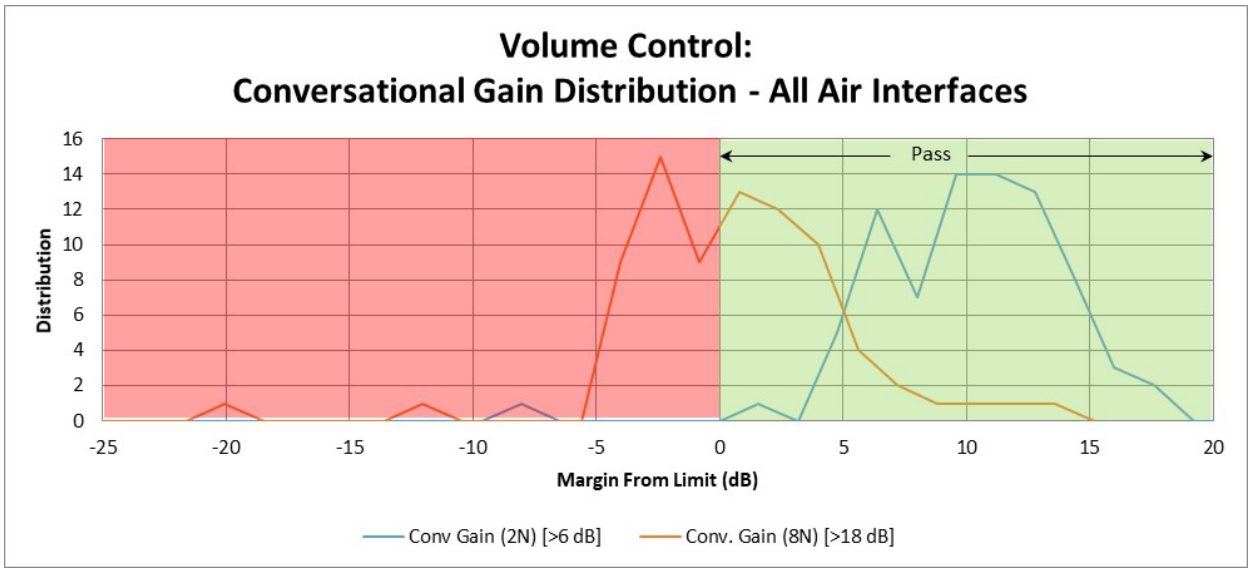


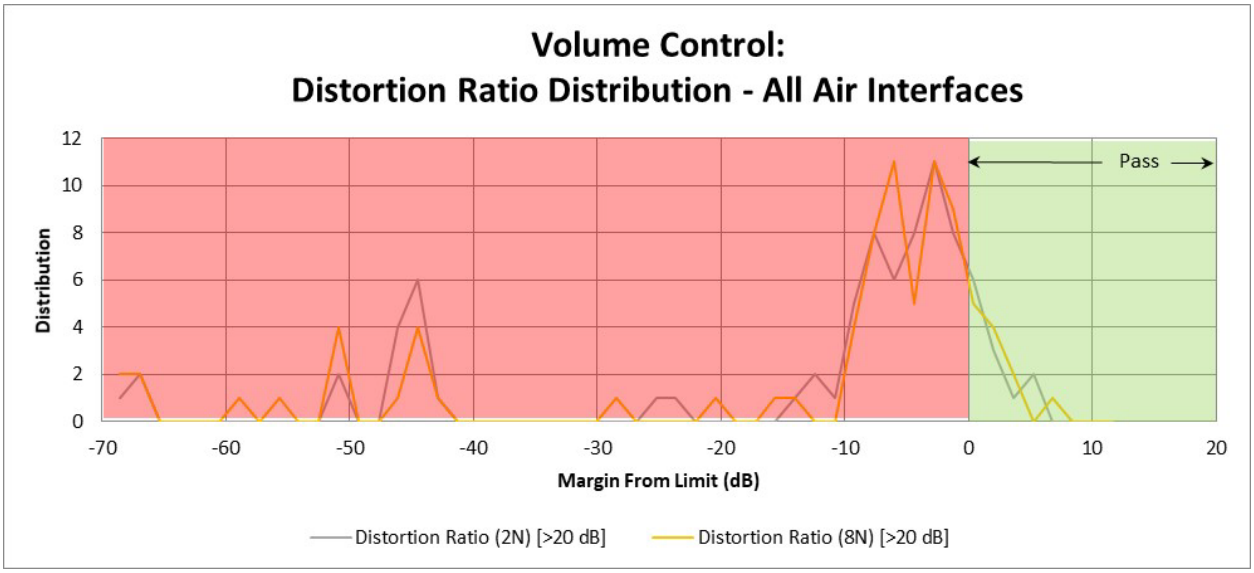
Figure 18: Distribution of Conversational Gain Relative to Limit



The overall distribution of receive distortion ratio (PN-SDNR) is found in Figure 19. WG3 observes a very low pass rate for all devices. It should also be noted that many of the large negative data points are likely a result of expressing the measured results as distortion-to-signal,

rather than the intended signal-to-distortion. This interpretation should be the subject of further clarification going forward.

Figure 19: Distribution of Receive Distortion Ratio (PN-SDNR) relative to limit of 20 dB



5.4. Further Analysis on Volume Control.

WG3 determined that signal-to-distortion-and-noise ratio ("SDNR") using a pulse noise ("PN") test signal was a key factor in devices failing to pass the volume control requirement and led to all devices not meeting the C63.19-2019 testing criteria. Further, a high failure rate for acoustic receive frequency response could also be a significant issue with passing C63.19-2019 testing criteria. WG3 also notes that TIA 5050 does not take into account super wide band codecs.

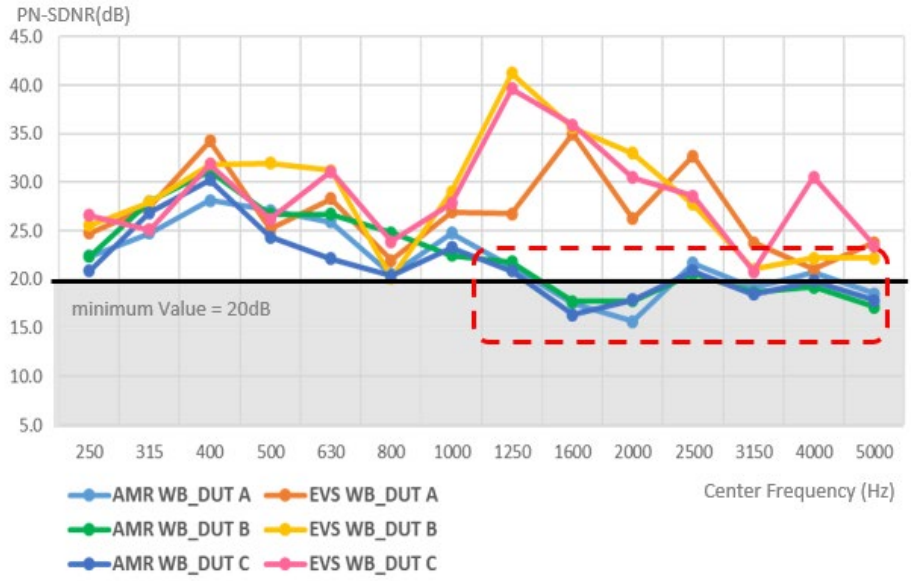
The intent of distortion and frequency response in TIA 5050 is to ensure the audio amplifier/speaker combination can reproduce speech signals at the required volume with little distortion and while maintaining a specified frequency response within certain limits, testing of one codec for distortion and frequency response is sufficient until the TIA 5050 standard is revised. It is important that individuals have conversational gain capability and WG3 recommends testing at only the 2N force for all codec and air-interfaces (but only for codecs under the scope of TIA 5050, codec with speech bandwidth with-in 50-7000 Hz). Conversational gain at the 2N level is relevant for individuals with hearing loss while wearing hearing aids.

5.4.1. PN-SDNR Further Test Data.

Additional evaluation of the test data provided details of measurements of PN-SNDR at the evaluation channels for Adaptive Multi-Rate (AMR[150]) and Enhanced Voice Services (EVS[151]) codecs. This test data was produced following TIA 5050.

One OEM provided test data set shown in Figure 20, this data (data set 1) is measurement results for three devices in each 1/3 octave band center frequency from 250-5000 Hz for both an AMR wideband codec and EVS wideband codec. Results indicate that the EVS codec does pass the 20 dB criteria but it has a very low margin at 800 Hz, 3150 Hz, and 4000 Hz. The AMR codec fails testing above 1250 Hz and has very low margin at 250 Hz, 800 Hz and 1250 Hz.

Figure 20: Test data set 1



Another OEM provided test data shown in Table 6 and Table 7. This data (data set 2) is from one device showing test results for AMR narrowband and wideband codecs as well as EVS narrowband and wideband codecs.[152] Testing results show that the ability to meet the test criteria of TIA 5050 is heavily dependent on which codec is used, e.g., the PN-SDNR in EVS modes could be 5-10 dB higher than in AMR modes. Further, PN-SDNR could drop by 5-10 dB for frequencies above 1000 Hz in AMR codecs and for frequencies above 3150 Hz in EVS codecs.

[150] Adaptive Multi-Rate Codec, https://en.wikipedia.org/wiki/Adaptive_Multi-Rate_audio_codec (last visited Nov. 7, 2022).
[151] Enhanced Voice Services, https://en.wikipedia.org/wiki/Enhanced_Voice_Services (last visited Nov. 7, 2022).
[152] The test setup used HEAD acoustics HAC-Suite (code 60021) and R&S network simulator CMW500 (AMR and EVS speech codecs).

Table 6: Narrowband Codec Test Data

AMR NB 12.2kbps **Report – Receive Distortion and Noise** TIA-5050 (2018-01)\ Measurements\Narrowband\5.2R		
Region	**Frequency**	**SDNR**
1	400Hz	29.39 dB
2	500Hz	28.52 dB
3	630Hz	25.74 dB
4	800Hz	22.89 dB
5	1000Hz	22.57 dB
6	1250Hz	21.73 dB
7	1600Hz	24.77 dB
8	2000Hz	25.74 dB
9	2500Hz	22.10 dB
10	3150Hz	19.48 dB

EVS NB 13.2kbps **Report – Receive Distortion and Noise** TIA-5050 (2018-01)\ Measurements\Narrowband\5.2R		
Region	**Frequency**	**SDNR**
1	400Hz	29.87 dB
2	500Hz	32.60 dB
3	630Hz	29.62 dB
4	800Hz	36.96 dB
5	1000Hz	33.93 dB
6	1250Hz	26.74 dB
7	1600Hz	35.90 dB
8	2000Hz	31.06 dB
9	2500Hz	32.42 dB
10	3150Hz	30.15 dB

Table 7: Wideband Codec Test Data

AMR WB **Report – Receive Distortion and Noise** TIA-5050 (2018-01)\ Measurements\Narrowband\5.2Rec		
Region	**Frequency**	**SDNR**
1	250Hz	29.80 dB
2	315Hz	29.89 dB
3	400Hz	29.88 dB
4	500Hz	31.40 dB
5	630Hz	30.99 dB
6	800Hz	28.29 dB
7	1000Hz	23.96 dB
8	1250Hz	19.11 dB
9	1600Hz	21.46 dB
10	2000Hz	17.64 dB
11	2500Hz	21.87 dB
12	3150Hz	24.60 dB
13	4000Hz	18.90 dB
14	5000Hz	16.00 dB

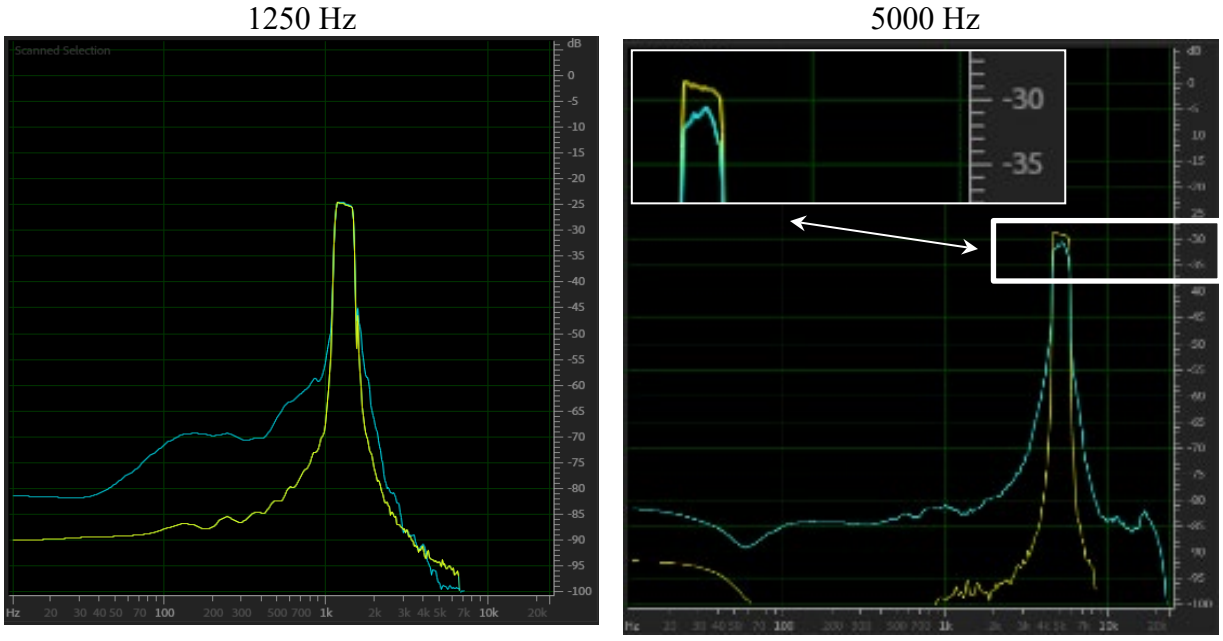
EVS WB **Report – Receive Distortion and Noise** TIA-5050 (2018-01)\ Measurements\Narrowband\5.2Rec		
Region	**Frequency**	**SDNR**
1	250Hz	28.15 dB
2	315Hz	31.00 dB
3	400Hz	31.14 dB
4	500Hz	33.86 dB
5	630Hz	36.52 dB
6	800Hz	38.85 dB
7	1000Hz	37.55 dB
8	1250Hz	26.17 dB
9	1600Hz	36.66 dB
10	2000Hz	33.87 dB
11	2500Hz	32.67 dB
12	3150Hz	32.33 dB
13	4000Hz	24.21 dB
14	5000Hz	25.90 dB

Data set 2 also provided the waveforms captured by the logging tool to compare the vocoder data after speech codec decoding without audio processing. The data shows a real speech signal at the 1/3 octave band followed by the PN-SNDR signal with-in the same 1/3 octave bands, this is repeated for all 1/3 octave bands from 250-5000Hz. The data shows pulsed noise stimulus signal

level in AMR wideband codec is about 3-7 dB lower than that in the EVS wideband codec for frequencies above 1000 Hz. The finding is that the PN-SNDR is heavily dependent on the speech codec characteristics, getting smaller as a result of the smaller measured stimulus amplitude.

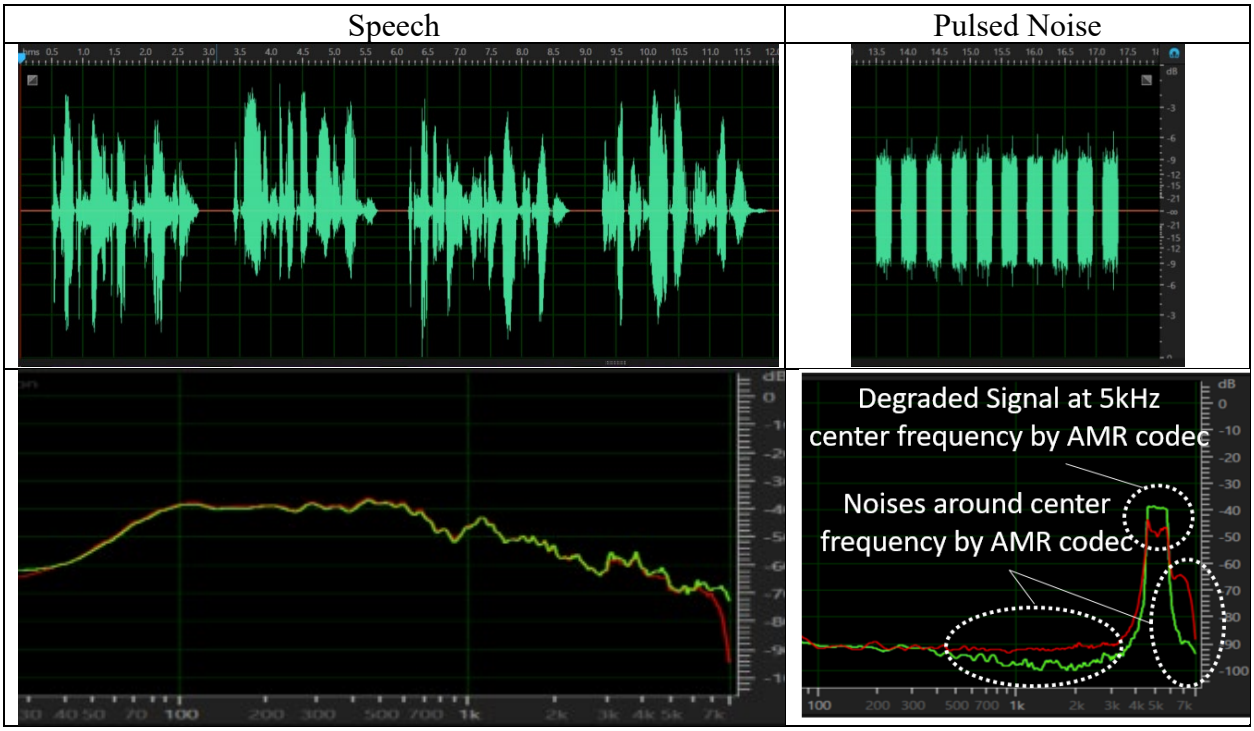
A further analysis (data set 1) was done to evaluate AMR and EVS wideband codes through simulation. In this instance each codec was analyzed through computer simulation using the pulsed noise signal. Shown in Figure 21 are the results for 1/3 octave at 1250 Hz and 5000 Hz. Signals for the AMR codec show increased noise around the center frequency and distortion on the main signal that is not seen with the EVS codec.

Figure 21: Computer simulation of AMR and EVS wideband codecs to pulsed noise signals. Yellow line is data captured for the EVS codec and blue line is for the AMR codec.



The characteristics of each codec were analyzed by the receiving audio pack of the device that includes the influence of the network codec and the mobile device. Shown in Figure 22 is the time domain signal in the top set of graphs with the corresponding frequency response of the respective codecs in the bottom set of graphs. Pulsed noise passes through the AMR codec and produces unintended noise and distortion of the signal.

Figure 22: EVS and AMR wideband codec Frequency Response to speech and Pulsed Noise. Red is AMR wideband codec and green is EVS wideband codec



5.4.2. Acoustic Receive Frequency Response.

WG3 data found that a significant number of devices did not pass acoustic receive frequency response testing. WG3 notes that there is a significant difference between the TIA standards and 3GPP standards used to produce the frequency response.

Shown below in Figure 23 is the test data using the TIA 5050 testing guidance as well as the test data using the 3GPP standard TS 26.132 Section 5.1. The difference is the filter used to transform the drum reference point spectrum measurement to the far field (FF) or diffuse field (DF). Figure 24 below shows the two transforms.

WG3 recommends that TIA 5050 be aligned with 3GPP standard TS 26.132.

Figure 23: TIA 5050 and 3GPP Acoustic Receive Frequency Response

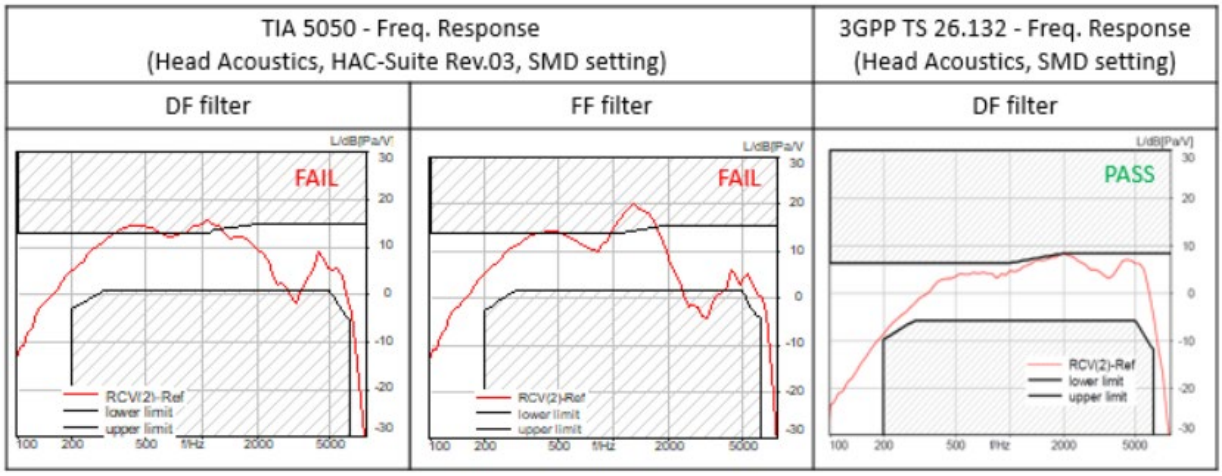
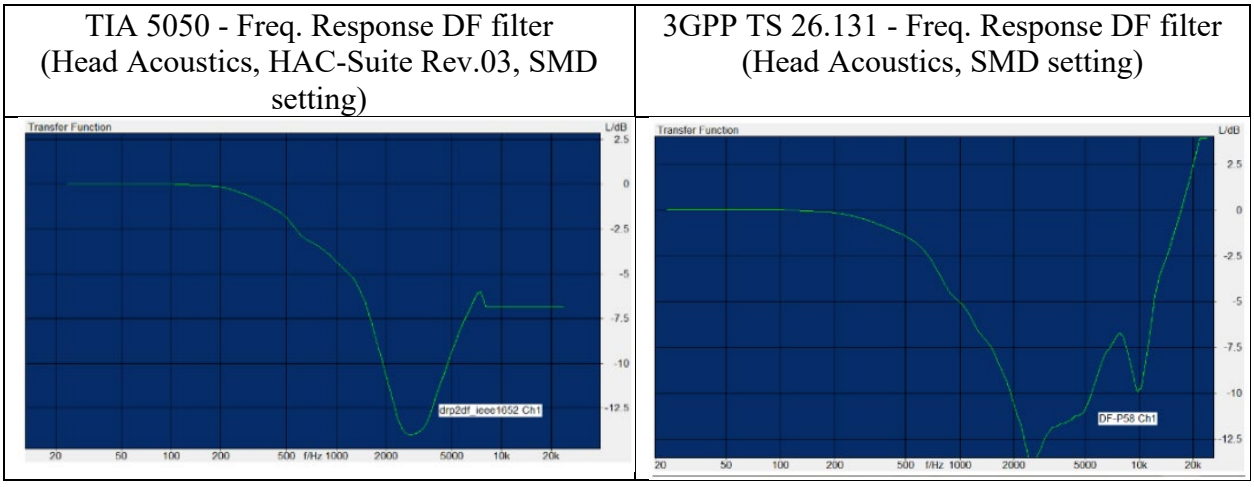


Figure 24: TIA 5050 and 3GPP TS 26.131 DF Filter



5.4.3. Intent of Volume Control.

5.4.3.1. Distortion and Frequency Response.

The 2019 ANSI Standard volume control requirements come by reference to TIA 5050. However, the Commission's requirement that handsets pass TIA 5050 for all combinations of available codec and air interface is not in line with the original intent of TIA 5050. The technical issue being addressed by TIA 5050's distortion and frequency response requirements is that the handset has an amplifier/speaker combination that can produce a loud enough speech signal without unacceptable distortion and frequency response deviation.

Essentially, the testing is to ensure that the audio amplifier/speaker combination can reproduce speech signals at the required volume with little distortion and while maintaining a specified frequency response within certain limits. TIA 5050 tests were developed for this purpose. Its tests were not intended to be used to validate the quality of electrical transmission of the codec

(or air interface) itself. The standard's developers did not attempt to fully resolve the technical difficulty of developing a test signal with speech-like characteristics that could pass substantially unchanged through all possible speech codecs, or that would evaluate the end-to-end transparency of the various speech codecs. However, if the acoustic output distortion and frequency response requirements are met with the specified test signal for at least one codec/air interface combination, then the test device's audio amplifier/speaker combination should have similar output capability for all codec/air interface pairings.

In that spirit and until the standards process concludes, a reasonable interim proposal would be that the distortion and frequency response measurements would be performed using any one codec and air interface, which would show that the amplifier/speaker does not cause unacceptable distortion and frequency response deviation. TIA 5050 specifies that testing is to be done using any air interface, but only the AMR codec. TIA 5050 could be simply modified or reinterpreted to allow any codec and air interface combination for the distortion and frequency response measurements.

5.4.3.2. Conversational Gain.

Separately, there is the question of whether for each codec/air interface combination, the required volume levels can be achieved (conversational gain). The discussed difficulties with testing distortion and frequency response do not appear to be present with this test, so requiring conversational gain testing for all combinations of codec and air interface should not be problematic.

A high failure rate in this test at the 8N force indicates a potential issue that should be investigated further. However, the 2N test is the more relevant aspect of the standard for hearing aid use, which is the subject of the 2019 ANSI Standard. Therefore, a reasonable interim proposal until the standards process concludes would be that the conversational gain measurements would be performed for all combinations of codec and air interface only at the 2N application force, as this represents the hearing aid use case.

5.5. Additional Considerations and Notes.

WG3 observed that wireless handsets are typically tuned and adjusted by manufacturers, in advance of and potentially during certification testing, in order to optimize audio and RF characteristics to meet the specific requirements of the standard being used. However, since the wireless handset samples used during the WG3 study were representative of the models certified to the previous 2011 version of the C63.19 standard, they were not tuned or adjusted by manufacturers for the 2019 version of the standard. WG3 noted that while some characteristics are inherent to the handset, other characteristics such as audio gain or frequency response shaping may be within the scope of manufacturer tuning.

The Commission's testing approach adds test requirements for Volume Control, as compared to the approach taken in the adopted standard, where testing is based on supported codecs rather than channels, bands, and air interfaces:

> A mobile handset must meet the volume control requirements on all air interfaces as required by §20.19(b)(3) which states, "a handset is hearing aid-compatible if it meets

the 2019 ANSI standard for all frequency bands and all air interfaces over which it operates." This guidance does not require every combination of codec, codec data rate, air interface, band, band channel, bandwidth, modulation data rate, subcarrier spacings, and resource blocks to be documented in a test report. However, it is expected to investigate and document only the worst-case test conditions and results. Each submitted test report shall document the codec type (i.e., NB, WB, EVS, etc.), every air interface (i.e., LTE, 5G NR, WI-FI), and band supported for the worst-case codec bit rate, band channel, bandwidth, air interface bit rate, subcarrier spacings, and resource blocks, for the handset to be considered compliant to §20.19(b)(3).

To be compliant, at least one volume control setting must meet the test requirements with a mounting force at both 8N and 2N.[153]

In this WG3 investigation, test channels and bands were typically selected based on worst-case RFE or T-Coil result from certification testing to the 2011 ANSI Standard. A low passing rate for Volume Control was observed for selected channels.

5.6. Conclusions and Recommendations.

WG3 received data from eighteen mobile handsets, which were tested using the procedures of the 2019 ANSI Standard. WG3 found that none of the handsets were able to pass all testing. The key factor driving this observation is the inability of handsets to pass volume control testing. After further analysis on the volume control data, WG3 provides recommendations for TIA and the Commission.

WG3 recommends that TIA reopen the TIA 5050 standard for revision regarding (i) receive distortion and noise performance (ii) acoustic frequency response and (iii) consideration of codecs with speech bandwidth exceeding 50-7000 Hz. Specifically,

1) TIA Should Re-Open the TIA 5050 Standard – Mobile industry should lead this work and as a starting point for the work, below are proposed revisions for consideration.
    a) PN-SDNR Test Signal Interaction with Speech Codecs – TIA should decide how best to resolve issue noted above for PN-SDNR testing, below are three options for consideration.[154]
        i) Adjust the performance criteria – Revise the PN-SDNR limit from "≥ 20 dB" to "≥ 10 dB" for the test frequency bands over 1 kHz for all codecs. Below 1 kHz PN-SDNR limit should be revised to "≥ 15 dB.
        ii) Change the test signal and performance criteria – Consider adoption of test methods and criteria found in 3GPP TS 26.131 section 6.8 and TS 26.132 section 8.8. Noting that the 3GPP standard only tests to 1040 Hz, TIA should consider criteria above higher frequencies when applying the 3GPP standards as necessary to ensure adequate performance with hearing aids.

[153] FCC, OET, KDB 285076 – HAC Guidance v06r01 Section 2 (Oct. 25, 2022), https://bit.ly/3hDX1yZ.
[154] Depending on the option TIA pursues, WG3 notes that conforming edits to the hearing-aid testing may be required.

iii) Consider the use ITU-T P.863 POLQA MOS-LQO score to replace PN-SDNR – Consider adoption of speech signals and POLQA MOS-LQO score defined in the ITU-T P.863 Recommendation. TIA should evaluate the appropriateness of using the POLQA MOS-LQO metric and ensure any POLQA MOS-LQO performance criteria selected provides acceptable audio quality.

b) Acoustic Receive Frequency Response – Use 3GPP TS 26.132 Section 5.1 to transform Drum Reference Point (DRP) frequency spectrum measurement to the Free Field (FF) or Diffuse Field (DF) in place of Annex B of TIA 5050. This would lead to changes in TIA 5050 in Annex B, point 5 of section 5.3.2.

c) Testing of Codecs with Speech Bandwidth Exceeding 50-7000 Hz

i) Expand the Scope of TIA 5050 to be Consistent with Commission Guidance – Industry notes the standard scope considers narrowband (speech bandwidth of 300-3400 Hz) and wideband (speech bandwidth of 50-7000 Hz) codecs and conflicts with OET guidance. TIA should expand the scope and criteria to consider codecs with speech bandwidth exceeding 50-7000 Hz.

ii) Limit the Frequencies Tested for Codecs with Speech Bandwidth Exceeding 50-7000 Hz – Noting the performance of hearing aids is limited in frequency range there may not be a need for testing codecs with speech bandwidth exceeding 50-7000 Hz beyond the frequencies already specified in TIA 5050.

2) The Commission Should Modify the Volume Control Testing Requirements until the TIA 5050 Revision Is Complete – The Commission should issue guidance to allow the standards process to conclude prior to requiring full testing for volume control under the 2019 ANSI Standard. In the interim a device would pass volume control testing if the following conditions are met.

a) The distortion and frequency response requirements are deemed to have been met by the wireless device under test if passing results are achieved for at least one of the device's available codecs.

b) Conversational gain is to be tested and must pass for all available codecs and air interface combinations only at the 2N level.

c) Codecs used for testing are to be limited to those that are in scope for TIA 5050, which include narrowband and wideband codecs.

3) The Commission Should Address Codecs with Speech Bandwidth Exceeding 50-7000 Hz - Commission guidance should be clarified on codecs with speech bandwidth exceeding 50-7000 Hz, if the TIA 5050 standard, when updated, does not address those codecs then they should be excluded from Commission testing.

In order to enable devices to pass the Commission requirements for near term testing to the 2019 ANSI Standard, WG3 recommends that the Commission modify requirements associated with volume control testing until TIA can complete the revisions to the standard. Finally, if TIA cannot come to a resolution of testing of codecs with bandwidth exceeding 50-7000 Hz, WG3 recommends that the Commission exclude those codecs from compliance testing.

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