What does conformance testing entail

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Conformance Testing of Personal Listening Devices and Systems

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Conformance Testing

- Conformance testing is testing to see if an implementation meets the requirements of a standard or specification

- ISO/IEC DIS 10641 defined conformance testing as "test to evaluate the adherence or nonadherence of a candidate implementation to a standard."

- ISO/IEC TR 13233 defined conformance and conformity as "fulfillment by a product, process or service of all relevant specified conformance requirements."

Source: National Institute of Standards and Technology

Conformity Assessment Program

Conformity assessment program requires:

- Standard or specification

- Test method standard or conformance clause

- Test suite or test tools

- Procedures for testing

- Qualified body to do testing

Source: National Institute of Standards and Technology

Types of Conformance Testing

IEEE Standard 2003-1997 defines three types of testing:

- ## Exhaustive Testing

"Seeks to verify the behavior of every aspect of an element, including all permutations"

- ## Thorough Testing

"Seeks to verify the behavior of every aspect of an element, but does not include all permutations."

- ## Identification Testing

"Seeks to verify some distinguishing characteristic of the element in question. It consists of a cursory examination of the element."

Source: National Institute of Standards and Technology

Overview

- NIOSH research on sound listening devices

- Equipment

- Software

- Applicable Standards

- Findings

NIOSH Research

- Occupations where headphones/headsets are widely used (Call Center Ops, Audio Engs, Sports, Broadcasters, etc.)

- Use of personal listening devices in occupational settings

- Cumulative (occupational+recreational) exposure

- Effect of noise-cancelling technology and ambient background noise

NIOSH Research

- Collaboration between NIOSH and Hofstra University and Cardno on the effects of personal listening devices on hearing and tinnitus in young adults

- Examination of popular headsets and earphones w/ Apple and Android devices

- Sample files of several genres of music
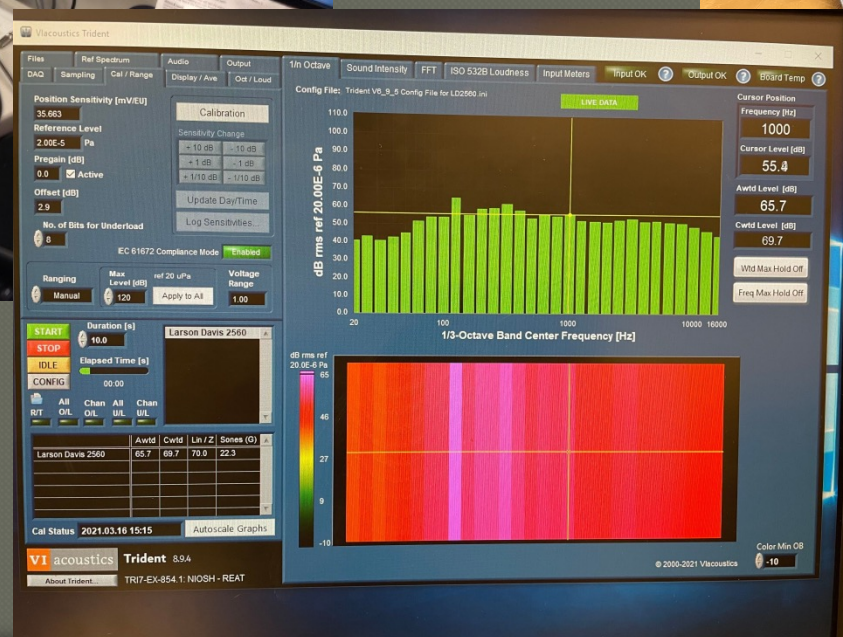
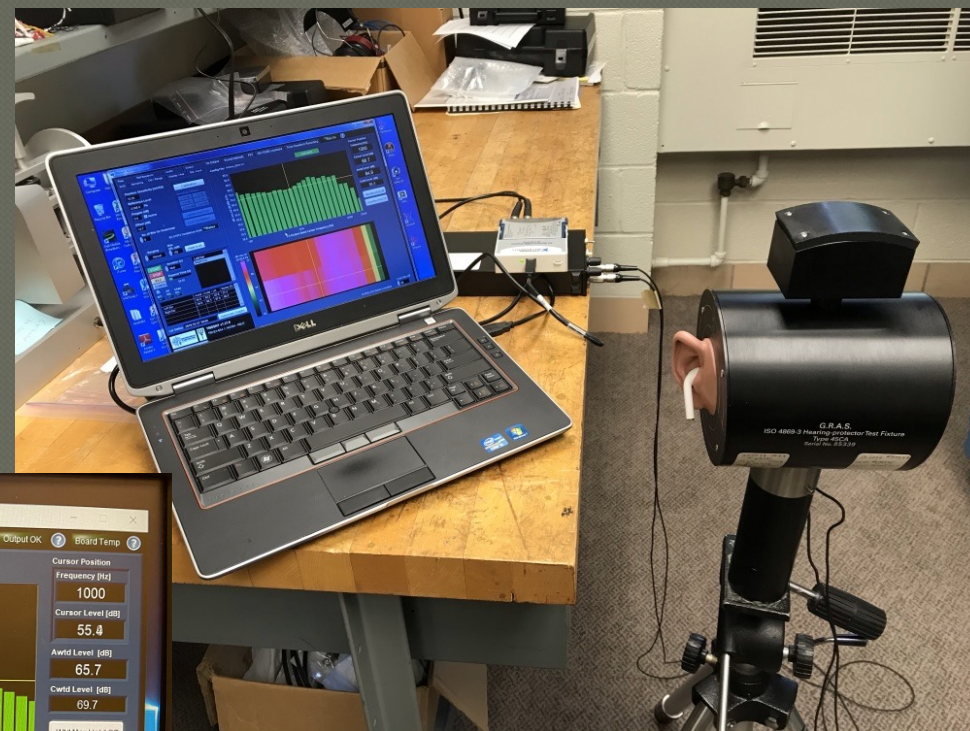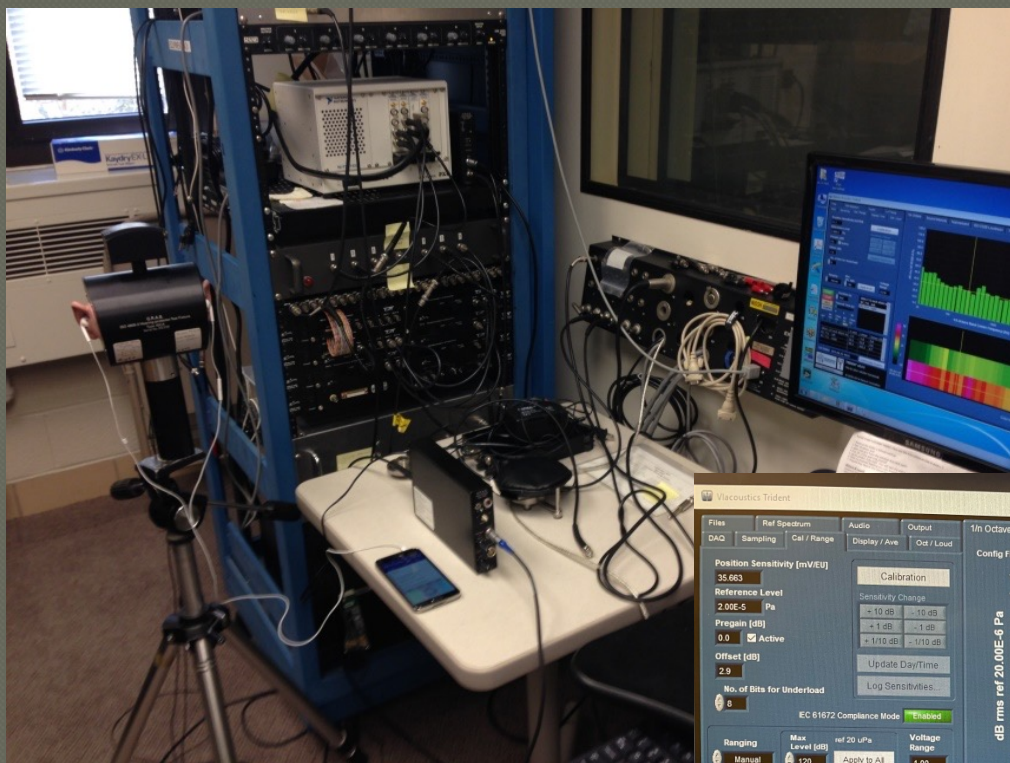# NIOSH Lab Setup

Hardware & Software

- GRAS 45 CA Acoustic Test Fixture (IEC 711) w/ GRAS 40 AG 1/2" microphone

- GRAS 12 AA Power Supply

- GRAS 42 AP Piston Phone (for calibration)

- National Instruments NI-OXI1037 Chassis (NI4461 data boards, 24-bit, 204.8 KS/s)

- ViaAcoustics Software: Trident v.8.9.4, SigPro v1.5.1, Wavefrom Analyzer v3.1

Headsets/Earphones

Hardware & Software

Test Signals

- Pink Noise used as test signal

- 9 Songs from billboard (3 from each genre: Pop, HipHop, Rock)

- 3 repetitions to ensure reliability of response

- Streamed vs. Downloaded music – No diff

- Pink noise and music downloaded to phone and switched to airplane mode to reduce interference

- Broadband noise used for ambient background

Applicable Standards

- ITU-T H.870 (03/2022) - Guidelines for safe listening devices/systems

- EN 50332: 1-3 (2013-2017) – Sound System Equipment…

- IEC 61672: 1-3 (2013) – Electroacoustics: Sound Level Meters…

- IEC 60318: 1-8 (2009-2022) – Electroacoustics: Simulators of human head and ear…

- ISO/IEC 17025 (2017) – General requirements for the competence and testing and calibration laboratories → in U.S., NVLAP

- ISO/IEC 17043 (2010) – Conformity assessment: General requirements for proficiency testing

Noise-cancelling headset

Bose Yoke	Level (dBA)	Left (dBA)	Right (dBA)	Level (dBC)	Left (dBC)	Right (dBC)	Noise Reduction (dBA)	Noise Reduction (dBC)
Pink Noise	73	60	61	77	59	61	12.5	17
125 Hz	57	37	37	74	45	51	20	26
250 Hz	67	38	38	74	45	51	29	26
500 Hz	74	54	54	77	57	57	20	20
1000 Hz	78	63	67	78	63	67	13	13
2000 Hz	78	65	68	77	64	67	11.5	11.5
4000 Hz	77	72	75	76	71	73	3.5	4
8000 Hz	75	66	60	73	64	59	12	11.5
Pink Noise	83	70	72	87	69	71	12	17
125 Hz	68	39	40	85	52	56	28.5	31
250 Hz	77	39	45	85	52	56	35	31
500 Hz	84	63	63	87	66	67	21	20.5
1000 Hz	88	73	77	88	73	77	13	13
2000 Hz	90	76	79	89	75	78	12.5	12.5
4000 Hz	89	84	87	87	82	85	3.5	3.5
8000 Hz	87	78	72	85	76	70	12	12

Noise reduction from noise cancellation ~10 dB(A) or 17 dB(C)

Measured Levels: iPhone 12/AirPod Pro

Sound_Type	Device	Ear Model	Volume_Level	Level dBA	Level dBC
Pink Noise	iPhone 12	Airpod Pro	1	44.9	49
Pink Noise	iPhone 12	Airpod Pro	2	48	50.9
Pink Noise	iPhone 12	Airpod Pro	3	52.6	54.8
Pink Noise	iPhone 12	Airpod Pro	4	57.7	58.5
Pink Noise	iPhone 12	Airpod Pro	5	62.6	63.2
Pink Noise	iPhone 12	Airpod Pro	6	67	67.7
Pink Noise	iPhone 12	Airpod Pro	7	71.5	72.2
Pink Noise	iPhone 12	Airpod Pro	8	75.5	76.1
Pink Noise	iPhone 12	Airpod Pro	9	79.5	80.1
Pink Noise	iPhone 12	Airpod Pro	10	**83.5**	**84.1**
Pink Noise	iPhone 12	Airpod Pro	11	**87.5**	**88.1**
Pink Noise	iPhone 12	Airpod Pro	12	**91**	**91.6**
Pink Noise	iPhone 12	Airpod Pro	13	**94.5**	**95.1**
Pink Noise	iPhone 12	Airpod Pro	14	**98**	**98.6**
Pink Noise	iPhone 12	Airpod Pro	15	**101.5**	**102.2**
Pink Noise	iPhone 12	Airpod Pro	16	**104.5**	**105.2**

Measured Levels: Samsung S20/Galaxy Buds Pro

Sound_Type	Device	Ear Model	Volume_Level	Level dBA	Level dBC
Pink Noise	Samsung S20	Galaxy Buds Pro	1	49	52.7
Pink Noise	Samsung S20	Galaxy Buds Pro	2	53.8	56.1
Pink Noise	Samsung S20	Galaxy Buds Pro	3	59.5	59.3
Pink Noise	Samsung S20	Galaxy Buds Pro	4	65.5	64.3
Pink Noise	Samsung S20	Galaxy Buds Pro	5	71.4	69.9
Pink Noise	Samsung S20	Galaxy Buds Pro	6	76.4	74.9
Pink Noise	Samsung S20	Galaxy Buds Pro	7	79.3	77.7
Pink Noise	Samsung S20	Galaxy Buds Pro	8	82.3	80.7
Pink Noise	Samsung S20	Galaxy Buds Pro	9	85.3	83.7
Pink Noise	Samsung S20	Galaxy Buds Pro	10	88.3	86.7
Pink Noise	Samsung S20	Galaxy Buds Pro	11	91.2	89.6
Pink Noise	Samsung S20	Galaxy Buds Pro	12	94.2	92.6
Pink Noise	Samsung S20	Galaxy Buds Pro	13	97.2	95.6
Pink Noise	Samsung S20	Galaxy Buds Pro	14	100.3	98.7
Pink Noise	Samsung S20	Galaxy Buds Pro	15	103.5	101.8

Measured Levels: Comparison on same model

Sound_Type	Ear Model	Volume_Level	iPhone 12		Samsung S20	
			Level dBA	Level dBC	Level dBA	Level dBC
Pink Noise	Sony WH1000XM4	1	45.8	52.4	45.3	53.8
Pink Noise	Sony WH1000XM4	2	53.1	55.5	52.4	55.5
Pink Noise	Sony WH1000XM4	3	56.8	58	58.9	60.2
Pink Noise	Sony WH1000XM4	4	62.6	62.9	64.8	65.2
Pink Noise	Sony WH1000XM4	5	68.6	68.7	70.8	70.9
Pink Noise	Sony WH1000XM4	6	74.5	74.7	75.8	75.8
Pink Noise	Sony WH1000XM4	7	78.5	78.6	79.8	79.7
Pink Noise	Sony WH1000XM4	8	82.5	82.6	83.8	83.8
Pink Noise	Sony WH1000XM4	9	86.5	86.7	87.8	87.7
Pink Noise	Sony WH1000XM4	10	90.5	90.6	91.8	91.8
Pink Noise	Sony WH1000XM4	11	93.5	93.6	93.8	93.8
Pink Noise	Sony WH1000XM4	12	94.5	94.6	95.8	95.8
Pink Noise	Sony WH1000XM4	13	96.5	96.6	97.8	97.7
Pink Noise	Sony WH1000XM4	14	98.5	98.6	98.8	99.7
Pink Noise	Sony WH1000XM4	15	100.5	100.6	101.8	101.7
Pink Noise	Sony WH1000XM4	16	102.5	103.3		
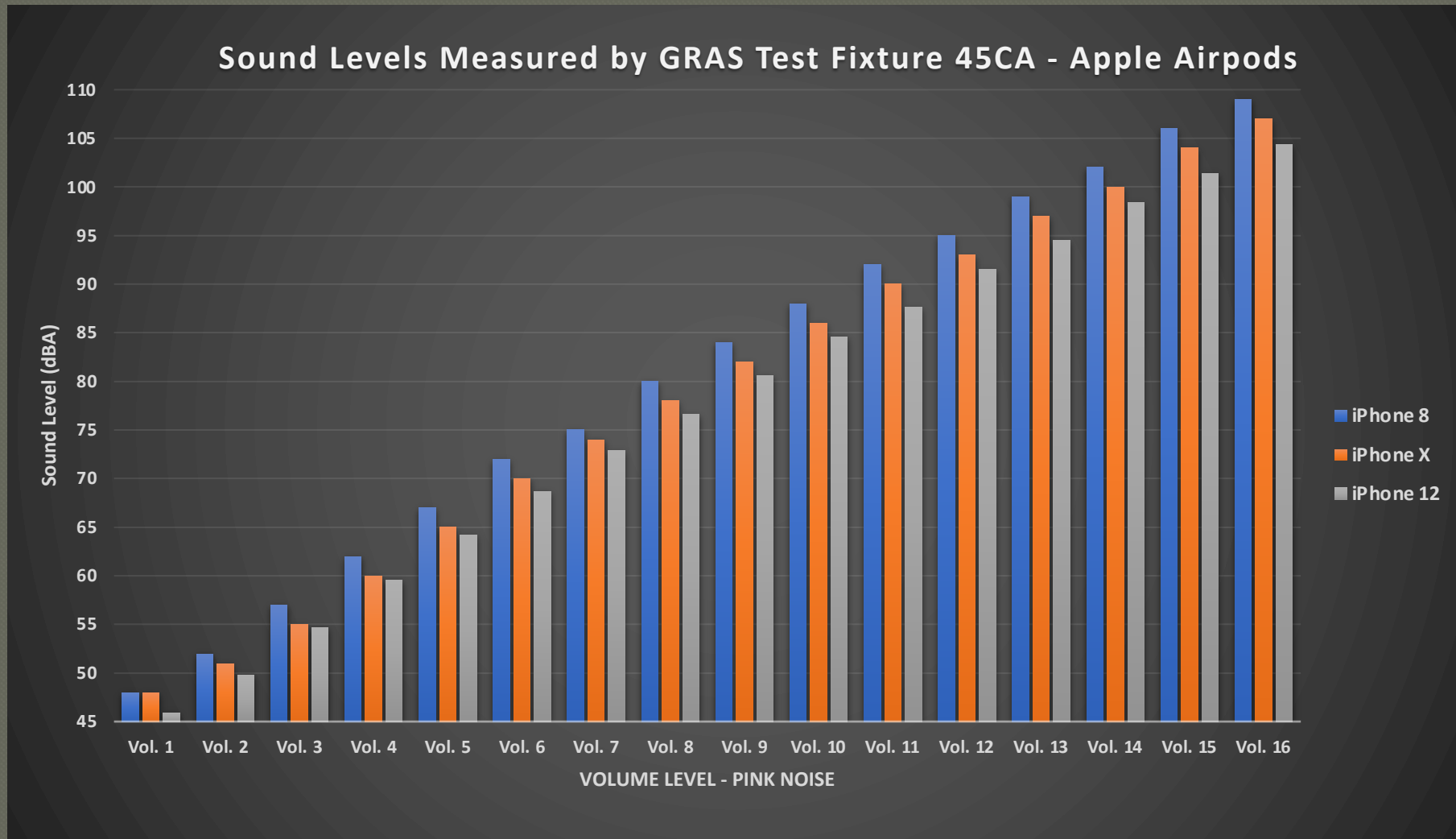
Headphones Comparison

Sound Levels Measured by GRAS Test Fixture 45CA - iPhone 12
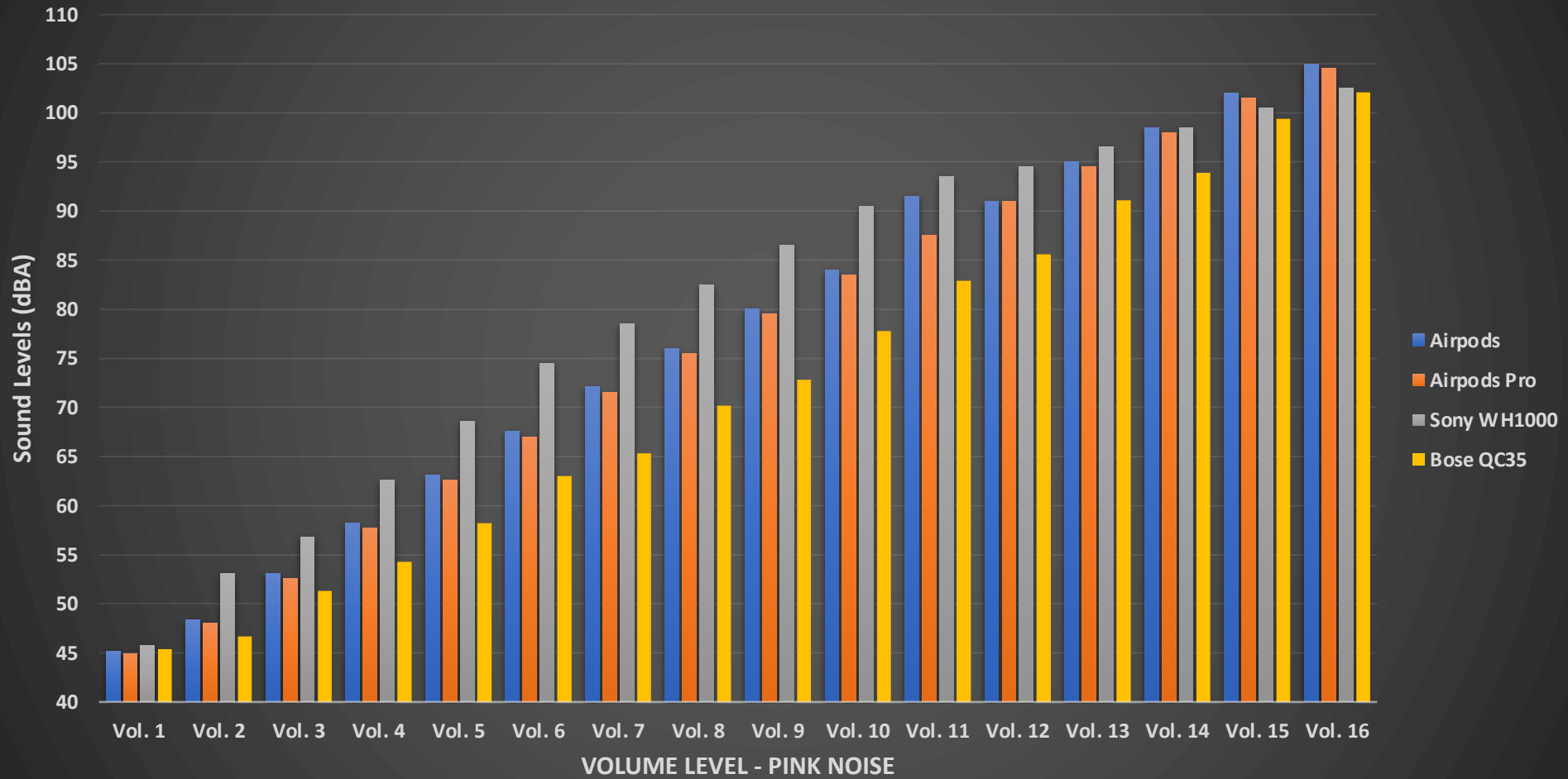
Conclusions

- To ensure success, conformity Assessment must be:

  - **Repeatable**: Different testers, following the same procedures and test methodology, should be able to get the same results on the same platform.

  - **Efficient**: Minimize costs burden on participants. Test tools must be optimized to maximize automation and minimize human intervention.

  - **Effective**: Must test the critical areas required by the specification or standard and provide the desired level of assurance for its customer base.

Thank you

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