



H.870 update and overview

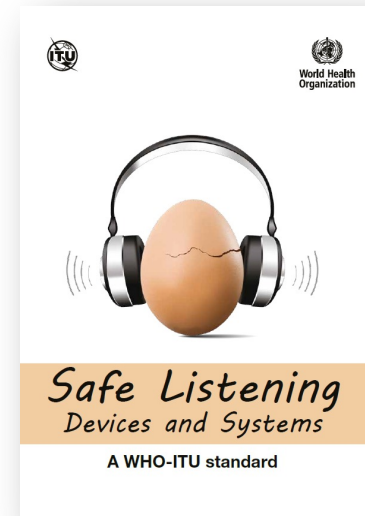
ITU

ITU-T Study Group 16

- ICT standardization sector of International Telecommunication Union
- Lead group for multimedia such as audio, video etc.
 - Well-known standards such as H.264 and H.265 (HEVC)
- E-health, digital health and telemedicine are important areas where multimedia and ICT can contribute (Question 28 is tasked with the work)
- Close collaboration with WHO
 - Focus Group on AI for Health
 - Joint work on “Make Listening Safe” Initiative
- As the oldest international organization, ITU provides a forum for discussion among private sectors, governments and UN agencies

A WHO-ITU standard

- ITU: “*Recommendation ITU-T H.870 (2018-08), Guidelines for safe listening devices/systems*”
- WHO publication: “*Safe listening devices and systems*”
 - **Free** publication
- It has the same level as ISO and IEC *de juris* standards



WHO/ITU H.870: Scope

- describes the requirements on safe listening devices and systems, especially those for playing music, to protect people from hearing loss.
- Version 2 has expanded its scope to include wireless head-sets
- For the purposes of this Recommendation, the following types of devices are excluded:
 - – two-way communication devices (such as walkie-talkies, etc.);
 - – rehabilitative and medical devices (e.g., hearing aids, FM systems and other assistive listening devices (ALD) approved as part of hearing aid and cochlear implant systems, etc.);
 - – personal sound amplification devices;
 - – professional audio equipment and devices.
- NOTE – There has been discussion on the exposure to sound from e-gaming

Personal Audio System



Personal Audio System (H.870v2)



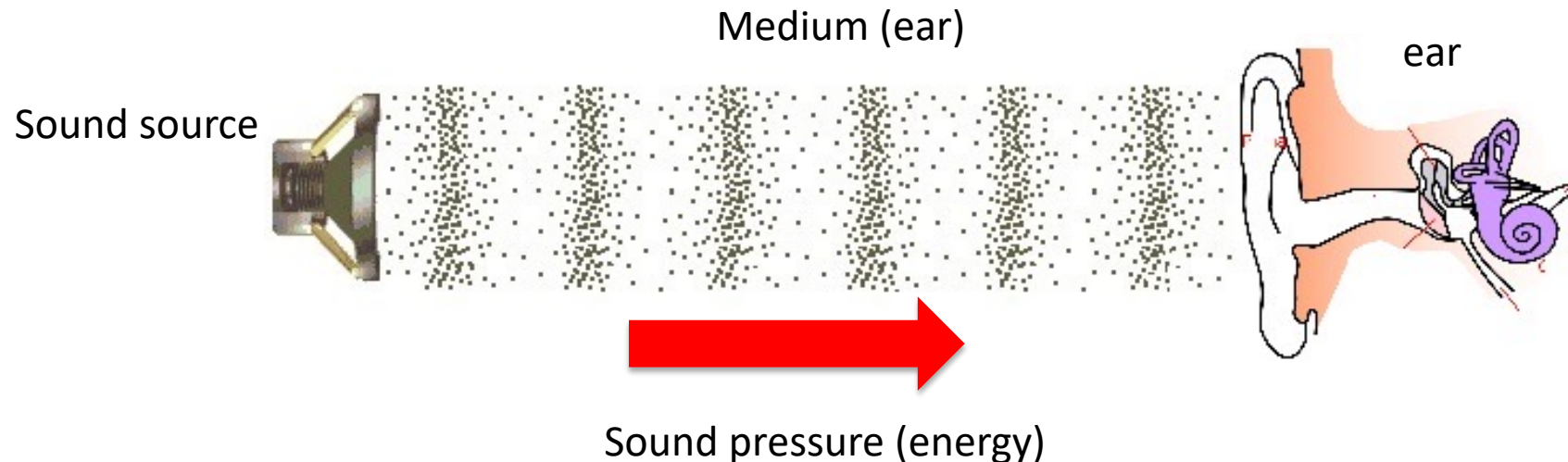
What's in WHO / ITU H.870?

- Introducing “**equal energy principle**” and **dosimetry**
- A new unit of sound exposure **Pa²h** (*pascal squared hour*)
- Recommending **2 modes of Safety levels**
- Guidance on **health communication** on personal audio devices
 - General information (how to listen safely, risk awareness, etc.)
 - General usage reporting (average levels, how much listening in a day & week)
 - Types of **warnings** when user reaches 100% of weekly allowance
- Gives **further guidance**: ambient noise control (e.g. noise cancelling) & parental control

Equal Energy Principle and Dosimetry

Basics: Sound

- Sound is propagation of energy (pressure) through medium (e.g., air), received by ear.
- Sound energy and pressure are usually associated with “loudness”
- Excessive energy (pressure), i.e., loud sound, received by ear can result in hearing damage
- Air pressure is commonly expressed in Pa (*Pascal*).
 - E.g., Hurricane Katrina in 2005 had 902 hPa (hectopascal) or 90,200 Pa
 - 2,600 Pa is the pressure to make water boil at room temperature



Definitions of decibel

- Conventionally, sound energy is expressed in terms of decibels
- There are many definitions of (different types of) “decibel” (dB), which makes things a bit confusing
 - **dB** - a relative logarithmic value used to express the ratio of one value of to another
 - **dB SPL** (Sound Pressure Level): the ratio of given sound pressure and a reference pressure, $20\mu\text{Pa}$ (minimal pressure that a human ear can detect at 1kHz).

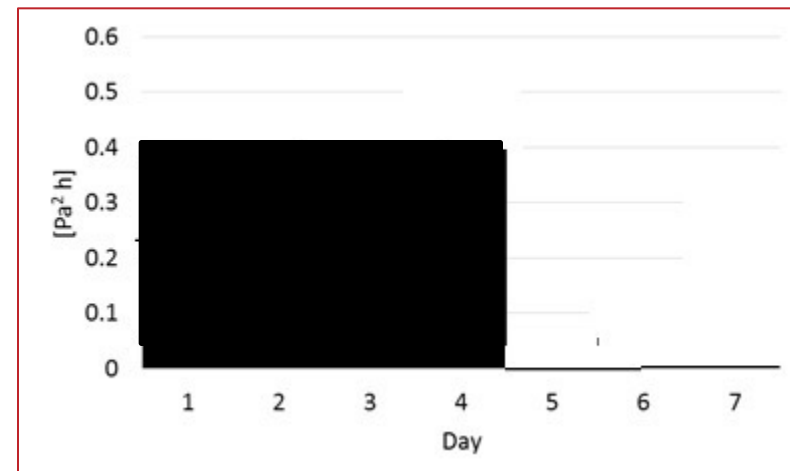
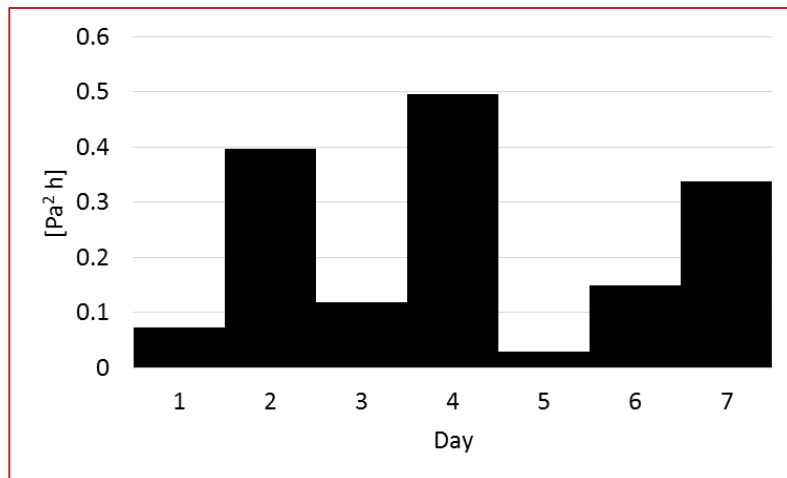
Important to note that it is not a simple linear absolute value

Decibels and Pressure

- Human ear is extremely sensitive
- Sound pressure expressed in Pa (*Pascal*) makes it easier to appreciate this fact
 - 0 dB (SPL) = 0.00002 (=20 x 10⁻⁶) Pa
 - 20 dB (SPL) = 0.0002 Pa
 - 40 dB (SPL) = 0.002 Pa
 - 60 dB (SPL) = 0.02 Pa
 - 80 dB (SPL) = 0.2 Pa
 - 94 dB (SPL) ≅ 1 Pa
 - (Pressure exerted by a US dollar bill resting flat on a surface)
 - 100 dB (SPL) = 2 Pa
 - 140 dB (SPL) = 200 Pa = 10⁷ (10 million) times the threshold of sound/hearing (10 thousand times more pressure than ordinary conversation)

Equal Energy Principle

- The premise that equal amounts of sound energy will cause equal amounts of sound induced hearing loss regardless of the distribution of the energy across time.
- I.e., the total effect of sound is proportional to the total amount of sound energy received by the ear, irrespective of the distribution of that energy in time
- “Less energy for longer period of time” “More energy for shorter period of time” Can have the same effect on ear



Dosimetry

- Based on the Equal Energy Principle, a 'dose' of sound energy is defined as the squared A-weighted sound pressure, p_A , integrated over the exposure time $T=t_2-t_1$.
- $$dose = \int_{t_1}^{t_2} (p_A(t))^2 dt$$
- Simply put, “dose” is (the energy of) Sound Pressure Level integrated over the duration of the exposure:
- Unit is Pa²h (pascal squared hour)
 - Use L_{EQ} and dB (SPL)A for reference
- This is line with other sound dose management standards:

IEC 62368-1:2018 and EN 50332-3:2017

Relationship between dB(A) and Dosage

Mode1

dB(A)	Weekly (1.6 Pa ² h)
107	4.5 min
104	9.5 min
101	19 min
98	37.5 min
95	75 min
92	2.5 h
89	5 h
86	10 h
83	20 h
80	40 h

Mode2

dB(A)	Weekly (0.51 Pa ² h)
107	1.5 min
104	3 min
101	6 min
98	12 min
95	24 min
92	48 min
89	1 h 36 min
86	3 h 15 min
83	6 h 24 min
80	12 h 30 min
77	25 h
75	40 h

Acceptable levels of risk for Safe-listening

- It is recommended that PAS includes a system (dosimeter) that tracks the user's exposure time and estimates sound level and the percentage that has been used up of a reference exposure limit (sound allowance).
- References are as follows:
 - **Mode 1: (WHO) standard level for adults: this will apply 1.6 Pa²h per 7 days as the reference exposure.**
 - **Suited for general public**
 - **– Mode 2: (WHO) standard level for sensitive users (e.g., children): this will apply 0.51 Pa²h per 7 days as the reference exposure.**
 - **Suited for children and other sensitive individuals**

Other features of H.870

Guidance on **how to communicate** with users of personal audio devices

- Keep record of usage information and provide personalized recommendations & cues
- General information (how to listen safely, risk awareness, etc.)
- General usage reporting (average levels, how much listening in a day & week)
- Types of warnings when user reaches 100% of weekly allowance

Gives **further guidance**: ambient noise control (e.g. noise cancelling) & parental control

Importance of Health Communication

- How to convey the message to the user
- What message to be conveyed:
 - *Risk information*, i.e. information about behaviours (and sounds) that put users at risk of hearing loss
 - *Usage information*, i.e. a personal listening profile and risk information (for example, through a dosimeter to check their decibel levels and sound-dose details)
 - *Concrete recommendations*, i.e. instructions on how to practice safe listening (for example, in the form of cues for action)

Adoption of H.870

- Available in 5 languages
- Already implemented by some manufacturers worldwide
 - Dosimeters are implemented by several organizations
- Referenced by other standards and specifications globally
 - Other specifications for e.g., PSAPs (personal sound amplifying products) are referencing H.870 and adopt some of its recommendations
- Strongly promoted by World Hearing Forum (WHF)
 - Involving the music industry and device manufactures to promote the standard as well as “Make Listening Safe” initiative

Some topics for future study in H.870

- Gaming devices
- VR/AR/MR/XR
- Sensitivity range and frequency response of headphones
- Profiles for different categories of PAS
- Uncertainties in dose estimation
- ...



Conformance Testing Specification for WHO-ITU Standard H.870

- HSTP.Conf-H870 “Conformance Specification for H.870” is drafted to provide a set of conformance testing requirements of H.870
- A “check-list” for implementation
- It accompanies H.870 to comprise a “Conformance Test Tool”
- **Call for “testing labs” is under way**

Further Related Work



Personal sound amplification products

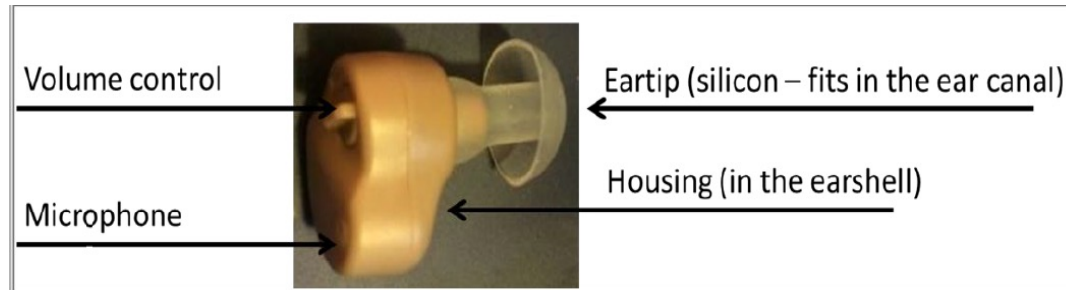
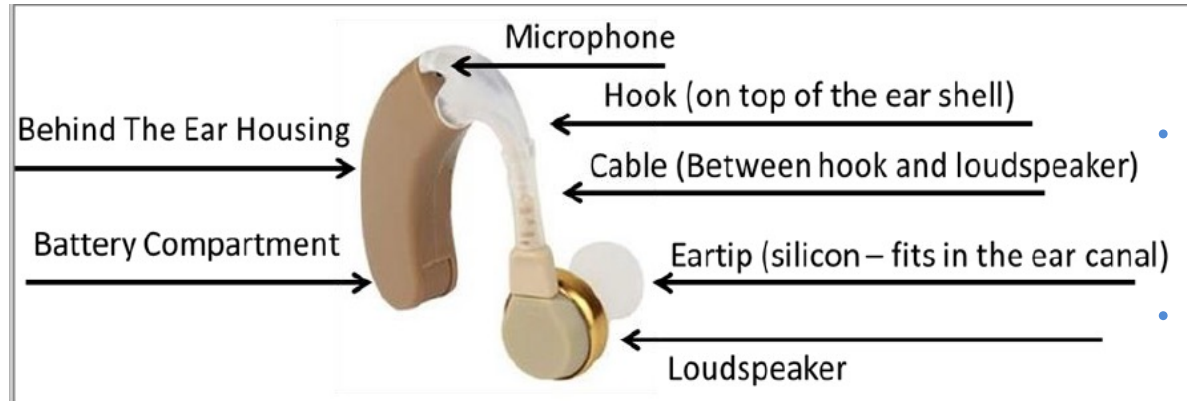
- Wearable electronic products or application on a wearable smart device (e.g. a mobile phone) that is **not** intended to compensate for impaired hearing, but rather is intended for non-hearing impaired consumers to amplify sounds in the environment for a number of reasons, e.g.
 - Recreational activities
 - Selective hearing in noisy environments
- **PSAPs** are off-the-shelf, non-regulated devices with a varying range of features
- Currently there are no international standards on the safety of PSAPs
 - Levels, exposure
- ITU-T's Recommendation [F.781](#) "*Safety requirements for personal sound amplifiers*" is the first technical standard to address this issue, approved in July 2019
 - Project leaders: European Federation of the Hard of Hearing (EFHOH), European Association of Hearing Aid Professionals (AEA).
- Based on the same principle as ITU / WHO H.870
- Conformance testing specification under development

Standard on Personal Sound Amplifier

- Personal Sound Amplifier is a wearable electronic product (PSAP) or application on a wearable smart device (PSAA) that is not intended to compensate for impaired hearing, but rather is intended for non-hearing impaired consumers to amplify sounds in the environment for a number of reasons, such as for recreational activities.
- Currently there is no International standard on the safety (volume, etc.) of PSAs
- ITU-T's new draft Recommendation is to address this issue
- Proposed and drafted by European Federation of the Hard of Hearing (EFHOH) and the European Association of Hearing Aid Professionals (AEA).
- Based on the same principle as H.870



Personal Sound Amplifier



- PSA looks like a hearing aid, a **medical device**
- PSAs are not intended to be used for persons with hearing problems
- PSAs are readily available in the market, priced from around \$10 USD up to \$400 USD.
- Some people, indifferent to the difference, sometimes led to using PSAs in place of hearing aids to compensate their hearing
- This is a very dangerous situation

PSA on a smartphone



- Recently more and more audio enhancing apps are available in the market.
- This situation is becoming more like that PAS (though the user base is much smaller)

New work Item on Guidance for safe listening venues

Sound levels and acoustics

Rest zones

Earplugs

Information and announcements

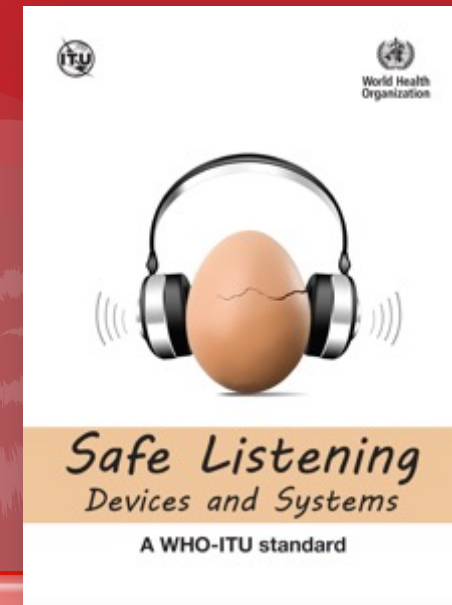
- WHO created a global standard for recreational sound in entertainment venues
 - Different components are identified (e.g. type of venues, sound limits, quiet spaces, hearing protection, warning messages and monitoring)
 - WHO will explore on identification of information needs, collection of existing evidence and collaboration with experts towards development of guidelines for sound exposure in recreational venues
- ITU has decided to create a Technical Paper based on the new WHO standard

Future Work

- Discussion on H.870-V3
- Conformance Testing Spec. H.870-V2
- Conformance Testing Spec. H.871
- Work Item on E-gaming
- Technical Paper on new devices
- Other environments for safe-listening.
- ...

- Thank you!!

WHO-ITU global standard for safe listening devices, 2019



Monitor and display

- Volume levels (in dB)
- Time spent listening
- Use of sound allowance

Offer volume limiting options

- Automatic volume reduction
- Password-protected volume control

Inform

- Regarding personal sound use
- Give personalized warnings, messages and cues for action