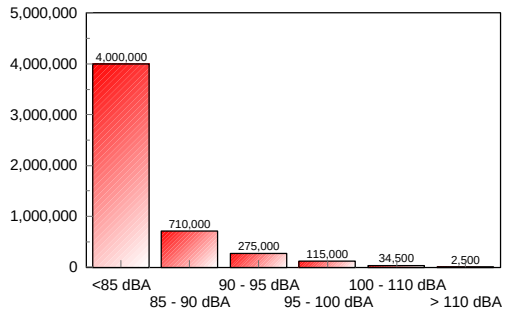
Occupational Hygiene - Physical Agents

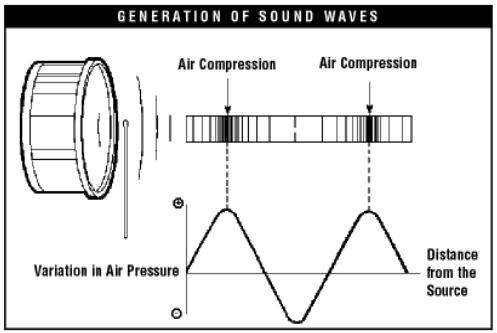
Mike Slater

Noise - Health Effects

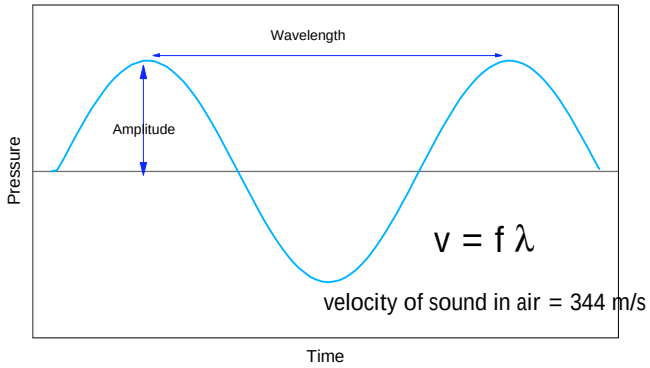
- Temporary threshold shift
- Noise induced hearing loss
- Noise trauma
- Disturbance / interference

Number of people exposed to noise at work (HSE 1996)

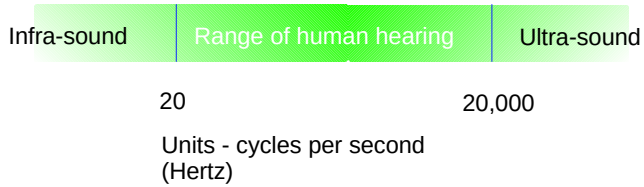




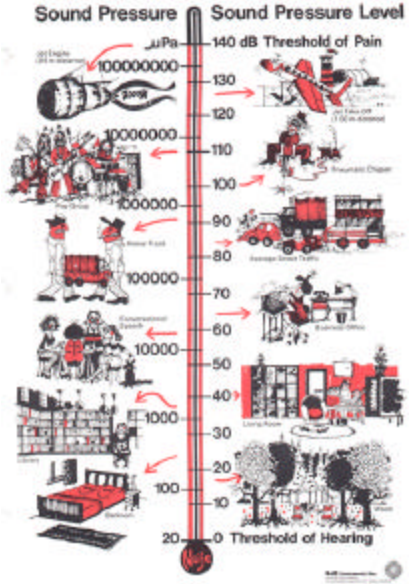
Sound Wave



Frequency



Speech frequencies - 500 Hz to 3 kHz

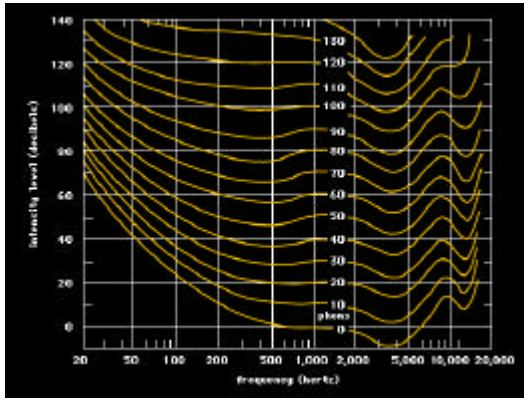


Decibels

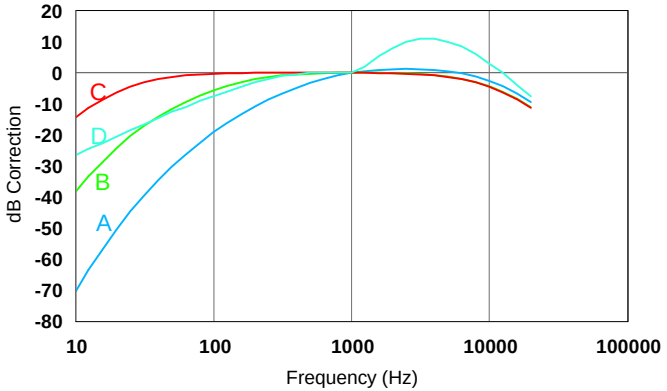
Intensity α (pressure)^2

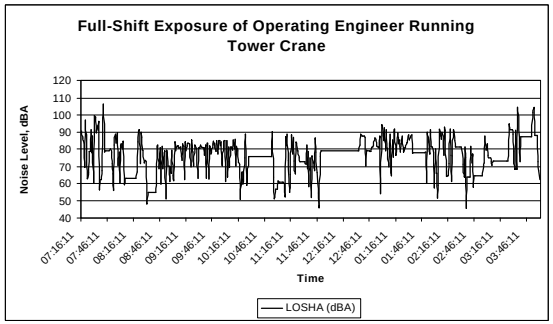
$$dB = 20 \log \frac{P_1}{P_{ref.}}$$

Frequency Response of Ear



Noise Weighting Curves

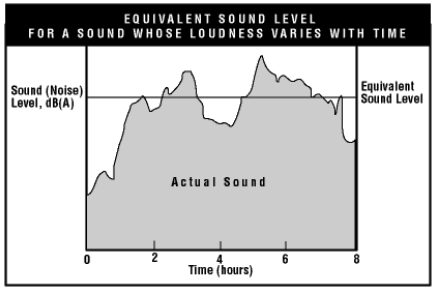




Leq - Continuous Equivalent Sound Level

That continuous sound level over a given period of time which has the same energy content as the actual, varying, noise experienced

$$L_{Aeq,Te} = 10 \log_{10} \left\{ \frac{1}{T_e} \int_0^{T_e} \left[\frac{p_A(t)}{p_0} \right]^2 dt \right\}$$



Equal Energy Principle

- Equal amounts of A weighted sound energy are equally damaging
- If noise level increases by 3 dB, exposure time must be halved

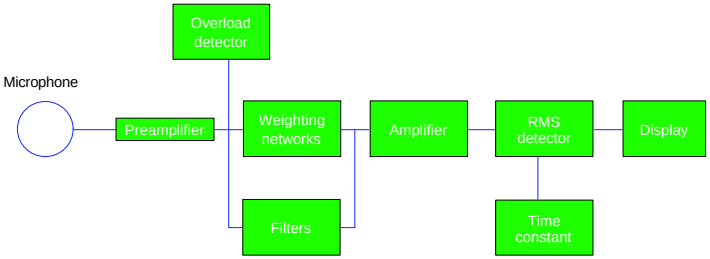
Noise Action Levels

- First Action Level
  - $L_{EP,d}$ of 85 dB(A)
- Second Action Level
  - $L_{EP,d}$ of 90 dB(A)
- Peak Action Level
  - 200 Pa
  - equivalent to 140 dB

Noise Measurement

- Sound level meters
- Integrating sound level meters
- Octave filter sets
- Dosimeters
- Calibrators

Sound Level Meter



Sound Level Meters

Type	Application	Accuracy at reference conditions	Probable typical accuracy
0	Laboratory	± 0.4	± 0.5
1	Laboratory/Field	± 0.7	± 1.0
2	General Field	± 1.0	± 1.5
3	Field Survey	± 1.5	± 3.0

Detector Response

- Fast - 125 milliseconds
- Slow - 1 second
- Digital displays
  - indicate maximum rms value measured within previous second

Frequency Analysis

- Octave band analysis
- Breaks down noise spectrum into defined "chunks"
- An octave
  - higest frequency double lowest
  - described by centre frequency (c)
  - range $c/\sqrt{2}$ to $c\sqrt{2}$

Frequency Analysis

- Octave band analysis
- Third octaves
  - smaller "chunks"
  - 3 per octave
- Narrow band
  - sound pressure level in each narrow bands

Dosimetry

- Measure personal exposures
- Affected by body reflections
- Accuracy -1 to +2 dB
- Mount on edge of shoulder
- Ensure 3dB exchange rate

Calibration

- Calibrator types
  - electronic
  - pistonphone
- Use calibrator before and after survey
- Full calibration every 2 years

Noise Surveys

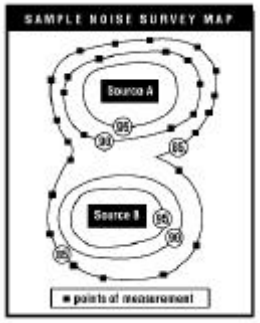
Approach taken depends on:

- Objective
- Noise variability
- Working pattern

Noise Surveys

- Walkthrough survey
- "Noise mapping"
- Leq measurements at workstations
- Octave band analysis
  - ear defender selection
- Dosimetry
  - where exposures variable

Noise Mapping



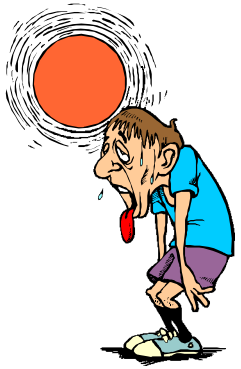
Impulse Noise

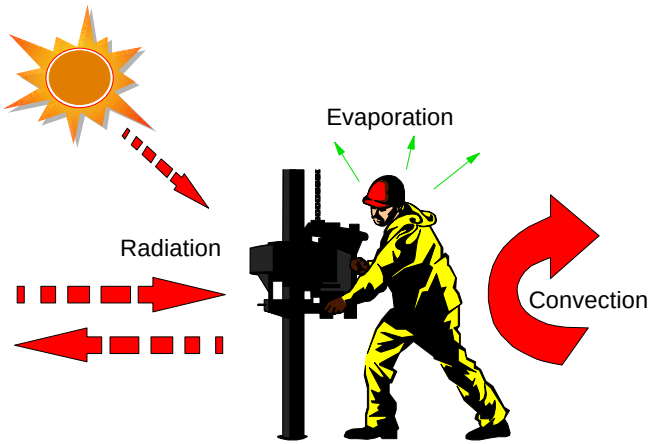
- Difficult to measure!
- Instrumentation
  - type 1 meter
  - C weighting
  - fast response
  - peak hold
- Accuracy $\pm$ 6 dB

Noise Assessments

- Determine employee daily noise doses
- Define hearing protection zones
- Information on
  - noise sources
  - frequency characterisitics
- Advise on control measures
- Advise on other measures

Heat Stress





Harmful Effects

- Heat Rash (Prickly heat)
- Heat cramps
- Fainting
- Heat exhaustion
- Heat stroke

Increased Risk

- Personnel wearing impervious clothing
- Alcohol
- Medication / drugs
- Obesity
- Poor physical fitness

Acclimatisation

- Physiological adaption to heat
- Results in :
  - increased sweat rate
  - reduced skin temperature
  - reduced core temperature

Evaluation of Heat Stress

- Environmental Factors
  - air temperature
  - radiant heat
  - humidity
  - air velocity
- Human Factors
  - work rate
  - clothing
  - fitness / susceptibility

Measurement

- Air temperature
  - standard thermometer
- Radiant heat
  - globe thermometer
- Humidity
  - whirling hygrometer
- Air velocity
  - kata thermometer

Thermal Stress Indices

- Empirical
  - ET / CET
  - WBGT
  - Predicted 4 hour sweat rate (P4SR)
- Rational
  - Heat Stress Index (HSI)
  - Required Sweat Rate

The WBGT Index

Indoors

$WBGT = 0.7\ T_{nwb} + 0.3 T_g$

Outdoors

$WBGT = 0.7\ T_{nwb} + 0.2\ T_g + 0.1 T_a$

ACGIH TLVs for Heat Stress

- determine the WBGT
- decide on whether a clothing correction needs to be applied
- compare the WBGT with the screening criteria
- if the corrected WBGT value is within the screening criteria, work can be continued
- if the corrected WBGT value is outside the screening criteria, then a more detailed assessment of heat stress or strain should be undertaken

Clothing Corrections

Summer work uniform	0
Cloth (woven material) overalls	+ 3.5
Double cloth overalls	+ 5

Values not provided for encapsulating or impervious suits

ACGIH TLVs Screening Crireia Unacclimatised Workers

	Workload			
	Light	Moderate	Heavy	V.Heavy
Continuous Work	27.5	25	22.5	-
75% work / 25% rest	29	26.5	24.5	-
50% work / 50% rest	30	28	26.5	25
25% work / 75% rest	31	29	28	26.5

Values in degrees C

ACGIH TLVs Screening Crireia Acclimatised Workers

	Workload			
	Light	Moderate	Heavy	V.Heavy
Continuous Work	29.5	27.5	26	-
75% work / 25% rest	30.5	28.5	27.5	-
50% work / 50% rest	31.5	29.5	28.5	27.5
25% work / 75% rest	32.5	31	30	29.5

Values in degrees C

ACGIH TLVs - Guidelines for limiting heat strain

Discontinue work if:

- sustained (several minutes) heart rate in excess of 180 bpm minus the individual's age in years, for individuals with assessed normal cardiac performance; or
- body core temperature is greater than 38.5 C for medically selected and acclimatised personnel, or 38 C in unselected, unacclimatised workers; or
- recovery heart rate at one minute after peak work effort is greater than 110 bpm; or
- there are symptoms of sudden and severe fatigue, nausea, dizziness or lightheadedness.