Safe listening standards for personal audio systems

Masahito Kawamori

Keio University

ITU-T SG16 Q28 (e-health) Rapporteur/

Keio University, Japan

WHO and ITU on Safe Listening


World Health Organization

centre Publications Countries Programmes Governance About WHO

Prevention of blindness and deafness

WHO-ITU Joint Stakeholders' Consultation on Safe Listening Devices

Geneva, Switzerland, 1 October 2015

Participation in the WHO-ITU Joint Stakeholder's Consultation on Safe Listening Devices is limited. If you wish to participate, please complete the form below and submit it before Thursday, **10 September 2015**. Owing to space restrictions, registration will be on a first-come, first-served basis. You will receive a confirmation e-mail once your registration has been processed.

For further information, please send an email to chadhas@who.int.

If you require a visa to enter Switzerland, please provide your passport information to cartilli

- WHO and ITU organized their first Joint Stakeholders' Consultation on Safe Listening Devices on 1 October 2015
- Based on the discussion, a new draft Recommendation F.SLD "Guidelines for safe listening devices/systems" was initiated at ITU-T Q28/16

Keio University
1858
CALAMVS GLADIO FORTIOR

ITU-T Rec. F.SLD:
"Guidelines for safe listening devices/systems

- Scope is for "Personal Audio System (PAS)"
- Following are excluded from the scope:
  - Communication devices (walkie-talkies, etc.)
  - Rehabilitative and medical devices (e.g. hearing aids, FM systems, and other assistive listening devices (ALD) approved as part of hearing aids and cochlear implants systems, etc.)
  - Personal sound amplification devices/products (PSAP)
  - Professional audio equipment and devices

Personal Audio System

Personal Audio Device

Listening Device

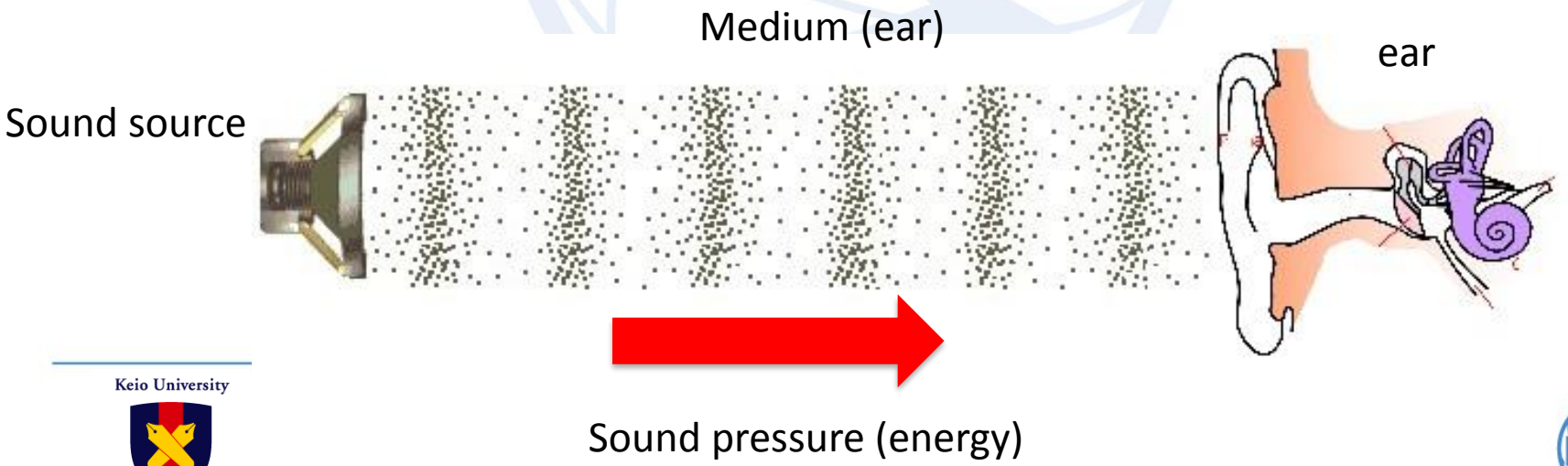
Keio University
1858
CALAMVS GLADIO FORTIOR

Focus

- The primary focus is on dosimetry (documenting listening level over listening time), with an upper ceiling to protect against acoustic trauma (the mechanical injury to the basilar membrane in the cochlea from a sound pressure that is extremely high and capable of exceeding the tissue's elastic limit).
- Healthcare communication an important aspect as well

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

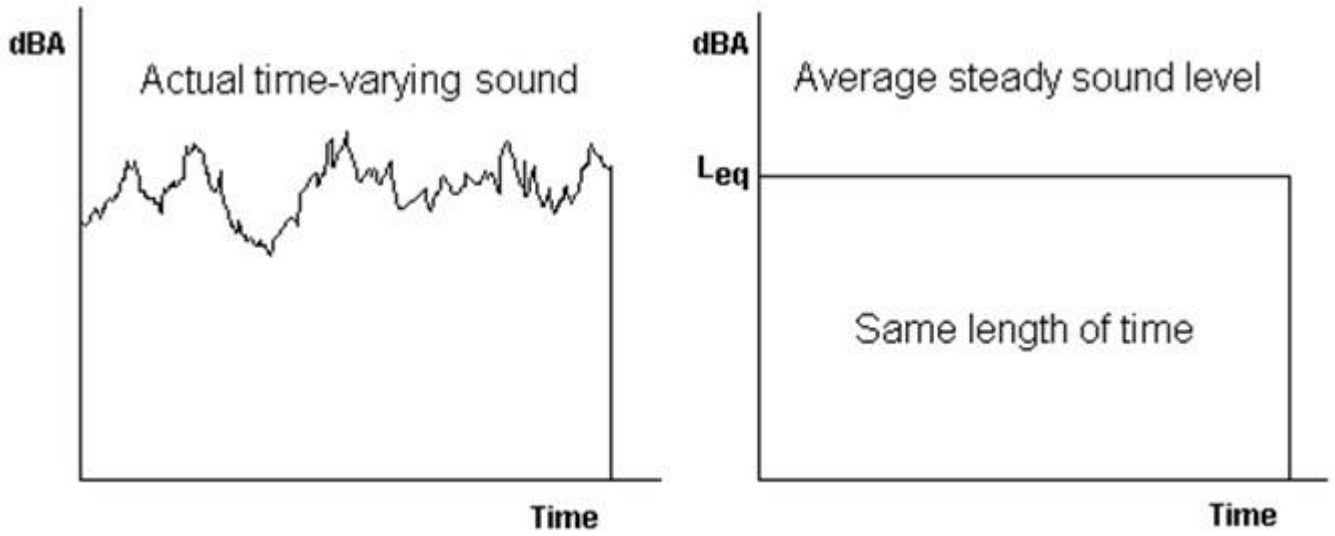
- Conventionally, sound energy is expressed in terms of decibels
- There are many definitions of “decibel” (dB), which makes things a bit confusing
- **dB** - a relative logarithmic value used to express the ratio of one value of to another
- **dB SPL** (Sound Pressure Level): the ratio of given sound pressure and a reference pressure, 20µPa (minimal pressure that a human ear can detect at 1kHz).
  - Important to note that it is not a simple absolute value

Decibels and Pressure

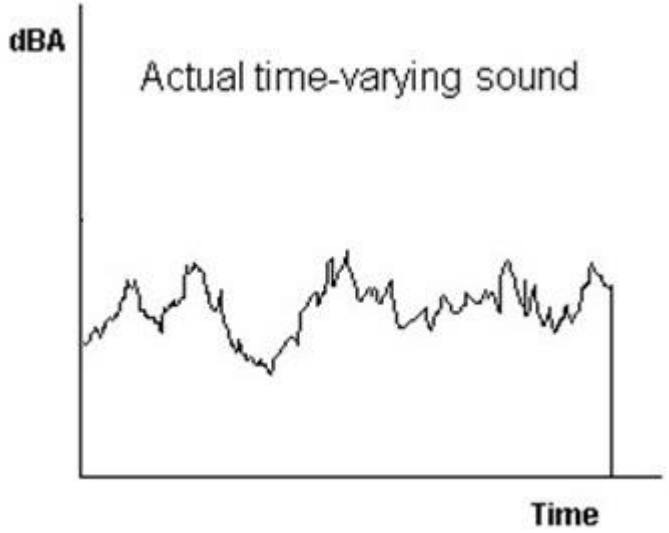
- Human ear is extremely sensitive
- Sound pressure expressed in Pa (*Pascal*) makes it easier to appreciate this fact
  - 0 dB (SPL) = 0.00002 (=20 x 10^{-6}) Pa
  - 20 dB (SPL) = 0.0002 Pa
  - 40 dB (SPL) = 0.002 Pa
  - 60 dB (SPL) = 0.02 Pa
  - 80 dB (SPL) = 0.2 Pa
  - 94 dB (SPL) ≒ 1 Pa
    - (Pressure exerted by a US dollar bill resting flat on a surface)
  - 100 dB (SPL) = 2 Pa
  - 140 dB (SPL) = 200 Pa = 10^7 (10 million) times the threshold of sound/hearing
    - (10 thousand times more pressure than ordinary conversation)

Equal Energy Principle

- hypothesis that states that 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
- i.e., equal amounts of sound energy will cause equal amounts of sound induced hearing loss regardless of the distribution of the energy across time.

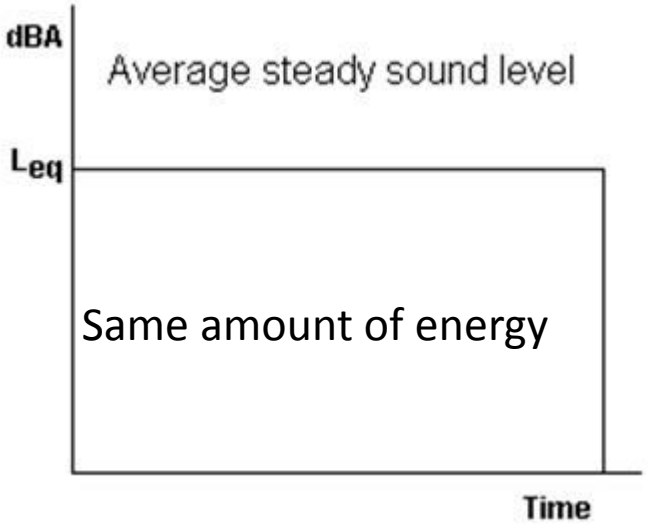


Equal Energy Principle (cont.)



- 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 in hearing impairment risk assessment
- Simply put, “dose” is (the energy of) Sound Pressure Level integrated over the duration of the exposure
- Unit is Pa^2h (*pascal squared hour*)
  - Use L_{EQ} and dB (SPL)A for reference
- Comparable to L_{EQ} used in occupational setting to measure occupational noise exposure

Sound Dose

- Definition
  - $SPL = 20 \log_{10}\left(\frac{p}{20\mu \mathrm{Pa}}\right)$
  - $dose = \int_{t1}^{t2} (p_A(t))^2 dt$
- E.g.: *Dose of listening to sound with 80 dB(SPL) for 40 hours*
  - SPL is by definition $80 = 20 \log_{10}\left(\frac{p}{20\mu \mathrm{Pa}}\right)$
  - Sound pressure is, by definition of **log:**

$$p = 10^{\frac{80}{20}} \cdot \frac{20\mu Pa}{1Pa} = 0.2 \text{ Pa}$$

  - By definition of dose above, $0.2^2 \cdot 40 = \mathbf{1.6\ Pa^2 h}$

Acceptable levels of risk

- Moderate: 40 hours for 80 dB SPL*) (in a week)
  - 1.6 $\mathrm{Pa}^2 h$
- Strict: 40 hours for 75dB SPL*) (in a week)
  - 0.51 $\mathrm{Pa}^2 h$

This is a stricter requirement for, e.g. children, as compared to adults

*) *Strictly speaking, the dB SPL is "A-weighted", but in this presentation, it is kept put as simply SPL, because the Pa²h is the primary unit used.*

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)

Further Topics under discussion

- Confidence level of dosimetry
- Consideration of implementing dosimeter
- Ambient noise control (active noise reduction, passive sound isolation, or both)
- User interface for healthcare information
- Controls for parents, options for users

Related Standards

- **[CENELEC] EN 50332-3: – Sound system equipment: Headphones and earphones associated with personal music players (PMPs) – Maximum sound pressure level measurement methodology**
- IEC/EN 60065:2014: Audio, video and similar electronic apparatus - Safety requirements
- IEC/EN 62368-1:2014 – Audio/video, information and communication equipment – Part 1: Safety requirements
- ISO 11904 Acoustics – Determination of sound immission from sound sources placed close to the ear
- ITU-T P.311 (03/2011) Transmission characteristics for wideband digital handset and headset telephones
- ITU-T P.380 (11/2003)– Electroacoustic measurements on headsets
- ITU-T P.381 (02/2014) – Technical requirements and test methods for the universal wired headset or headphone interface of digital mobile terminals
- ITU-R BS.1770-4 (10/2015) - Algorithms to measure audio programme loudness and true-peak audio level

Next steps

- Discussion with experts planned for 30 April 2018.
- It will be proposed for Consent at ITU-T SG16 meeting in July 2018
- Standards under development currently will be based on current knowledge. These will have the possibility of revision should the risk criteria change in future.

For more info.

If you are interested,

- Please visit ITU-T SG16 website:
  - http://www.itu.int/en/ITU-T/e-health
- Or contact:
  - tsbsg16@itu.int

Thank you

Keio University
1858
CALAMVS GLADIO FORTIOR