Occupational Health Clinics for Ontario Workers

Centre de santé des travailleurs et travailleuses de l'Ontario

NOISE - Its Effects and Methods to Reduce Exposure

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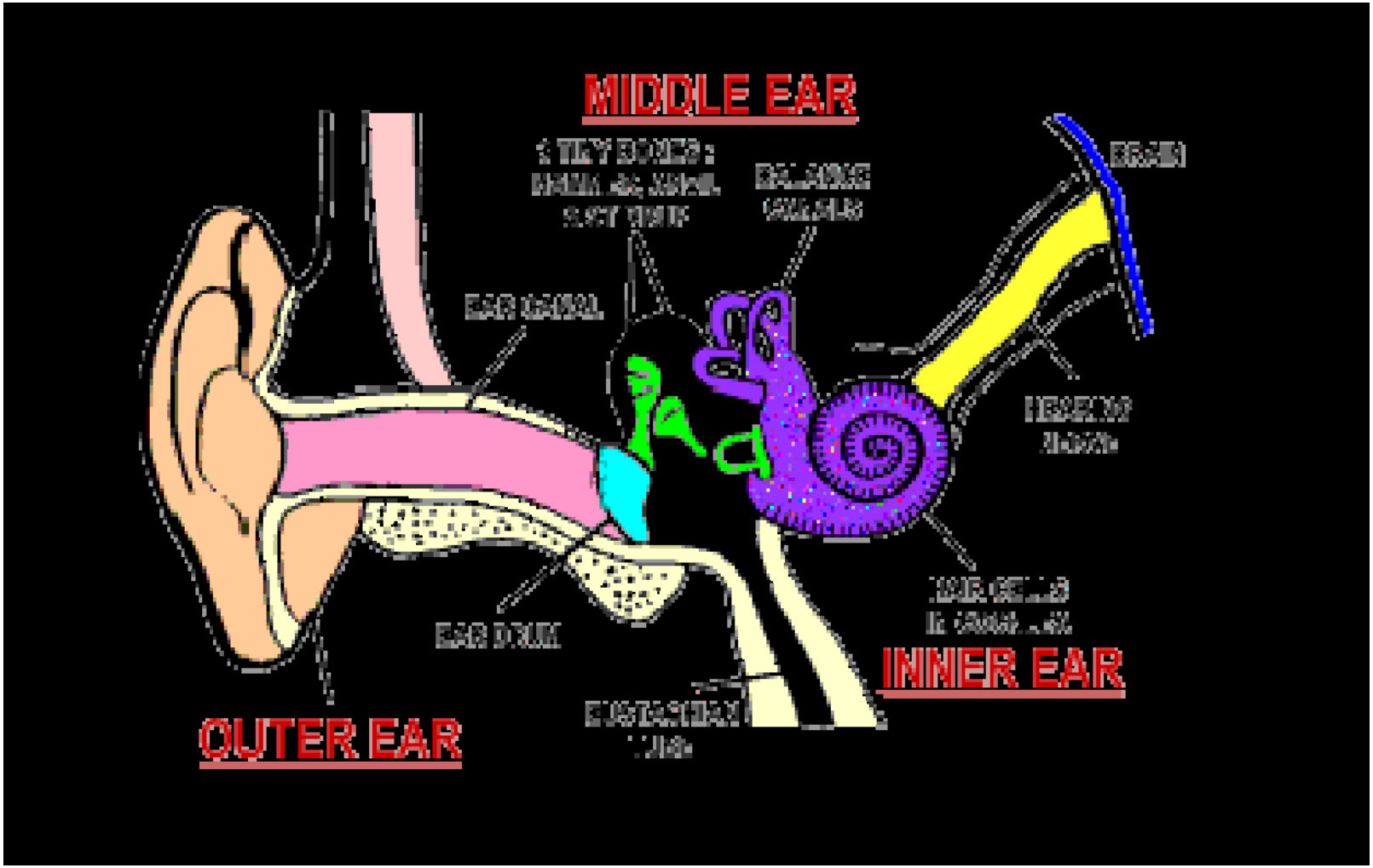
Occupational Hygienist

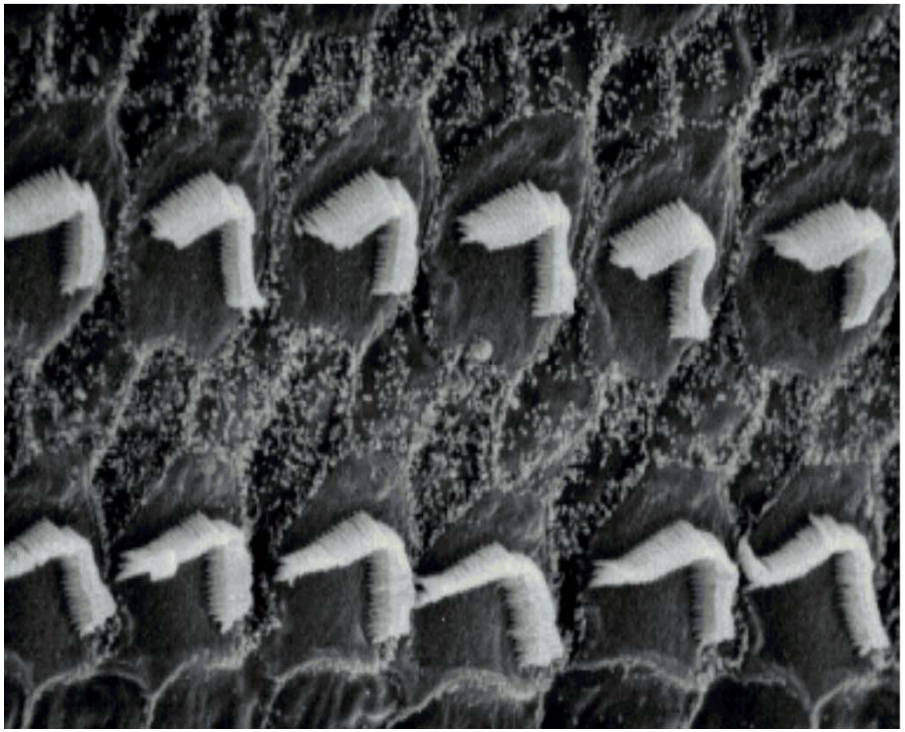
October 31, 2014

obligatory diagram of the ear:

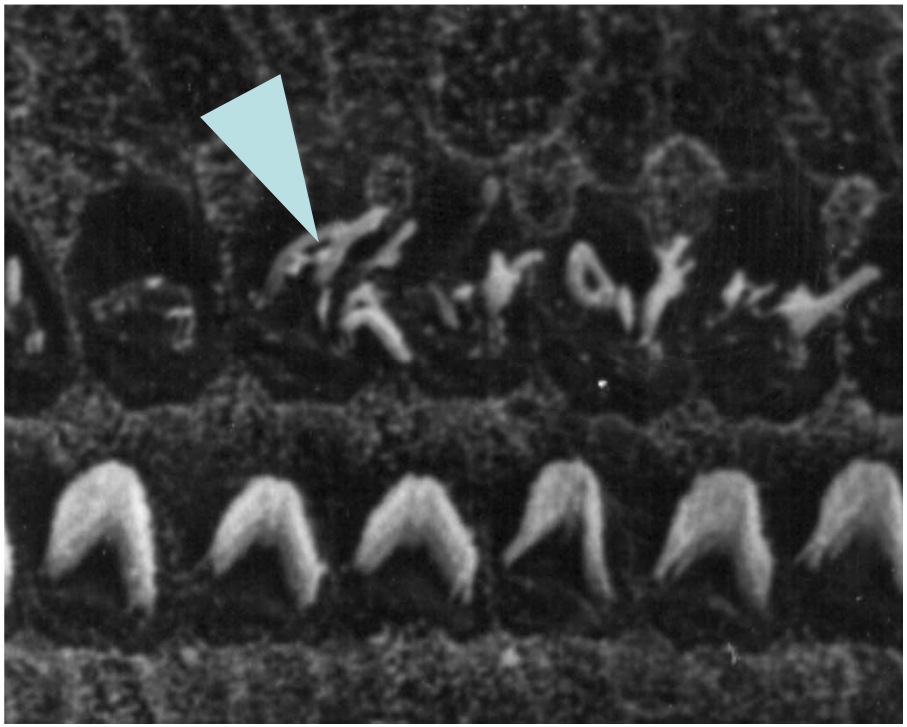


http://www.tinnitus.asn.au/ear1.htm

….what we're trying to prevent …

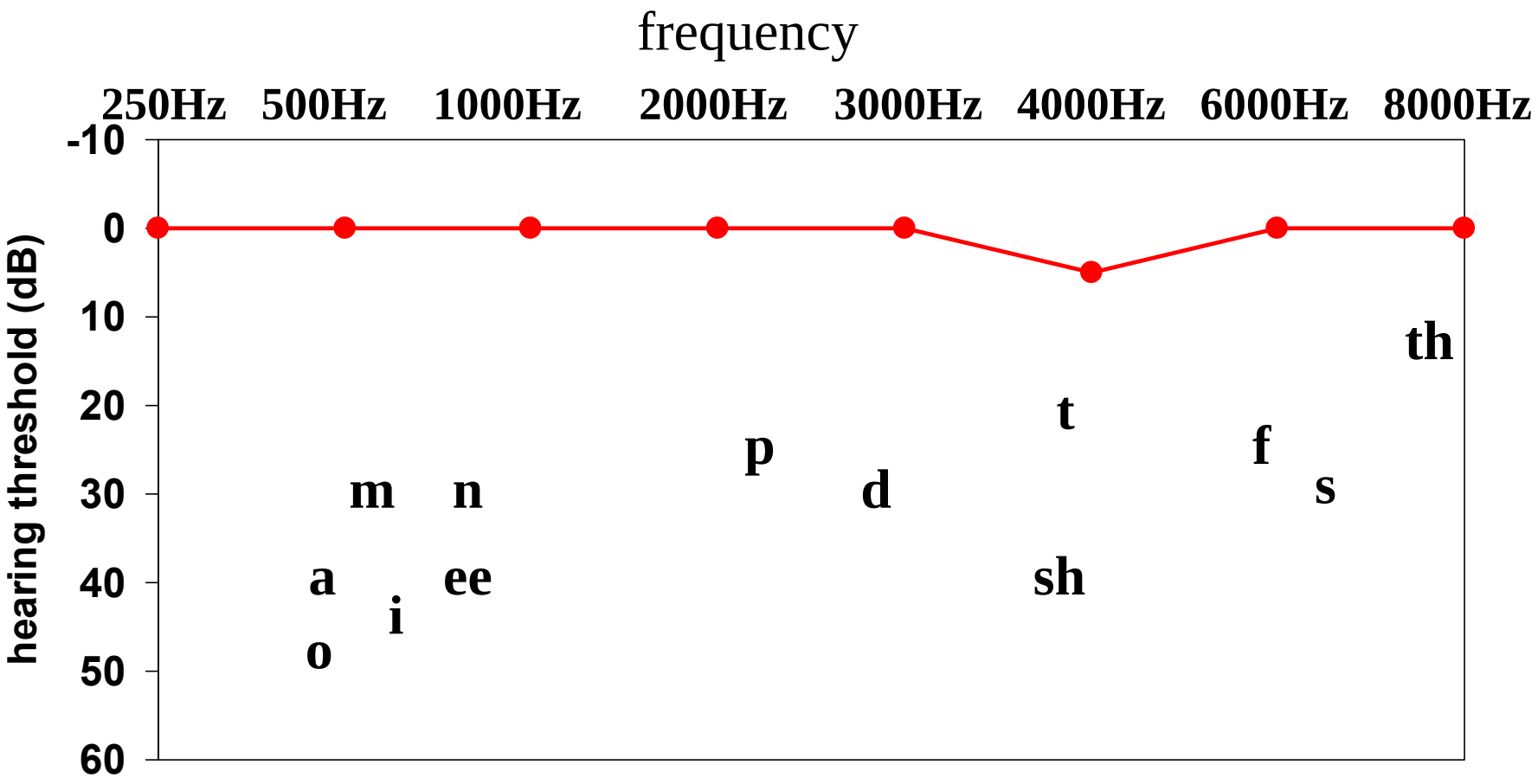


normal hearing cells



damaged hearing cells

progression of NIHL
(noise induced hearing loss)



pre-employment: worker starting first job

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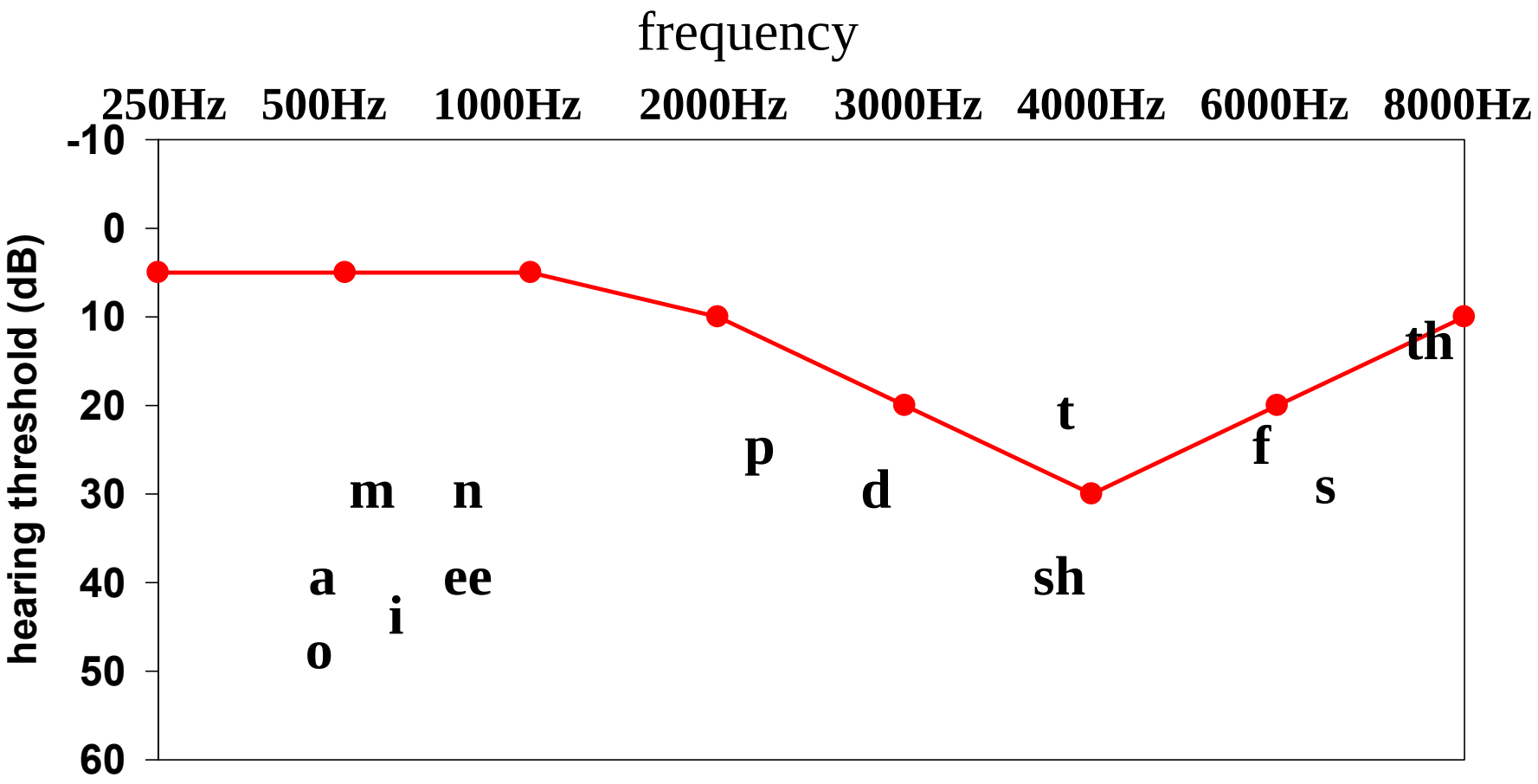
progression of NIHL
(noise induced hearing loss)



after 3-5 yrs exposure

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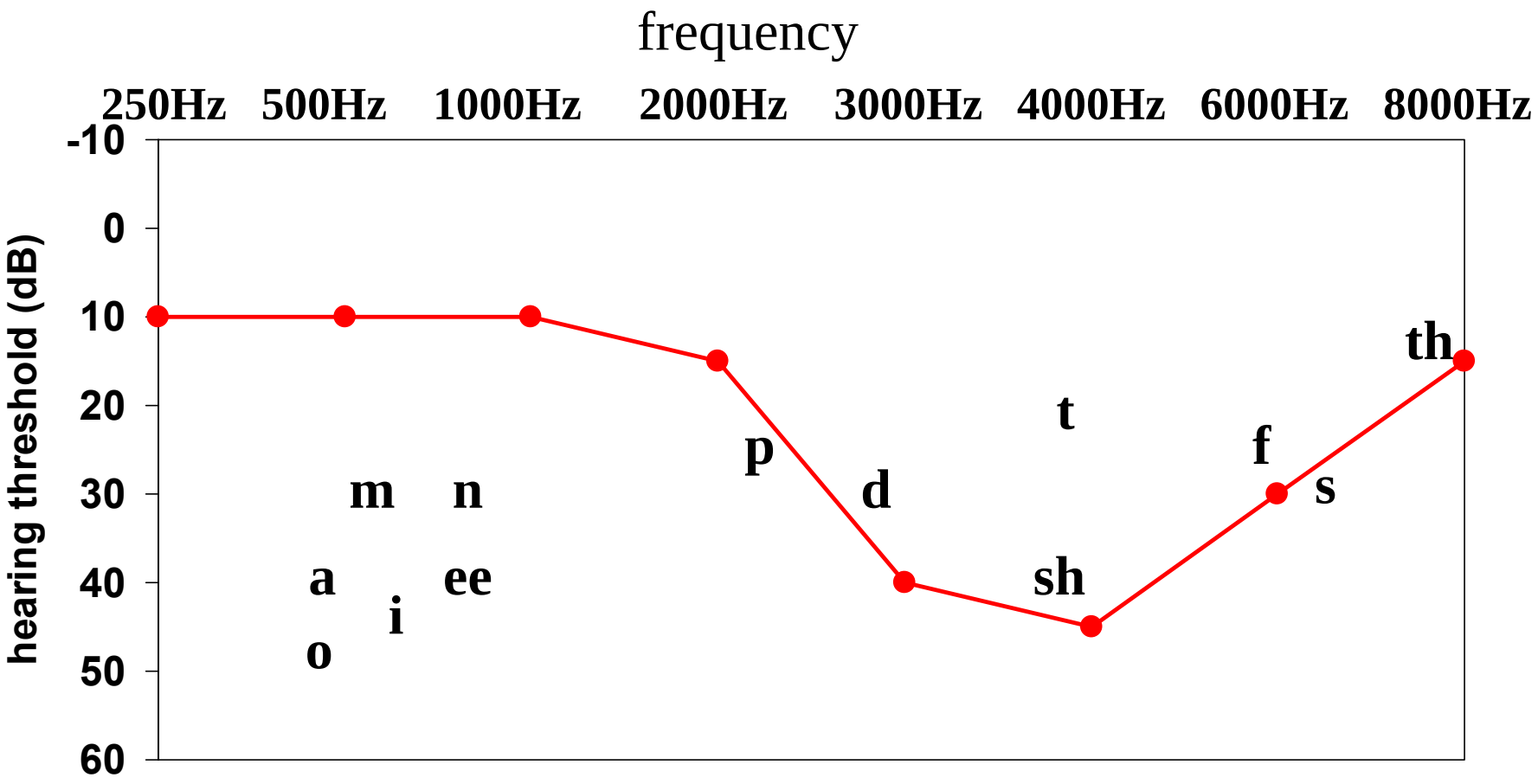
progression of NIHL
(noise induced hearing loss)



after 15-19 yrs exposu

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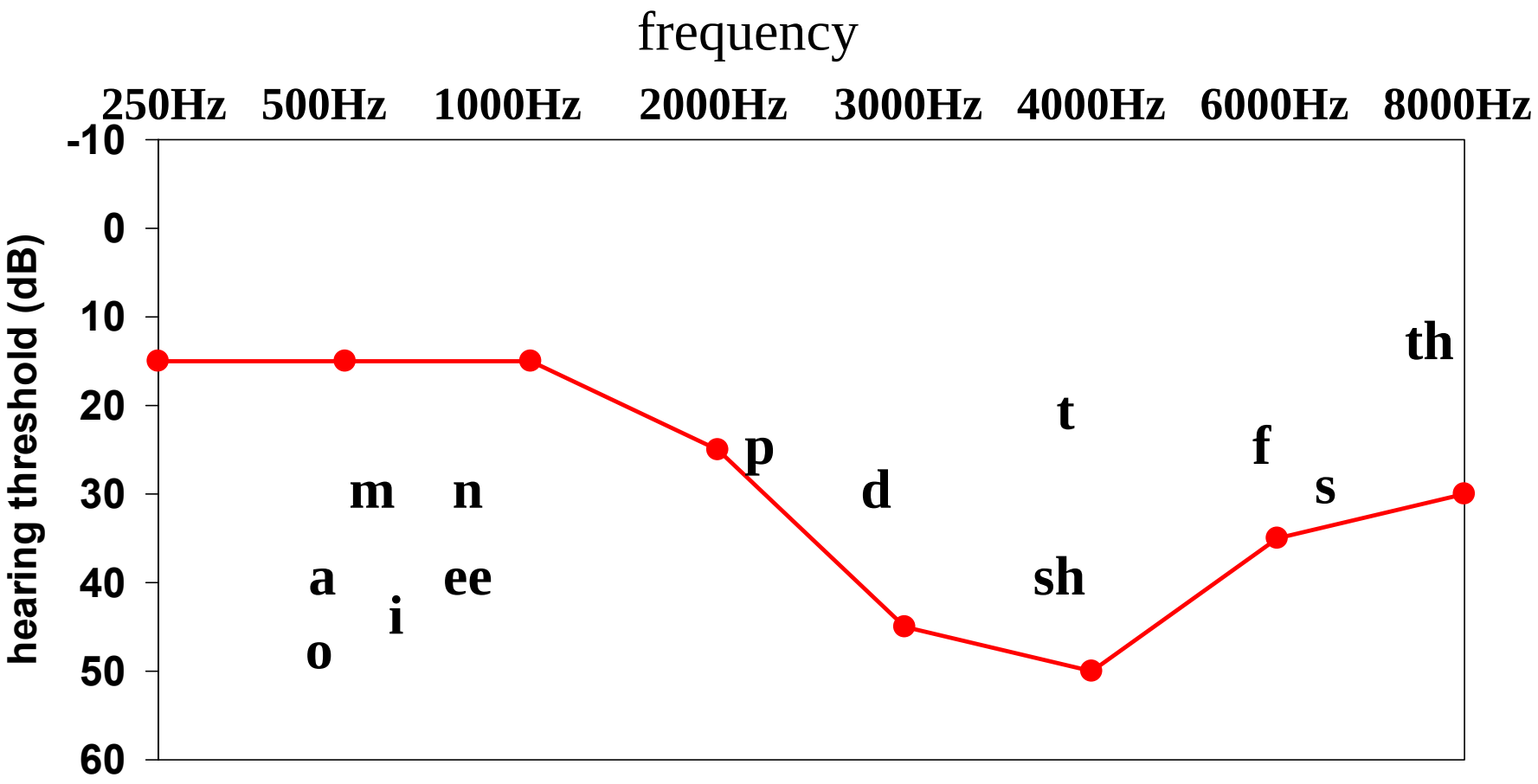
progression of NIHL
(noise induced hearing loss)



after 25-29 yrs exposu

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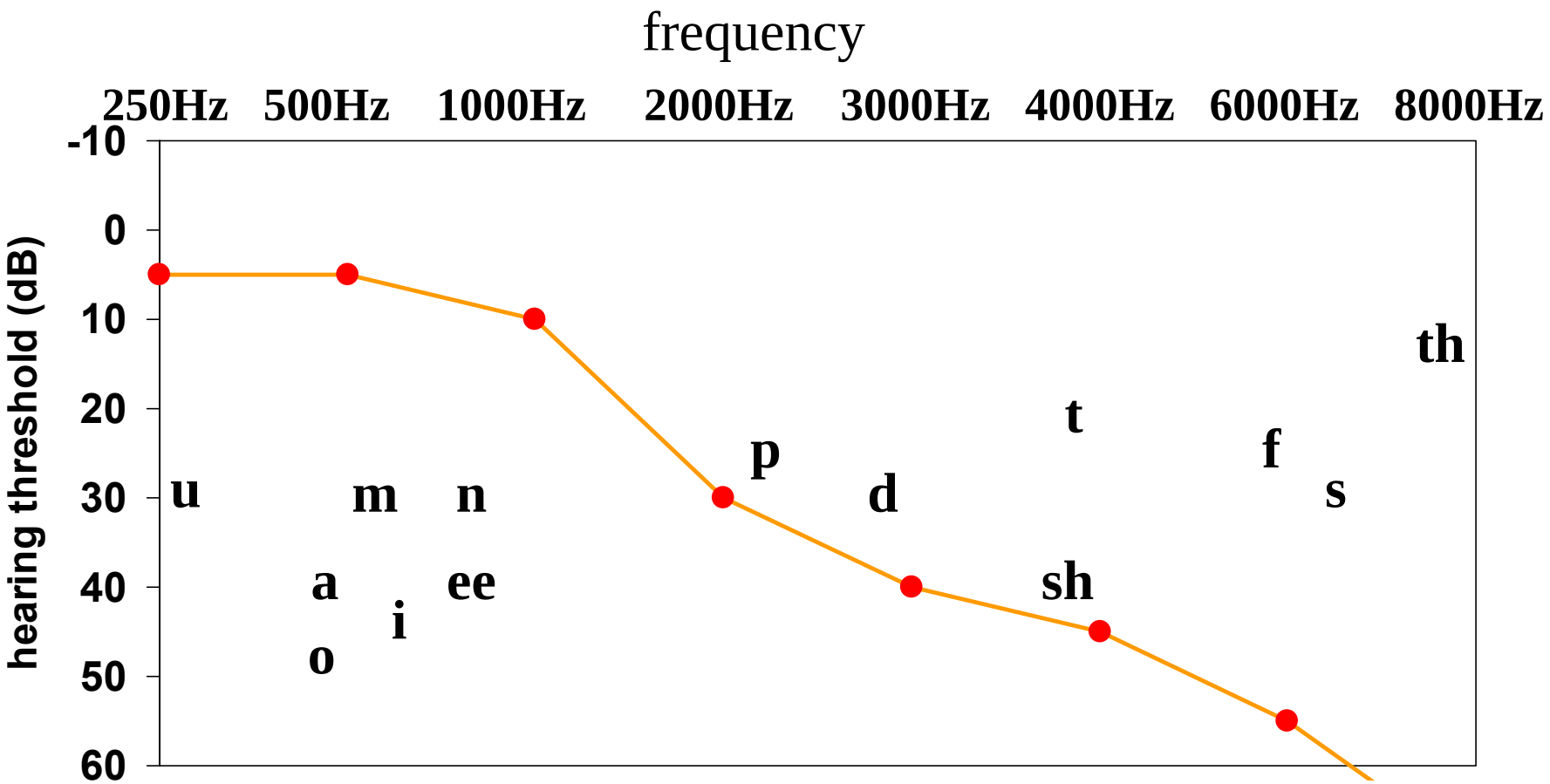
what are the chances?

- depends on the intensity of the noise (how loud it is – measured in decibels (dBA))
- depends on the frequency – high pitch (treble) sounds more damaging than low (bass) sounds
- depends on the length of time exposed (yrs)
- depends on the age (natural hearing loss due to age - presbycusis)

presbycusis
(age hearing loss)



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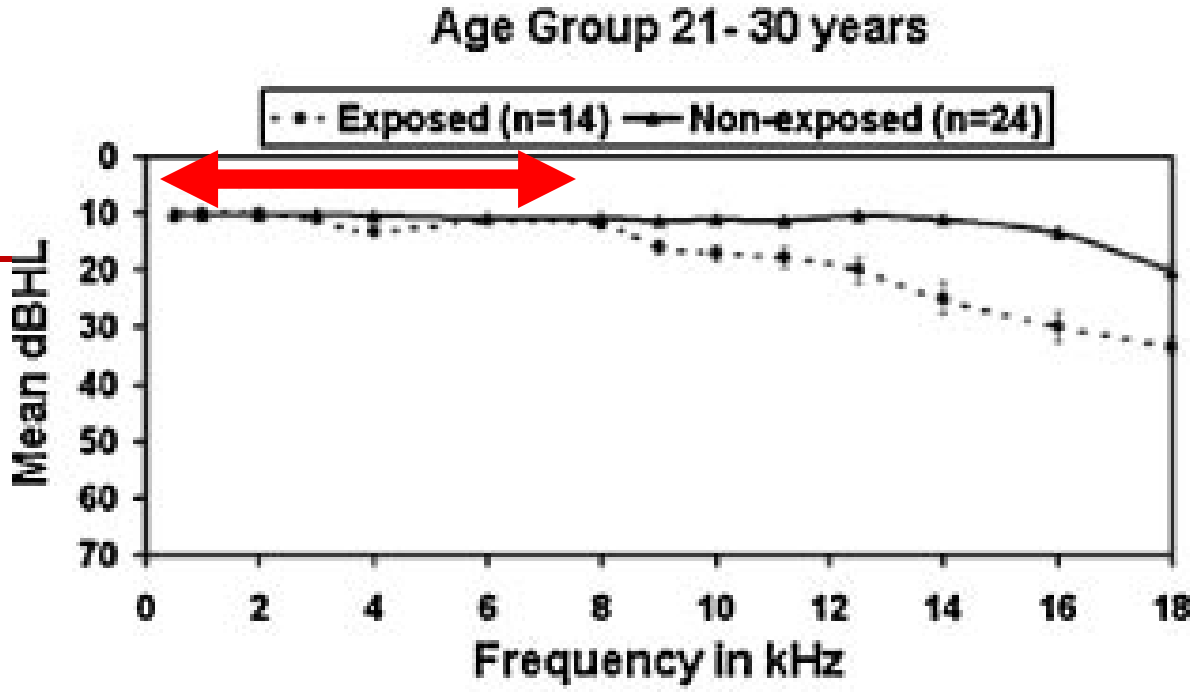
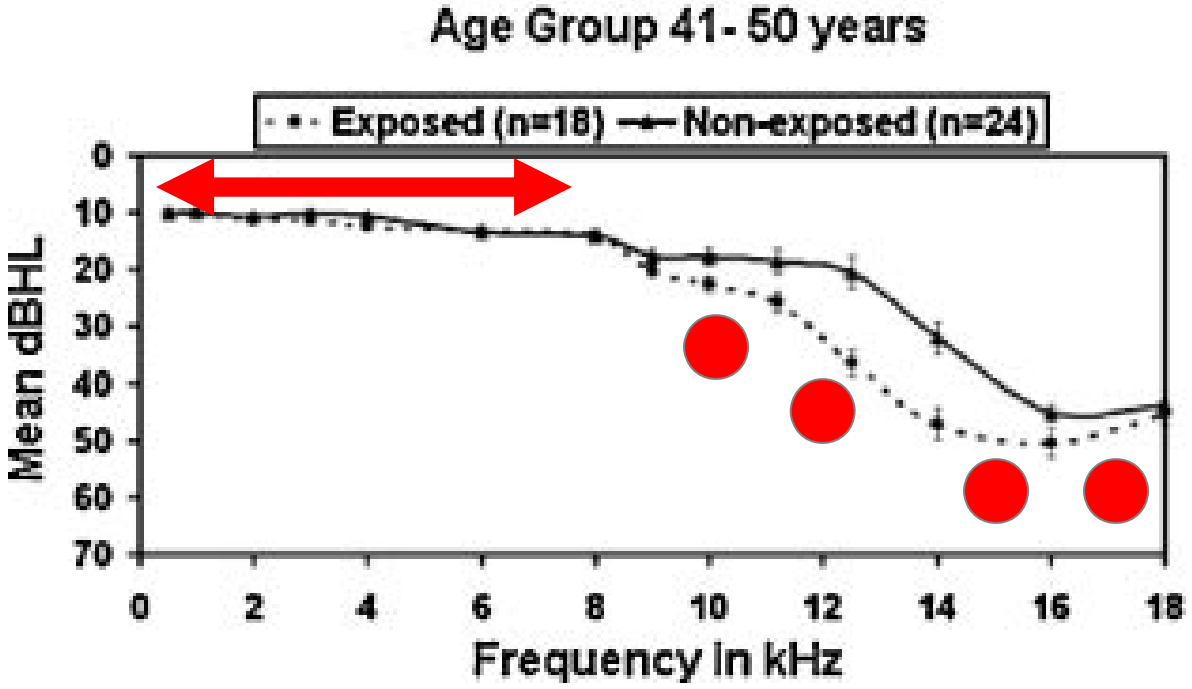
High frequency loss happens first





What are the symptoms of NIHL (noise-induced hearing loss)?

- usually gradual (not noticeable) but can be immediate (if close to an “explosive” noise)
- tinnitus
  - ringing, buzzing, or roaring in the ears or head
  - can be intermittent or continuous
  - extremely annoying and not curable

How Much Noise is too Much?

- Anything above **65 dBA** will eventually wear down your hearing.
- Years of exposure above **80-85 dBA** will lead to a percentage of workers with a hearing **disability** (legally deaf).
- Trying to carry on a conversation over the phone with a background noise level of **60-65 dBA** is very **stressful**.

Noise Induced Hearing Loss:

- WSIB recognizes noise-induced hearing loss (NIHL) compensation after an exposure of 90 dBA for 8 hrs/day for **5** years;
- the policy also lists equivalent exposures as 84 dBA for 40 yrs and 28 yrs at 85 dBA

WSIB Hearing Loss Exposure Equivalencies

The minimum hazardous noise exposure of **90 dB(A)** for 8 hours per day for **5 years** has the following equivalencies*:

84 dB(A) for 40 yrs	89 dB(A) for 7 yrs
85 dB(A) for 28 yrs	91 dB(A) for 3.5 yrs
86 dB(A) for 20 yrs	92 dB(A) for 2.5 yrs
87 dB(A) for 14 yrs	93 dB(A) for 1.8 yrs
88 dB(A) for 10 yrs	94 dB(A) for 1.25 yrs

* ISO 1999-1990. Acoustics – Determination of occupational noise exposure and estimation of noise-induced impairment. Internat. Standard ISO 1990. 2nd ed. Geneva, 1990.

NIHL does not normally develop in less than 1.25 years.

Other than hearing loss health effects:

- "… what the non-auditory effects of noise are is still not certain. In general, the suspected effects include:
  - cardiovascular function (hypertension, changes to blood pressure and/or heart rate),
  - changes in breathing,
  - annoyance,
  - sleeping problems,
  - physical health and
  - mental health.
- This wide range of effects has led researchers to believe that noise has the ability to act as a general, non-specific stressor."

http://www.ccohs.ca/oshanswers/phys_agents/non_auditory.html

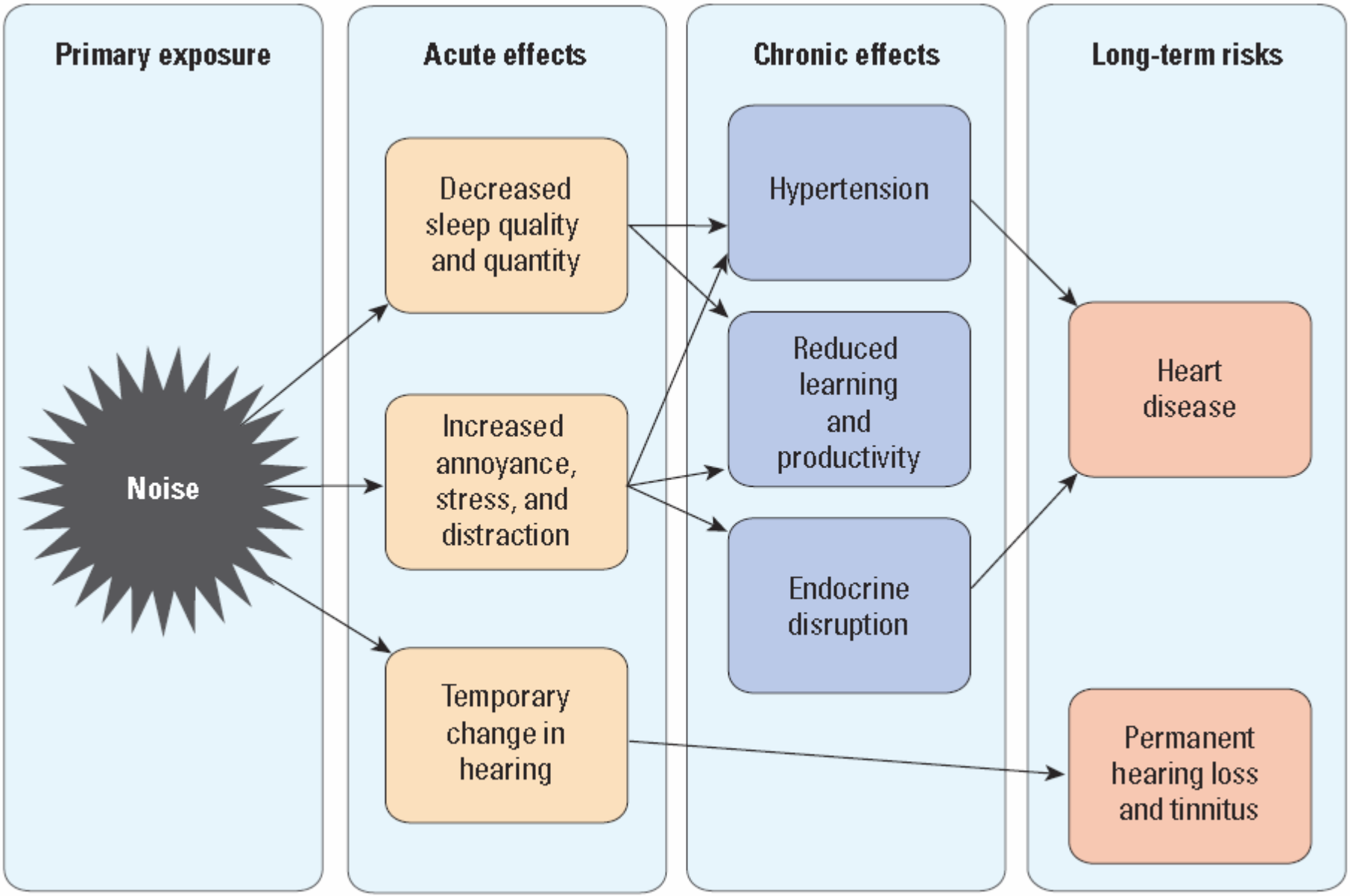
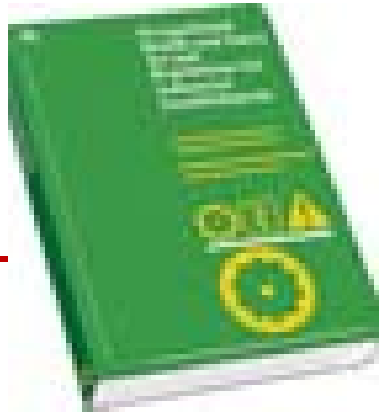


Figure 1. Select effects of noise.

http://ehp.niehs.nih.gov/1307272/



How is noise regulated in Ontario?

Noise Regulation
O.Reg. 851/139

- employers take **all measures reasonably necessary in the circumstances to protect** workers from exposure to hazardous sound levels.
- **protective measures** against noise exposure include engineering controls, work practices and personal protective equipment.
- **assessment of noise levels** in the shall be done without regard to any use of personal protective equipment.
- every employer shall ensure that **no worker is exposed to a sound level greater than an equivalent sound exposure level of 85 dBA, $L_{ex,8}$.**

O.Reg. 851/139 (continued)

- the employer shall protect workers from exposure to a sound level greater than 85 dBA, $L_{ex,8}$ **without requiring the use of personal protective equipment.**
- personal protective equipment is **only to be used if** engineering controls,
  a) do not existence or are not obtainable;
  b) are not reasonable or not practical to adopt, install or provide because of the duration or frequency of the exposures or because of the nature of the process, operation or work;
  c) are rendered ineffective because of a temporary breakdown of such controls; or
  d) are ineffective to prevent, control or limit exposure because of an emergency.

O.Reg. 565/06 (continued)

- if engineering controls can't be used then workers shall wear and use **personal protective equipment** appropriate in the circumstances to protect them from exposure to a sound level greater than 85 dBA, $L_{ex,8}$
- a clearly visible **warning sign** shall be posted at every approach to an area in the workplace where the sound level regularly exceeds 85 dBA.

The MOL has published a guideline to help workplaces understand the new regulation

Ontario

http://www.labour.gov.on.ca/english/hs/guidelines/noise/index.html

Amendments to Noise Requirements in the Regulations for Industrial Establishments

old table:

Column 1	Column 2
Sound Level — in Decibels	Duration — Hours per 24 hour day
90	8
92	6
95	4
97	3
100	2
102	1½
105	1
110	½
115	¼ or less
Over 115	No exposure

new table:

$$L_{ex,8} = 10\ \mathrm{Log}_{10}\left(\frac{\left[\sum_{i=1}^{n}\left(t_i \times 10^{0.1\,SPL_i}\right)\right]}{8}\right)$$

solution:
on-line calculator …

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Noise Exposure Calculator: This table calculates the 8 hour equivalent sound exposure level as per the equation in O.Reg 565/06. To use this table, enter the measured noise level (in db(A)) and the amount of time and press ENTER.

Noise Level (in dB(A))	Exposure Time (hrs)	Exposure Time (min)	8 hr Equivalent Exposure Level ($L_{ex,8}$) (in dB(A))
87	6	30	86.1

$L_{ex,8}$	
<80 dB(A)	minimal risk of noise induced hearing loss
80-85 dB(A)	some risk of noise induced hearing loss
85+ dB(A)	significant risk of noise induced hearing loss

www.ohcow.on.ca/menuweb/noisecalculator.xls

25 YEARS/25 ans Health Clinics for Ontario Workers | des travailleurs et travailleuses de l'Ontario

Sound Level (in db(A))	Duration (85 dBA $L_{ex,8}$) (hrs/24 hr day)	Duration (80 dBA $L_{ex,8}$) (hrs/24 hr day)
80¼	24	7½
81½	18	5⅔
82	16	5
83¼	12	3¾
84	10	3¼
85	8	2½
86¼	6	2
88	4	1¼
89¼	3	1
91	2	40 min
92¼	1½	30 min
94	1	20 min
97	30 min	10 min
100	15 min	5 min
101¾	10 min	3 min
104¾	5 min	1½ min
111¾	1 min	20 sec
114¾	30 sec	10 sec

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Centre de santé des travailleurs et travailleuses de l'Ontario

Measuring noise:

- **no measurement** – everyone agrees its too noisy and let's do something about it
- **communication scale** – do you have to raise your voice at an arm's length away – if so probably over 80-85 dBA
- $50-100 **type III sound meter** (Radio Shack @ Liquidation World) – can work well for area measurements (but no guarantee – calibration needed)
- **dosimeter** $1000-4000, does datalogging and acts as a sound level meter (usually downloadable) – measure individual exposures averaging over time
- **octave band analyzer** $3000-12,000, gives you noise frequency analysis usually used for acoustics and noise control engineering

There's an App for that!

- NIOSH recently reviewed various noise measurement apps and found that some do a reasonable job of measuring sound (and some not so reasonable)

https://itunes.apple.com/ca/app/splnfft-noise-meter/id355396114?mt=8

Prevention Opportunities

Best **Good** **Temporary**

check on effectiveness of controls

<u>source</u> > <u>path</u> > exposure > target > disease

too late!!





This is not the permanent solution!

… nor even a very effective temporary one.

Hierarchy of Controls:

1. **at the source** ⇒ **BEST**
   - eliminate, enclose, silencers, fix, specify
2. **along the path** ⇒ **GOOD**
   - barriers, curtains, absorbers
3. **at the worker** ⇒ **TEMPORARY**
   - PPE, audiometry, rotating exposures

Barriers to Prevention:

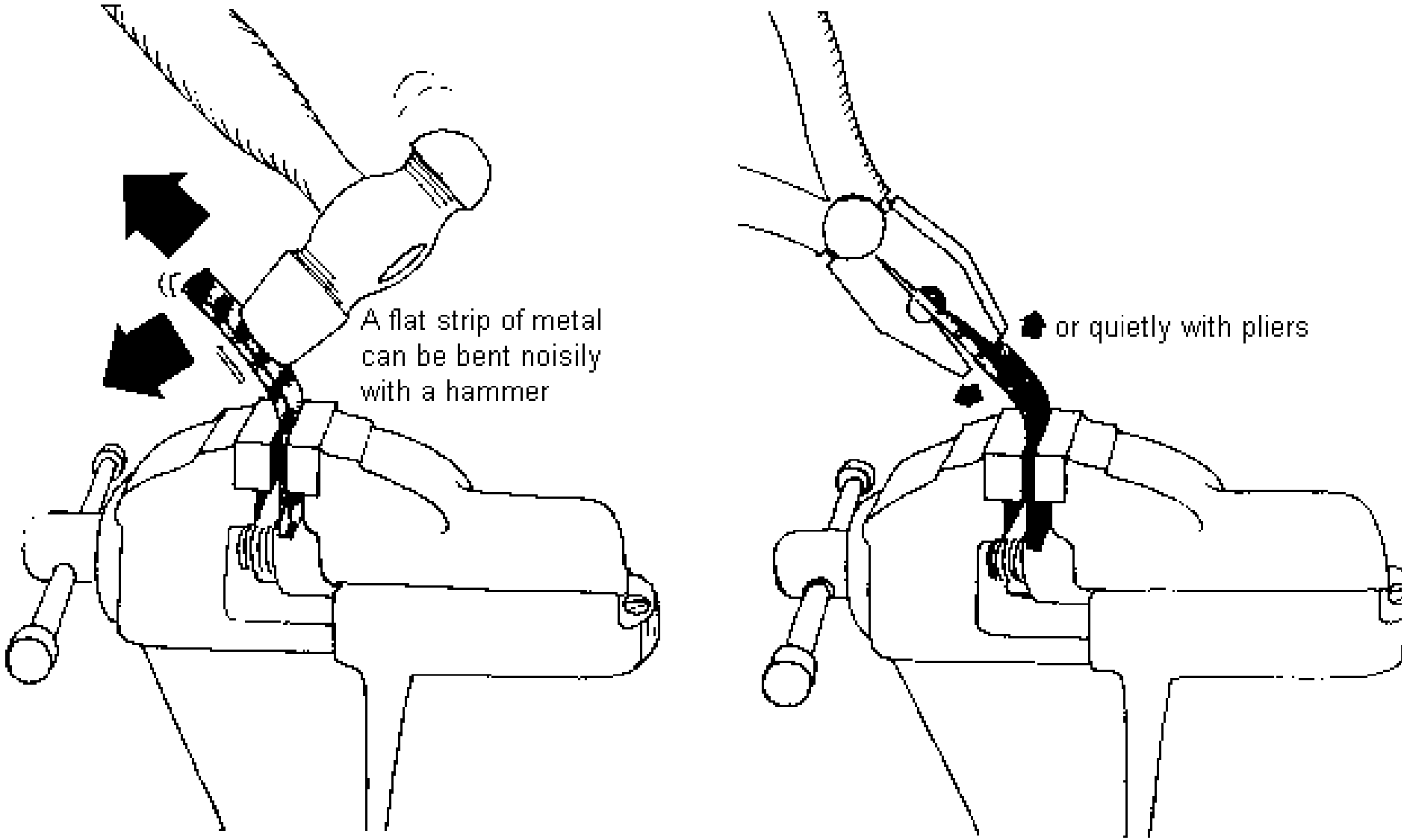
- **Complacency:** it's always been that way, things will never change …
- **Expertise:** we need an expert with one of those fancy noise meters to come in and measure the noise …
- **Expense:** noise control is just too expensive!
- **Shift the Blame:** they should have worn their ear plugs …

Preventing noise

- purchasing policy (new machinery <75 dBA)
- vibration control (isolators, damping)
- quiet materials for conveyors, bins (noiseless steel, plastic coatings, etc.)
- silencers, mufflers, specially designed compressed air nozzles
- balancing rotating parts, avoiding harmonic frequencies, etc.
- avoiding impacts in process flow (slide instead of drop)
- enclosures, barriers, curtains
- sound absorbing acoustic wall/ceiling treatment
- increasing distance from source
- OHCOW worksheet “Doing something about noise”

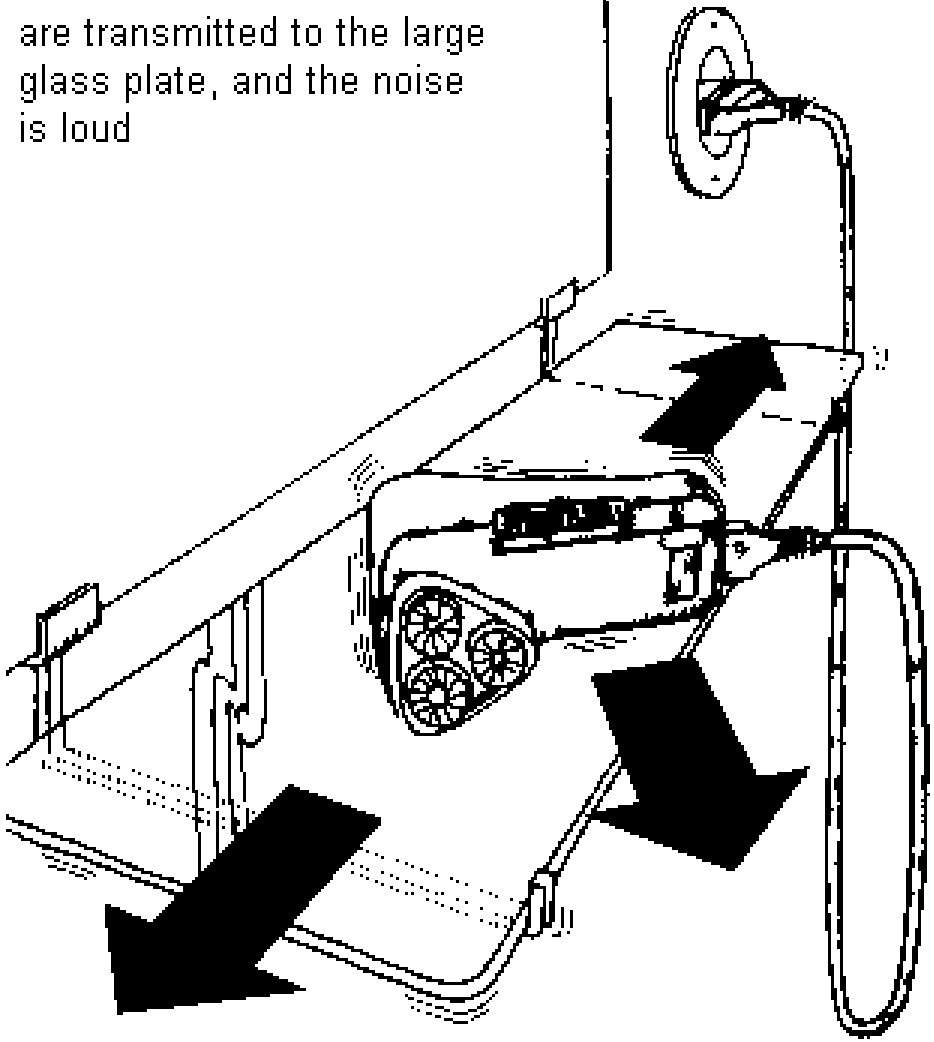
Noise control principles & examples …

Simple Noise Reduction

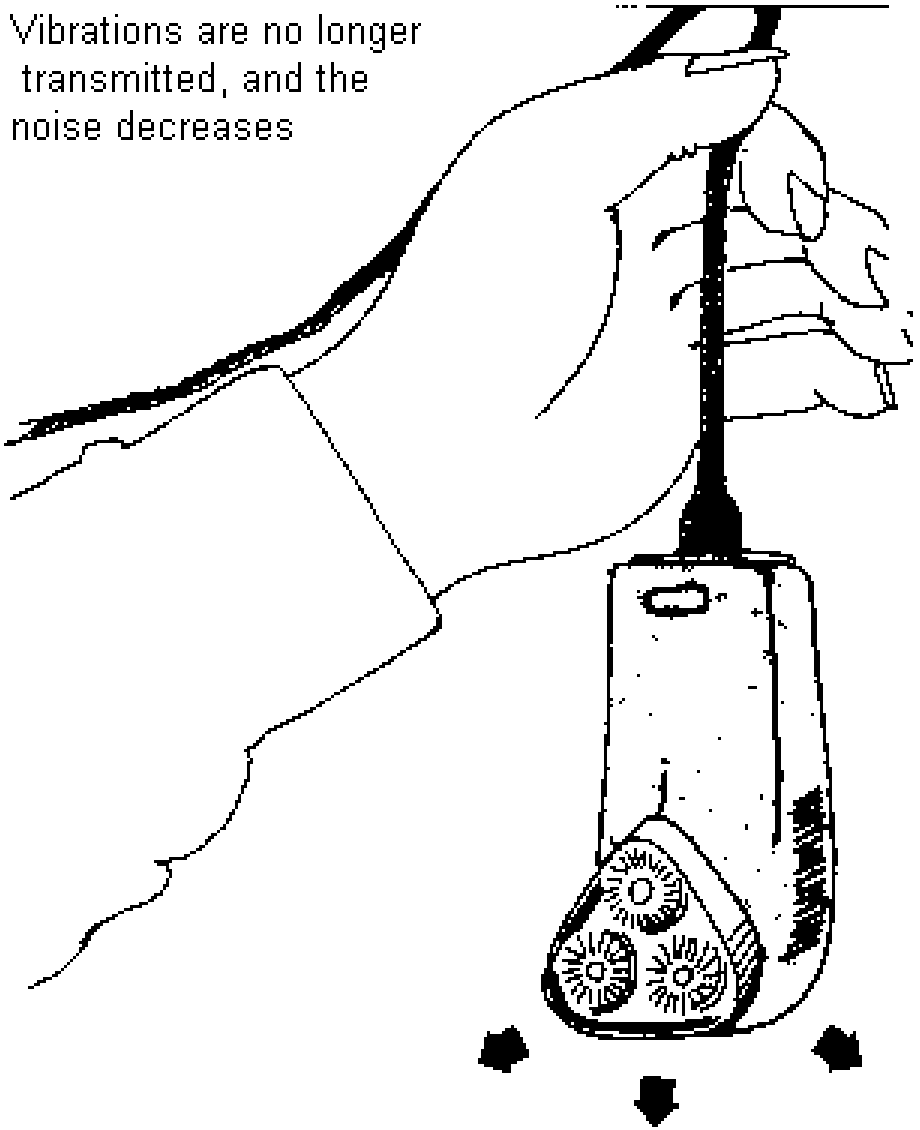


Vibration Transmission

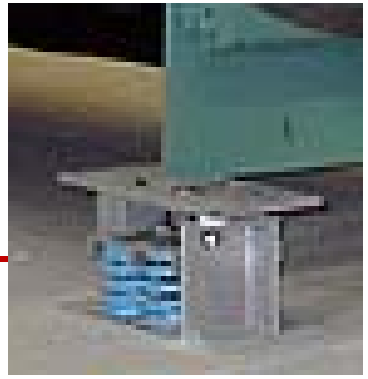
Vibrations from a shaver are transmitted to the large glass plate, and the noise is loud

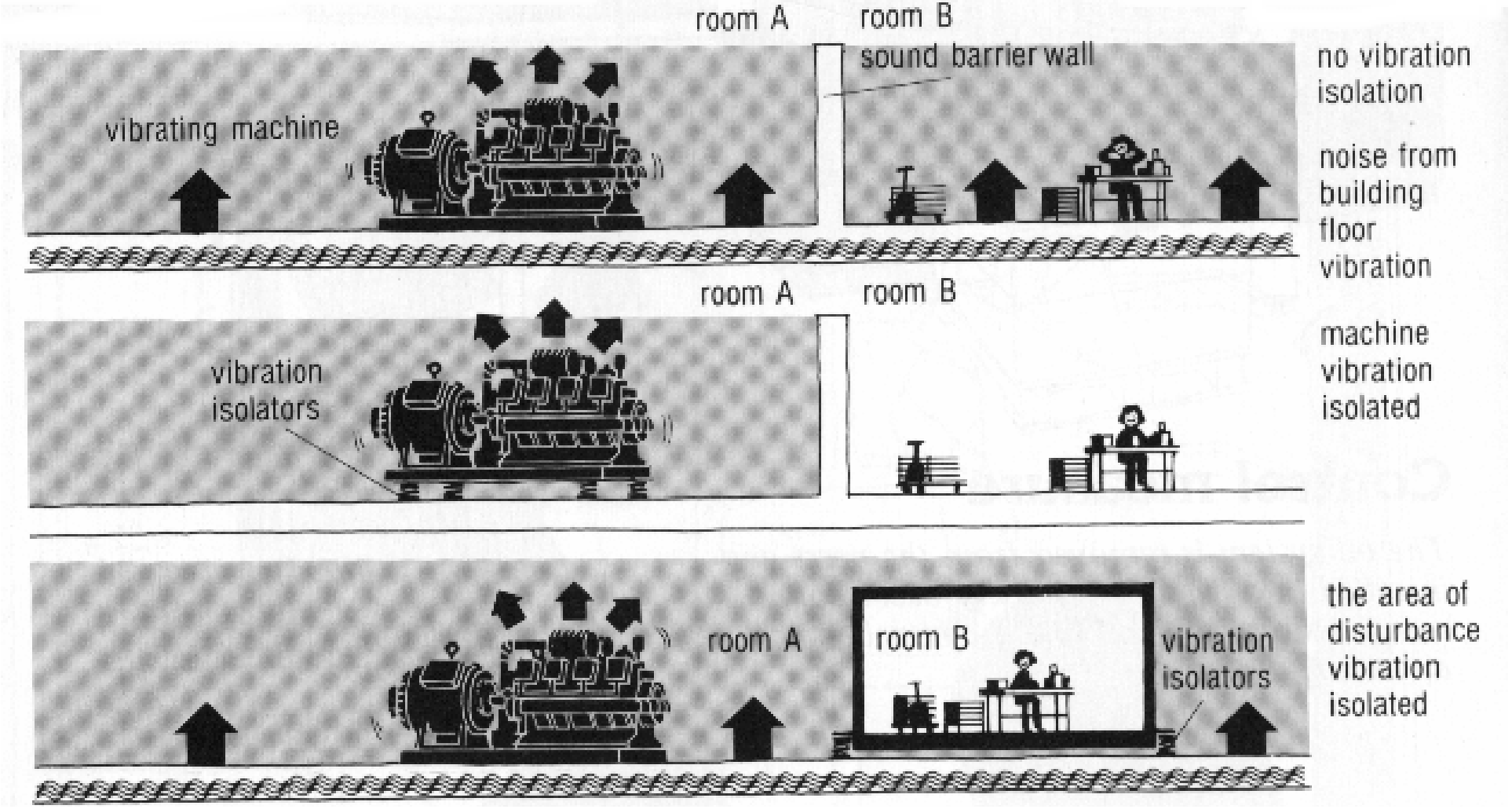


Vibrations are no longer transmitted, and the noise decreases

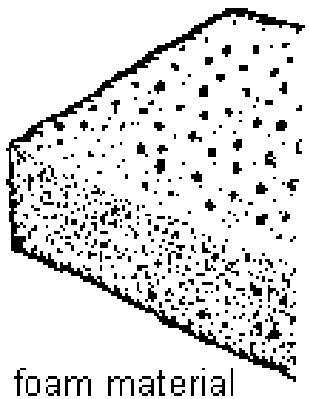


Vibration Isolation



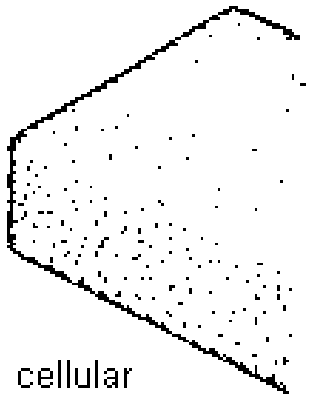


Vibration isolators are made of various materials

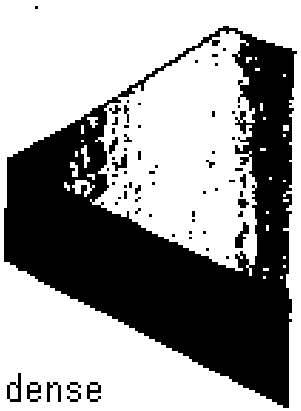


foam material
rubber-plastic

mineral wool



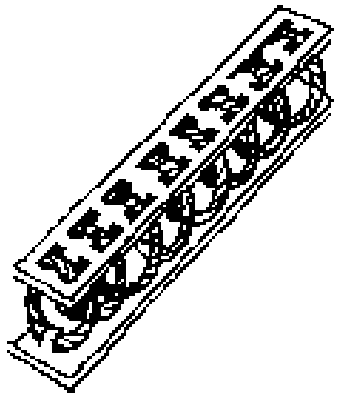
cellular
material,
rubber-plastic



dense
rubber-plastic

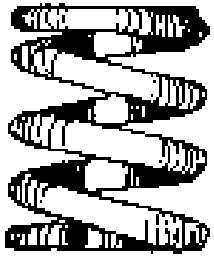
cork

softer springs ◄——●——► stiffer springs

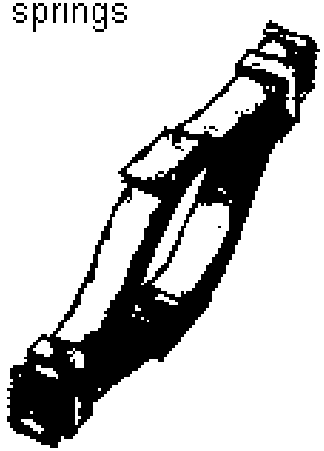


horizontal
wire coils

spiral spring,
long thin wire



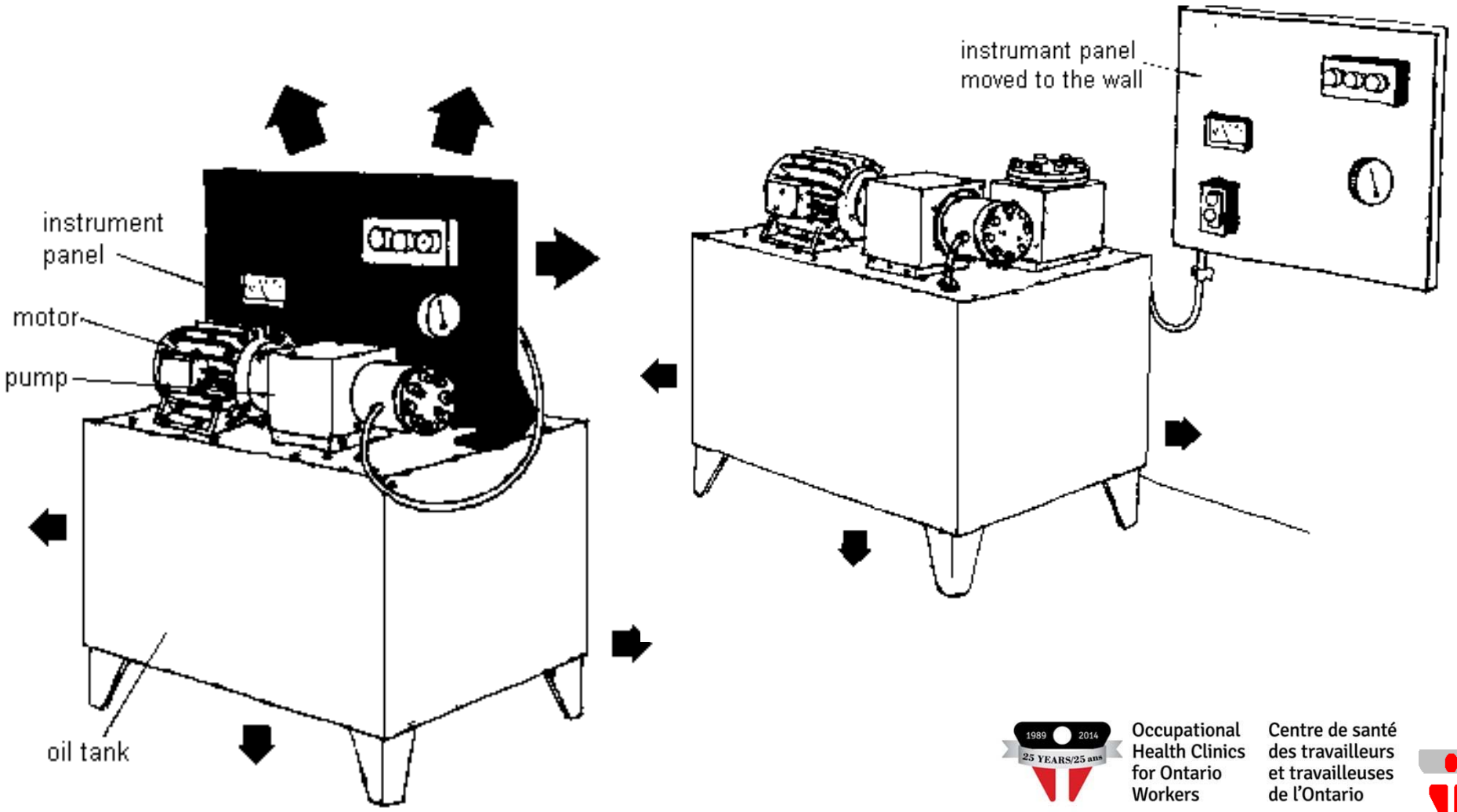
short thick
wire



leaf spring

plate spring

Vibration Transmission

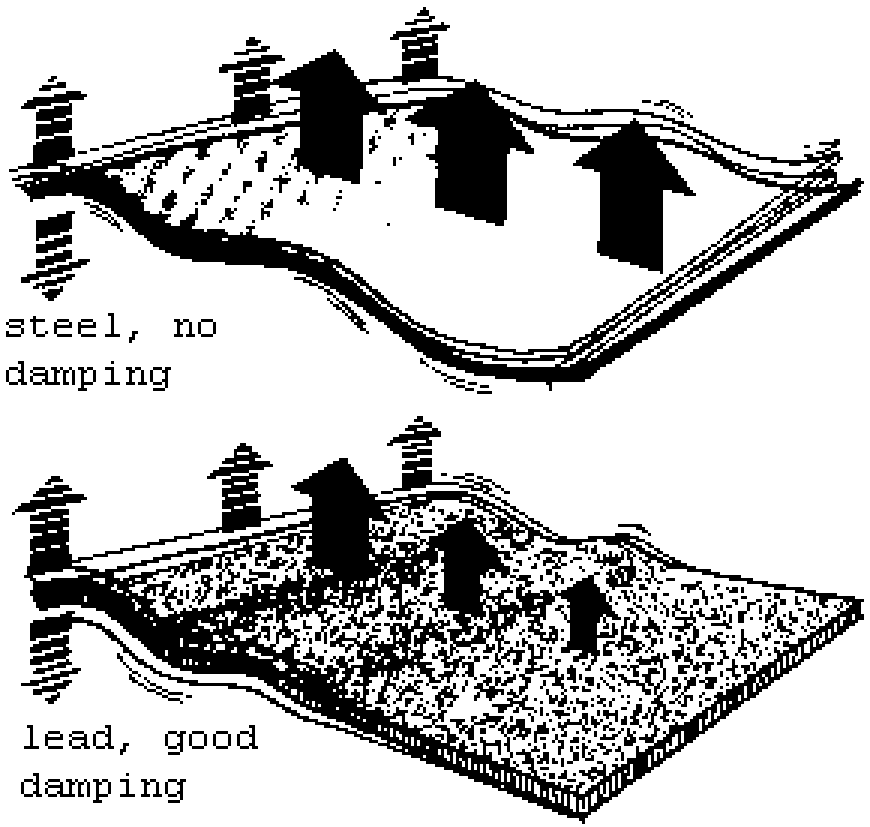


Vibration Damping Coatings

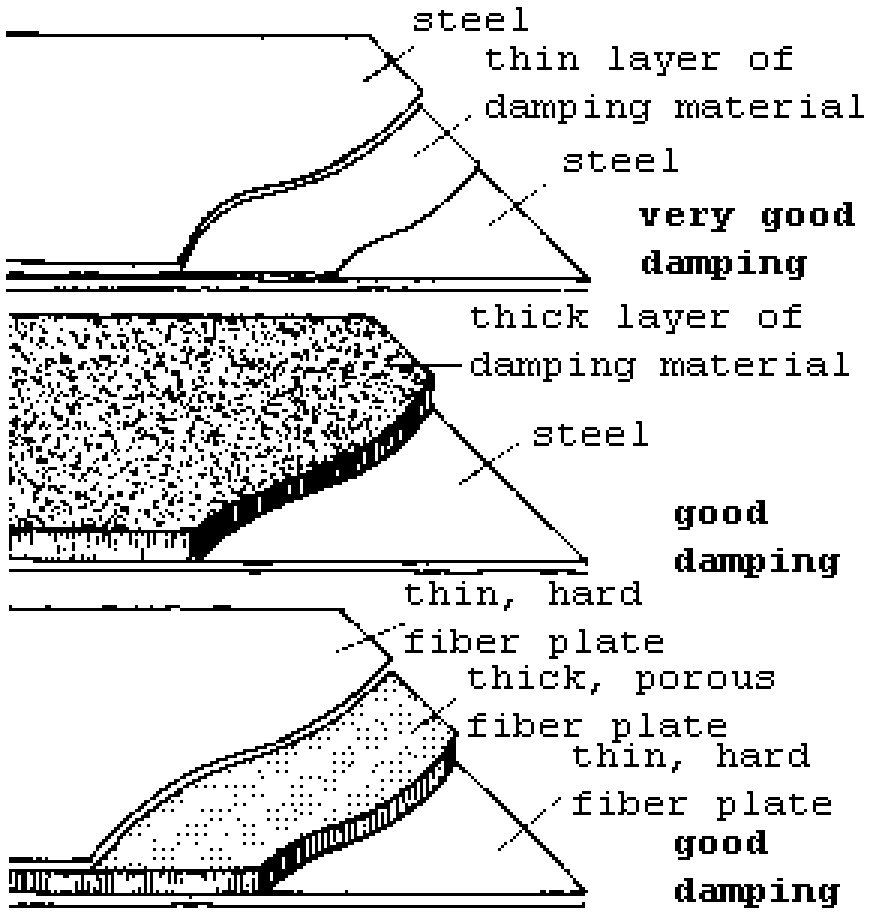
… or line metal conveyors with old rubber conveyor belts

“Noiseless Steel”

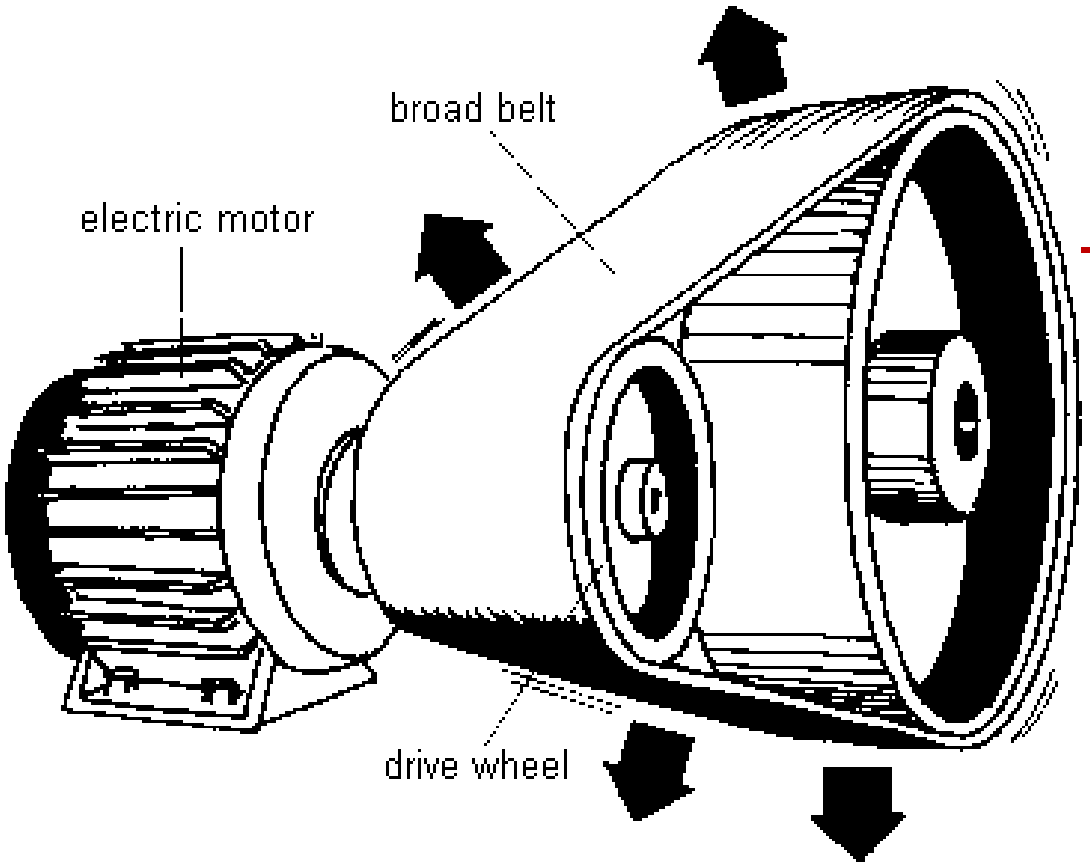
example of vibration movement in a plate

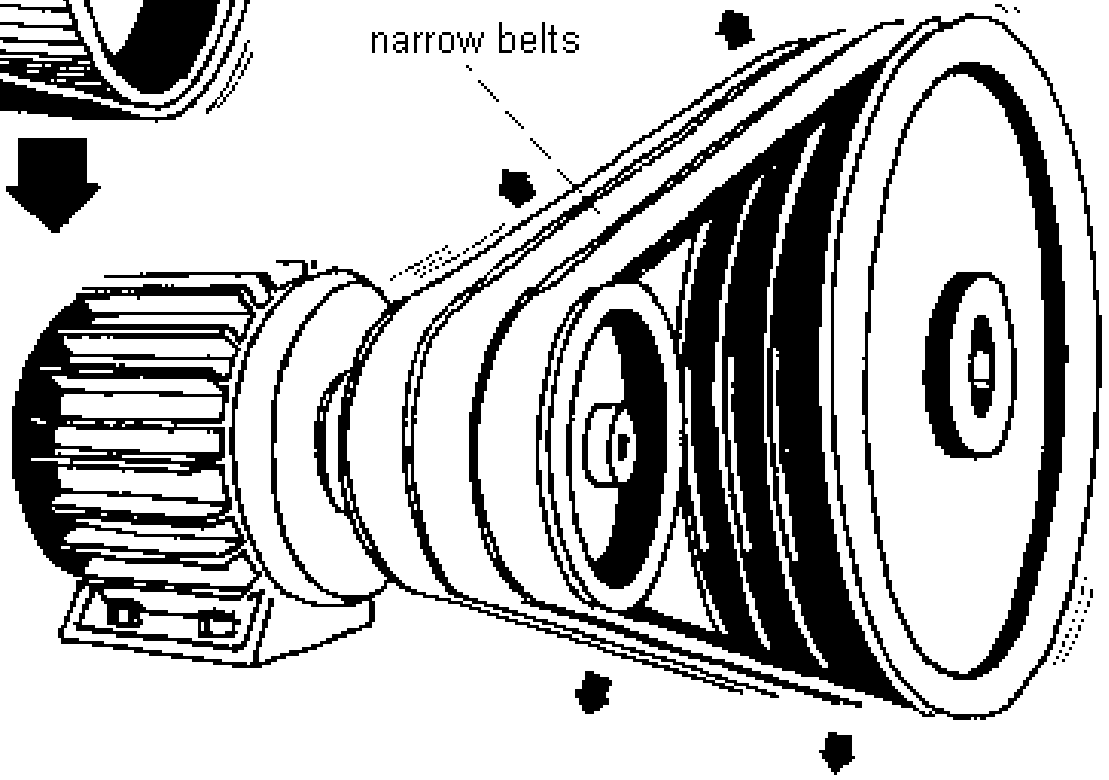


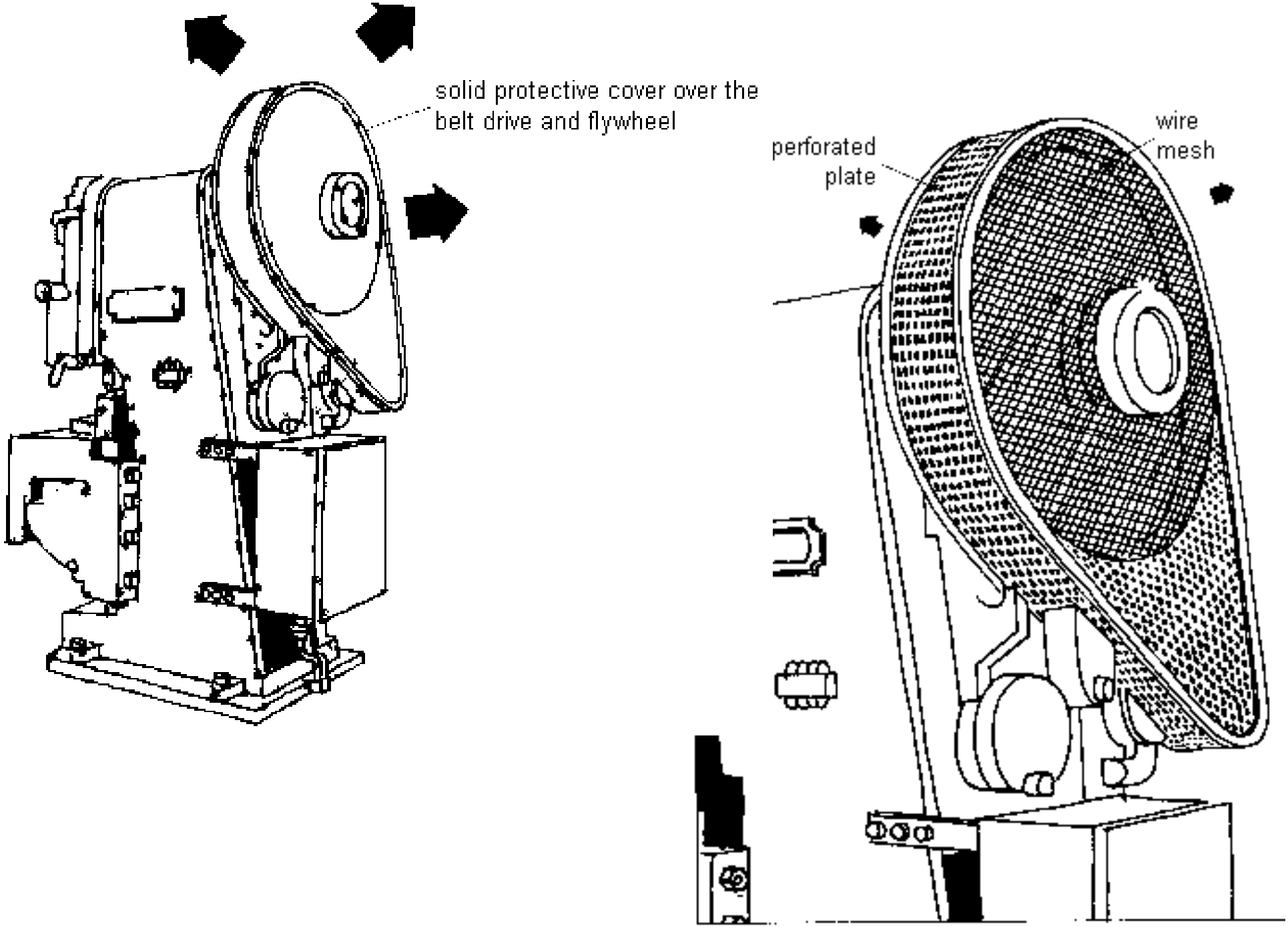
example of "artificial" damping



Surface area transmission





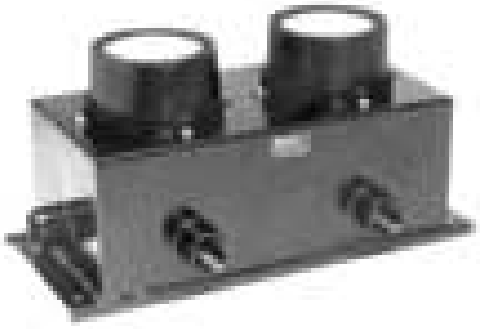

solid protective cover over the
belt drive and flywheel
perforated
plate
wire
mesh

“Quiet” air guns

KINETICS MODEL QF 8310			
Line Pressure PSI (bar)	Air Delivery CFM (CMM)	*Thrust Force, Grams	Noise Level dBA in Free Air
50 (3.4)	13 (0.37)	215	76
60 (4.1)	15 (0.42)	260	77
80 (5.5)	17 (0.49)	300	80
100 (6.9)	18.5 (0.52)	380	83

*Thrust is dynamic force exerted on a 3" (75 mm) disc at 3" (75 mm)

Compressed air nozzles & exhaust silencers



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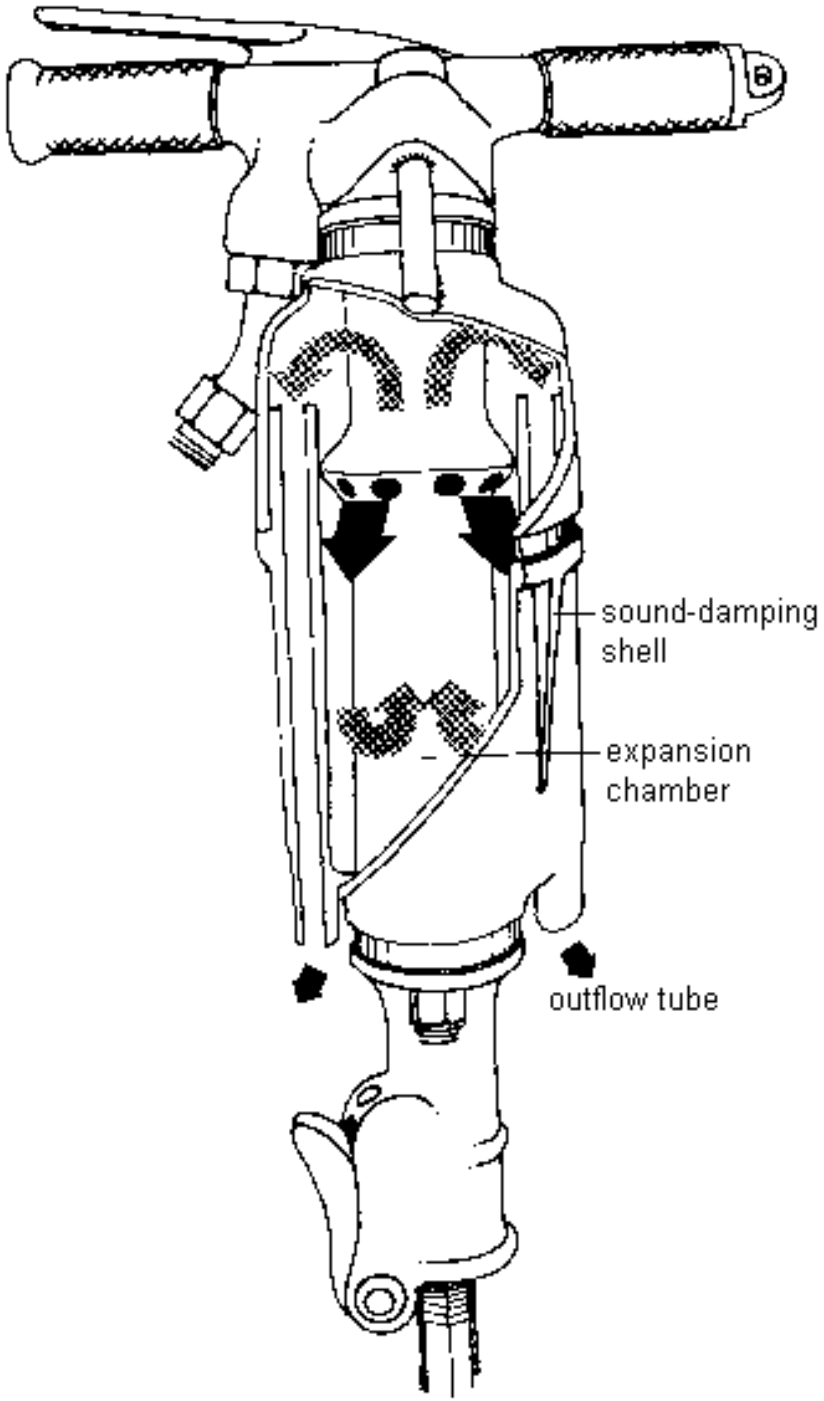
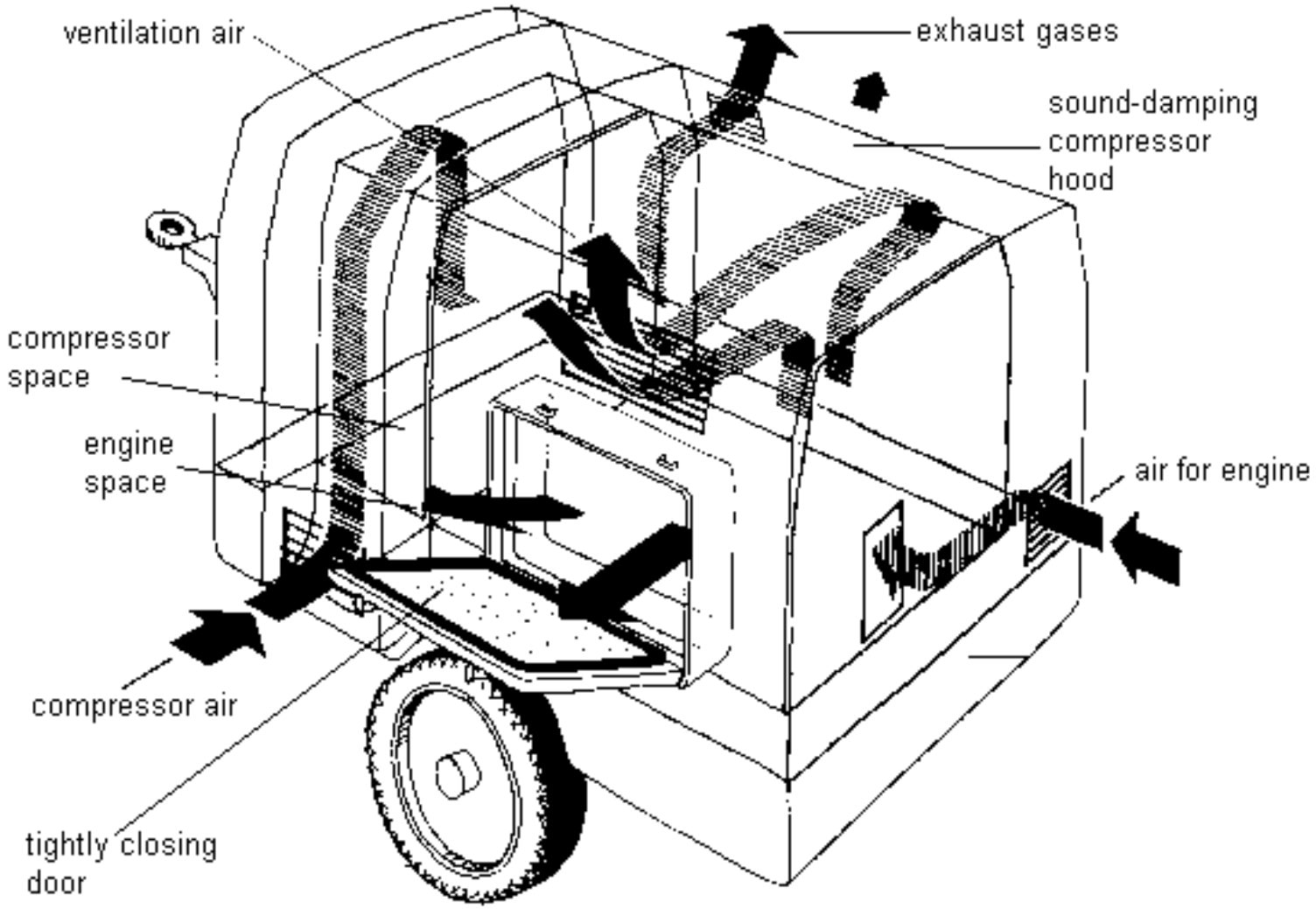
Tool Redesign

- *Using a jacket over the tubular outlet in the jacket, the high frequency noise given off by a jack hammer can be partially shielded. The low frequency noise in the exhaust air is effectively reduced. The enlarged sections are between the barrel and the jacket functions as an expansion chamber.*

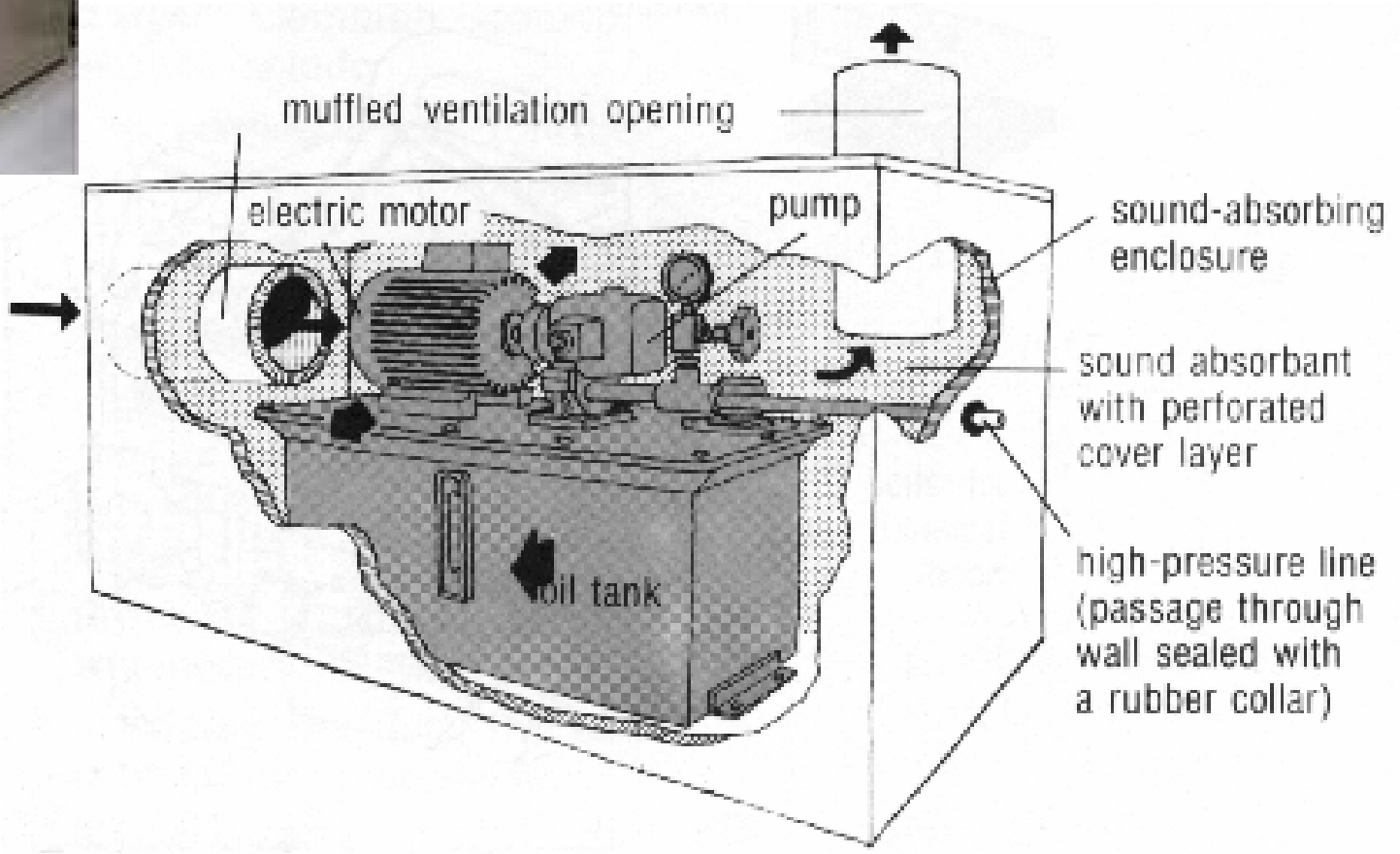


Enclosure


ventilation air
exhaust gases
sound-damping
compressor
hood
compressor
space
engine
space
air for engine
compressor air
tightly closing
door

Noise Barriers & Enclosures

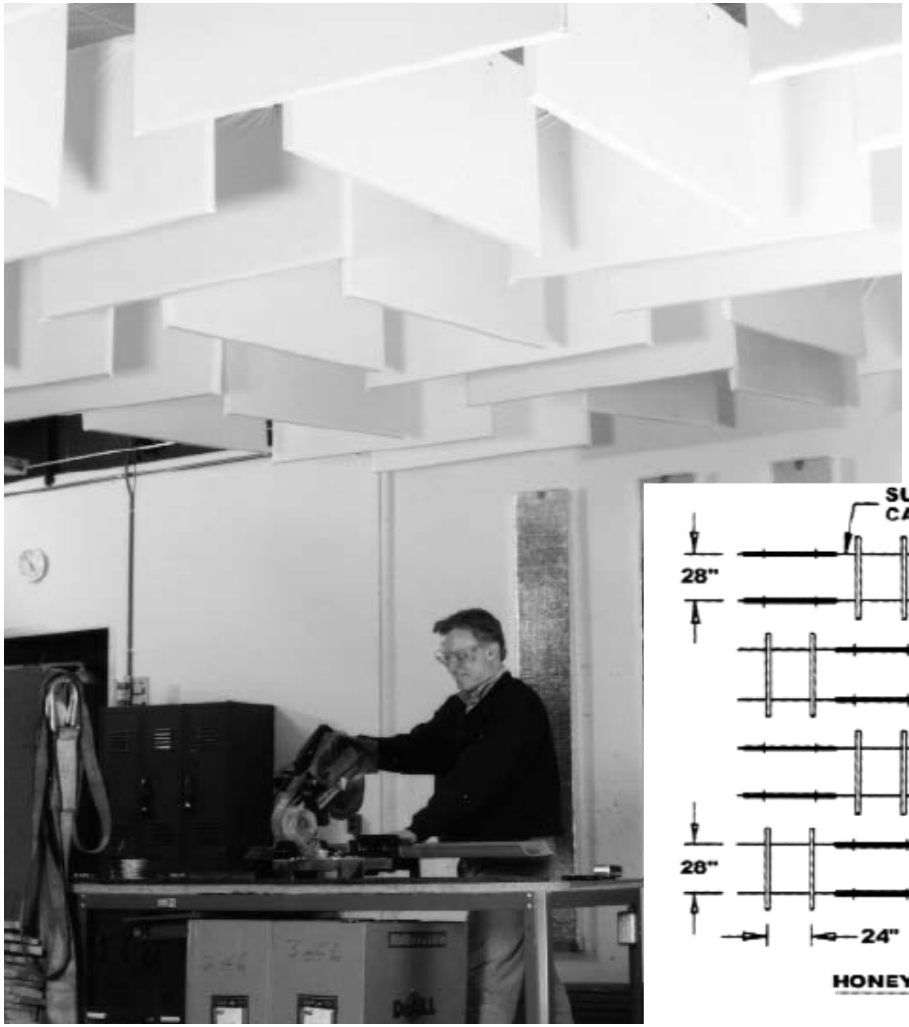
Enclosure of Electric Motor or Compressor

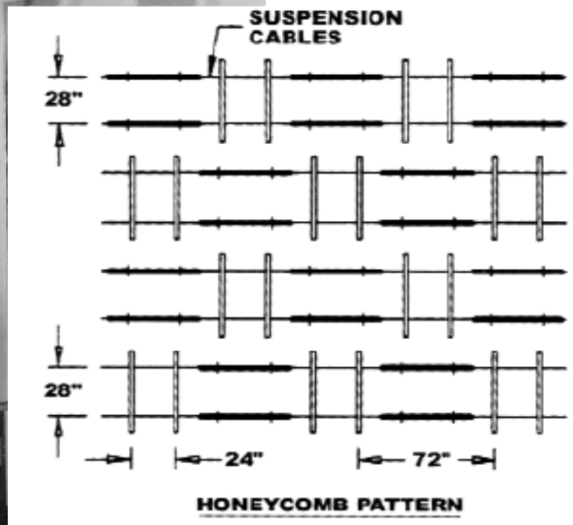


Effects of Openings in Enclosures (hypothetical)

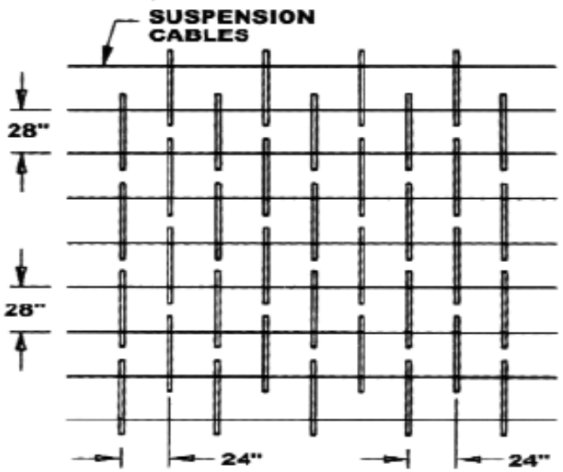
Degree of enclosure	decibel reduction
full enclosure	60 dB
0.1% open	30 dB
1% open	20 dB
5% open	13 dB
10% open	10 dB
30% open	5 dB
50% open	3 dB

Noise Absorbing Baffles





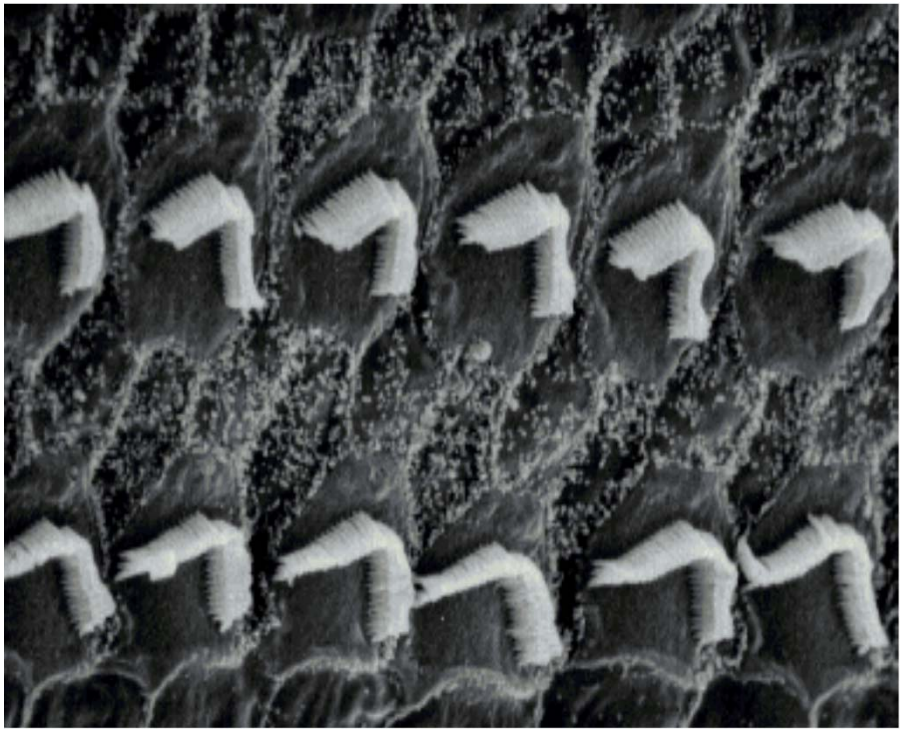
HONEYCOMB PATTERN



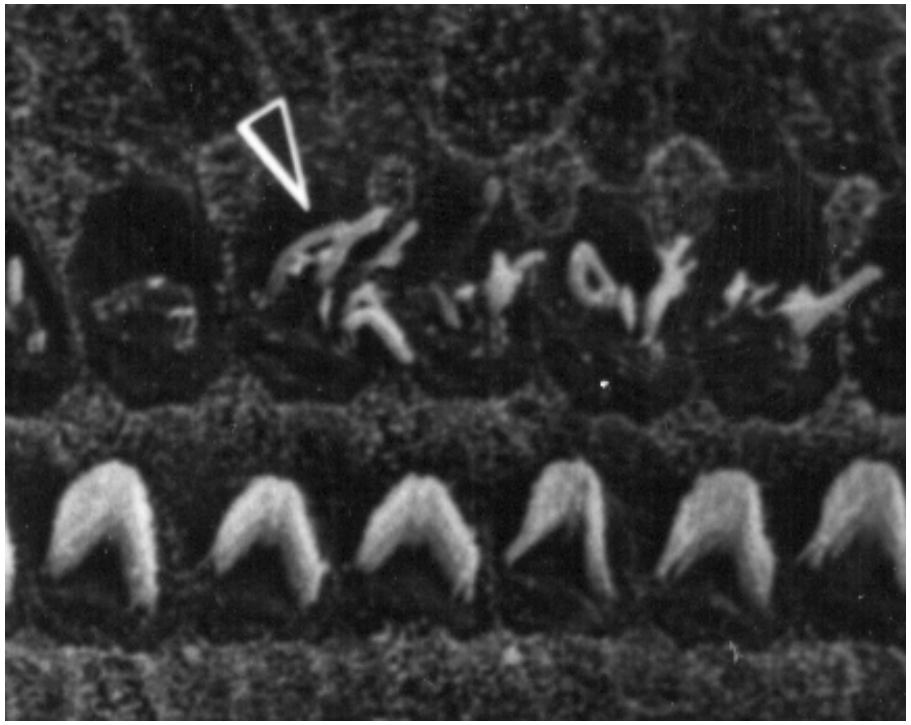
PARALLEL PATTERN

… so, what can we do? …

1) identify noise sources
2) evaluate the risks
3) recommend controls for each
4) get policy noise cap for new equipment
5) assume hearing impaired population
6) get hearing tested
7) look after your hearing
8) **KEEP AT IT!!**



This is your ear.



This is your ear on noise.

Any questions? …

Questions?