

**An update on the work of the ICNIRP project group
on developing exposure guidelines for Ultrasound**

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Project group members

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Why ultrasound?

ICNIRP Charter definition

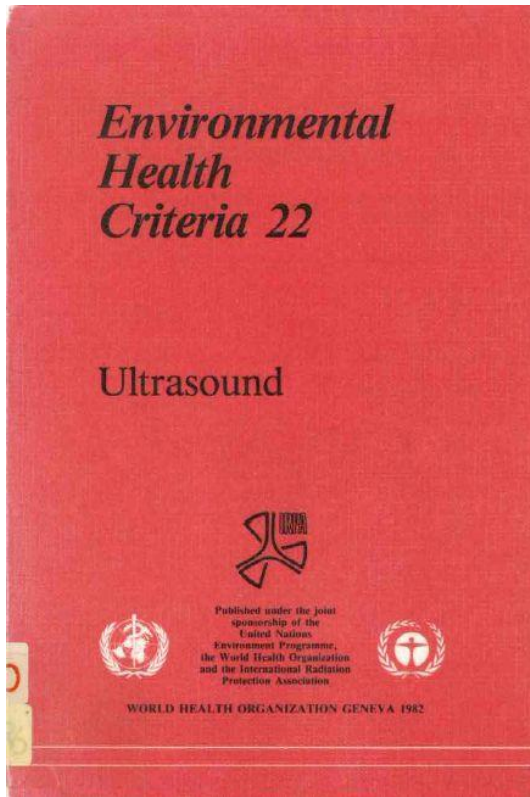
Non-Ionizing Radiations (NIR) include:

- (i) electromagnetic radiations and fields having wavelengths of 100 nanometres or greater, or frequencies from 0 - 3 PHz ($0 - 3 \cdot 10^{15}$ Hz) and include static electric and magnetic fields, extremely low frequency fields, radiofrequency fields (including microwaves), infrared, visible and ultraviolet radiation,
- (ii) acoustic fields with frequencies above 20 kHz (ultrasound) and with frequencies below 20 Hz (infrasound).

Radiation protection is a general term which includes all appropriate measures to protect the health of workers, patients, general public, and the environment from potentially adverse effects of exposure to NIR.

Approximate hearing ranges

	Low frequency (Hz)	High frequency (kHz)
Elephants	16	12
Humans	20	20
Cats	100	32
Horse	31	40
Dogs	40	46
Rodents	1000	100
Bats	1000	150
Whales, dolphins	70	150



WHO, 1982



**INTERIM GUIDELINES ON LIMITS OF HUMAN
EXPOSURE TO AIRBORNE ULTRASOUND**

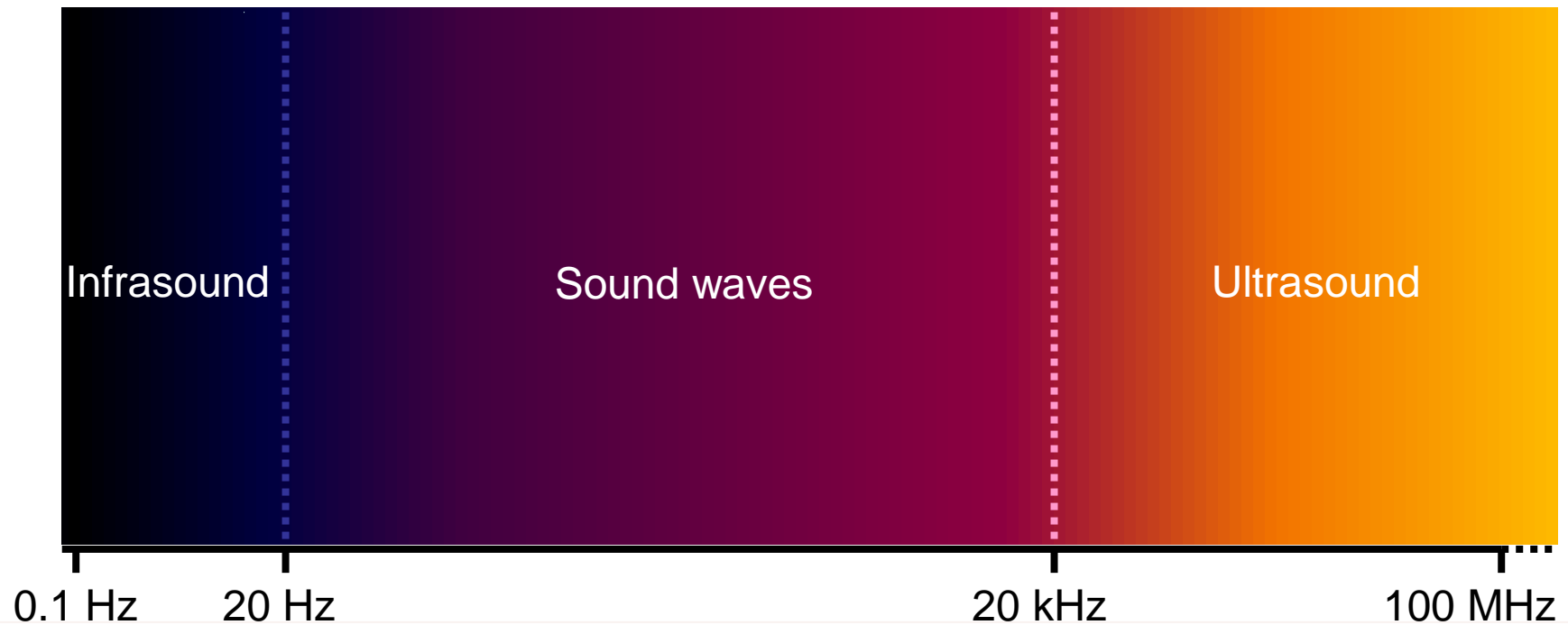
**International Non-Ionizing Radiation Committee of the International Radiation Protection
Association**

Health Physics, 1984

INIRC Guidelines for exposure to airborne ultrasound

Mid frequency of one-third octave band (kHz)	Exposure limits set to avoid effects on hearing and on subjective symptoms		Exposure duration (h)	Correction to SPL (dB)
	Public	Occupational		
20	70	75		
25	100	110		
31.3	100	110		
40	100	110		
50	100	110		
63	100	110	0-1	+9
80	100	110	1-2	+6
100	100	110	2-4	+3

Frequency bands for acoustic waves



Some uses of Ultrasound

Medical

Diagnostic

Obstetric

Abdominal, pelvic, cardiac

Therapeutic

Physiotherapy

Kidney stone destruction

Tumour ablation (HIFU)

Sonoporation (drug delivery)

Industrial

Non-contact sensors, non-destructive testing

Cleaning

Cutting and welding

Cleaning, water and soil remediation

Consumer

Range finders and movement detectors

Pest repellents

Cleaning

Cosmetic and non-medical

Natural

Echolocation

Established mechanisms of interaction

Coupling important

skin reflects airborne ultrasound

propagation in air is less than 1mm above 300 kHz

Thermal effects

heating (Thermal Index, TI)

Mechanical effects

acoustic cavitation (gas bubbles in liquids)

non inertial

inertial (Mechanical Index, MI)

radiation pressure

acoustic streaming (in liquids)

Progress to date

Definition and coverage

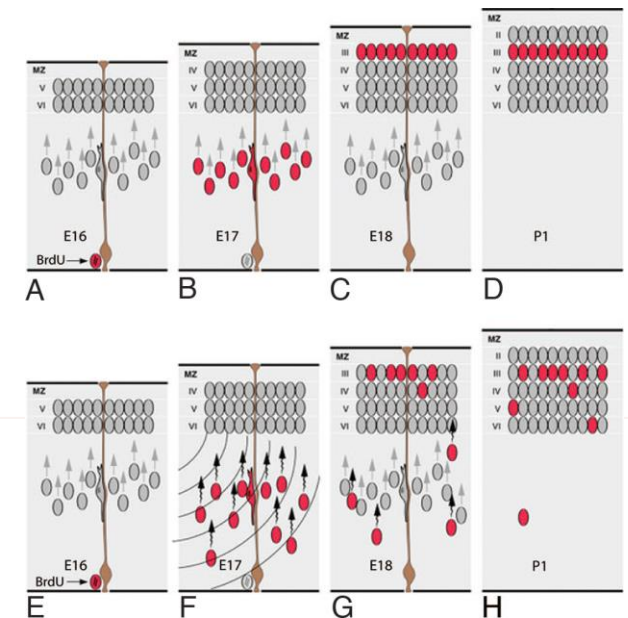
- not include Mosquito-like devices
- 3 distinct bands to differentiate ultrasound

Band name	Frequency range	Main physical interaction	Main biophysical response	Quantitative definitions
HFS	15-20 kHz	Vibration	Hearing	Hearing threshold
US(A)	20 -100 kHz	Acoustic cavitation	Mechanical strain	Rayleigh-Plesset
US(B)	100 kHz - 100 MHz	Visco-thermal absorption	Heating	Acoustic dose (J/kg)
US(C)	>100 MHz	Scatter ?	N/A	Rayleigh scatter

Progress to date

Use pre-existing reviews

- many areas well researched
- others less so
 - effects of public exposure to airborne ultrasound
 - possible changes on prenatal neuronal migration (one 2006 study in mice)



Next steps

Update work in reviews

Try to identify thresholds for adverse effects for all types of exposures

Be aware of developments in airborne exposure/measurements/effects

Synthesise into draft guideline document, for public consultation in late 2017

Thank you for your attention

Any (simple) questions?