Industrial Health and Safety

Lecture 7
Electrical Hazard and Acoustical Noise

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Electrical Hazards

The use of electrical equipment and appliances is so common that most person fail to appreciate the hazards involved. Five principal categories of electrical hazards:

- **Shock to personnel**
- **Ignition of combustible (or explosive)**
- **Overheating damage burns**
- **Explosion**
- **Inadvertent**

Shocks

- **Chief source of injury with 60-Hz alternating current:**
  - **1 milliampere: Shock becomes perceptible.**
  - **5 to 25 milliamperes: Loss control of muscles.**
  - **25 to 75 milliamperes: very painful and injurious.**
  - **75 to 300 milliamperes: ≥1/4 second, immediately death.**
  - **2.5 or more amperes: clamp the heart as long as it flows.**

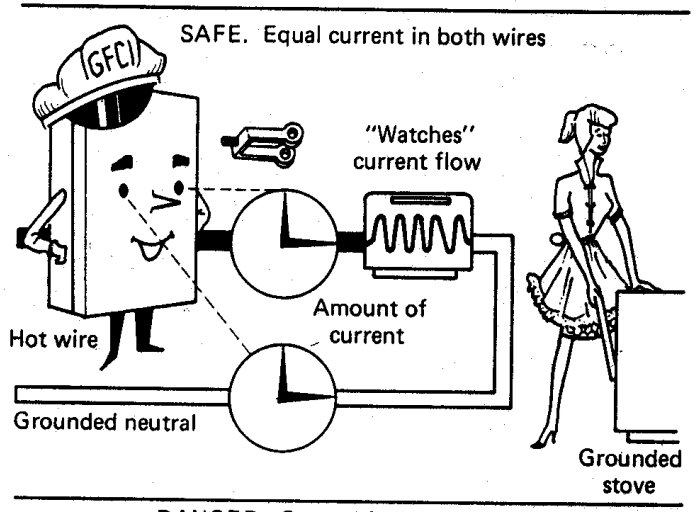
Shocks

- **Other Factors: Current path, frequency, and the duration.**
  - **Leg to leg (Completion of circuit): Contact burns.**
  - **Arm to Arm/Leg: clamp the heart/paralyze the respiratory muscles.**
  - **Alternating: ≥18V, fatal.**
  - **Direct current: ≥140V, fatal.**
  - **Frequency: 20 to 100 Hz are the most hazardous.**
  - **High-frequency less hazards.**
  - **≥2000Hz: Cause severe skin burns, less internal effect.**

Causes of a Shock

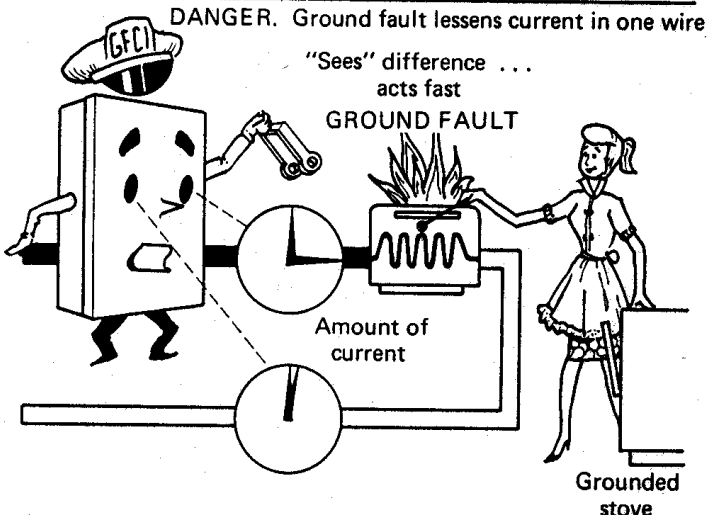
- Contact with a normally bare energized conductor
- Contact with insulation deteriorated/damaged conductor
- Equipment failure → open or short circuit
- Static electricity discharge
- Lightning strike

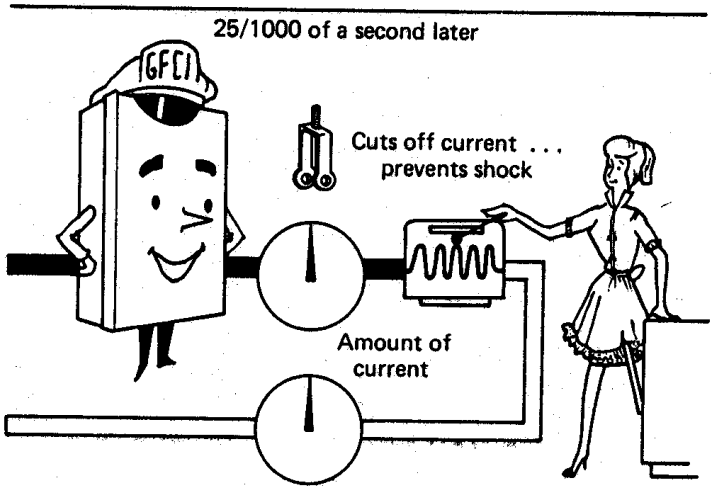
Ground-Fault Circuit Interrupter



GROUND-FAULT CIRCUIT INTERRUPTER (GFCI)*

The Ground-Fault Circuit-Interrupter (GFCI) monitors the current flow in the hot wire and the grounded neutral wire. The instant a fault develops, indicating a current flow to ground through a person or object not intended to carry it, the GFCI snaps off the power in as little as 25 milliseconds (0.025 second).





Ignition of Combustible Materials

- **Commonest means:**
  - » **Spark, arc, corona through a flammable mixture**
- **Protection Measures:**
  - » **Containment of discharges, Inherently safe devices**
  - » **Encapsulation, Embedment, and potting**
  - » **Hermetic sealing, Liquid filling**
  - » **Explosion-proof equipment**
  - » **pressurization and Isolation**

Heating and Overheating

- **Effects of Heating and Overheating:**
  - » **Raise a flammable mixture to a temperature ➡ easy ignites**
  - » **Raise the mixture to its autoignition temperature**
  - » **Cause materials to melt, char, or burn**
  - » **cause rapid vaporization of liquid fuels**
  - » **Noncombustible polymeric ➡ combustible compound**

Electrical Explosions

- **Causes of Explosion**:
  - » **Inadequate conductor-size/material, very heavy current.**
  - » **Short circuits, current surges.**
  - » **Other ways of electrical explosion.**

Circuit and Equipment Protection

- **Protection:**
  - **Circuit: fuses, circuit breakers, special piece of equipment.**
  - **Unit protection: Thermal & magnetic relays.**
  - **Resets: manual or automatic.**

Effects of Vibration, Sound, and Noise

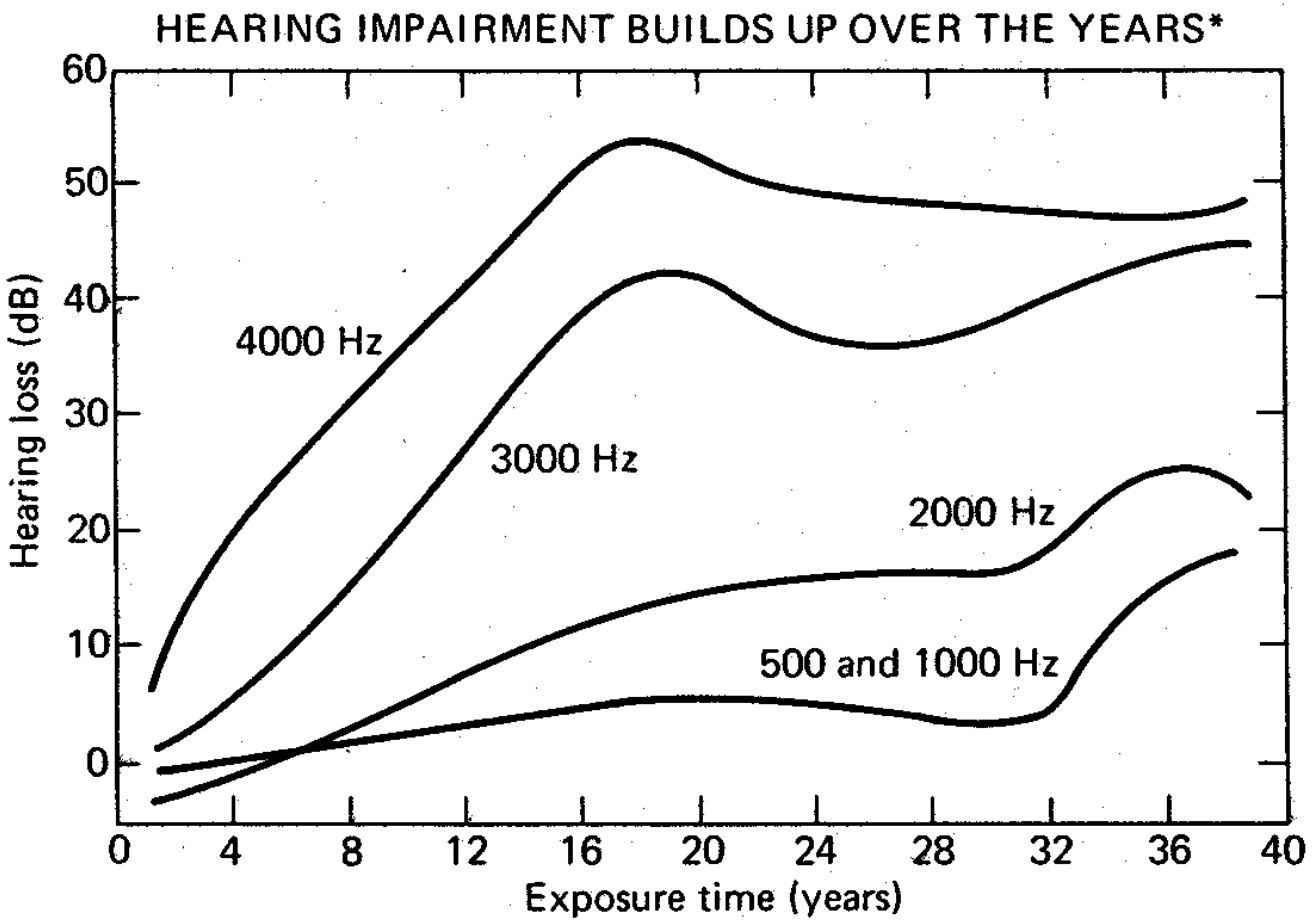
The commonest injury due to vibration is sound-induced hearing loss.

- **Noise--Unwanted sound**
- **Adverse effects:**
  - **Loss of hearing sensitivity.**
  - **Immediate physical damage (ruptured eardrums)**
  - **Annoyance, Distraction**
  - **Contributions to other disorders**
  - **Interference with other sound.**

Hearing Loss

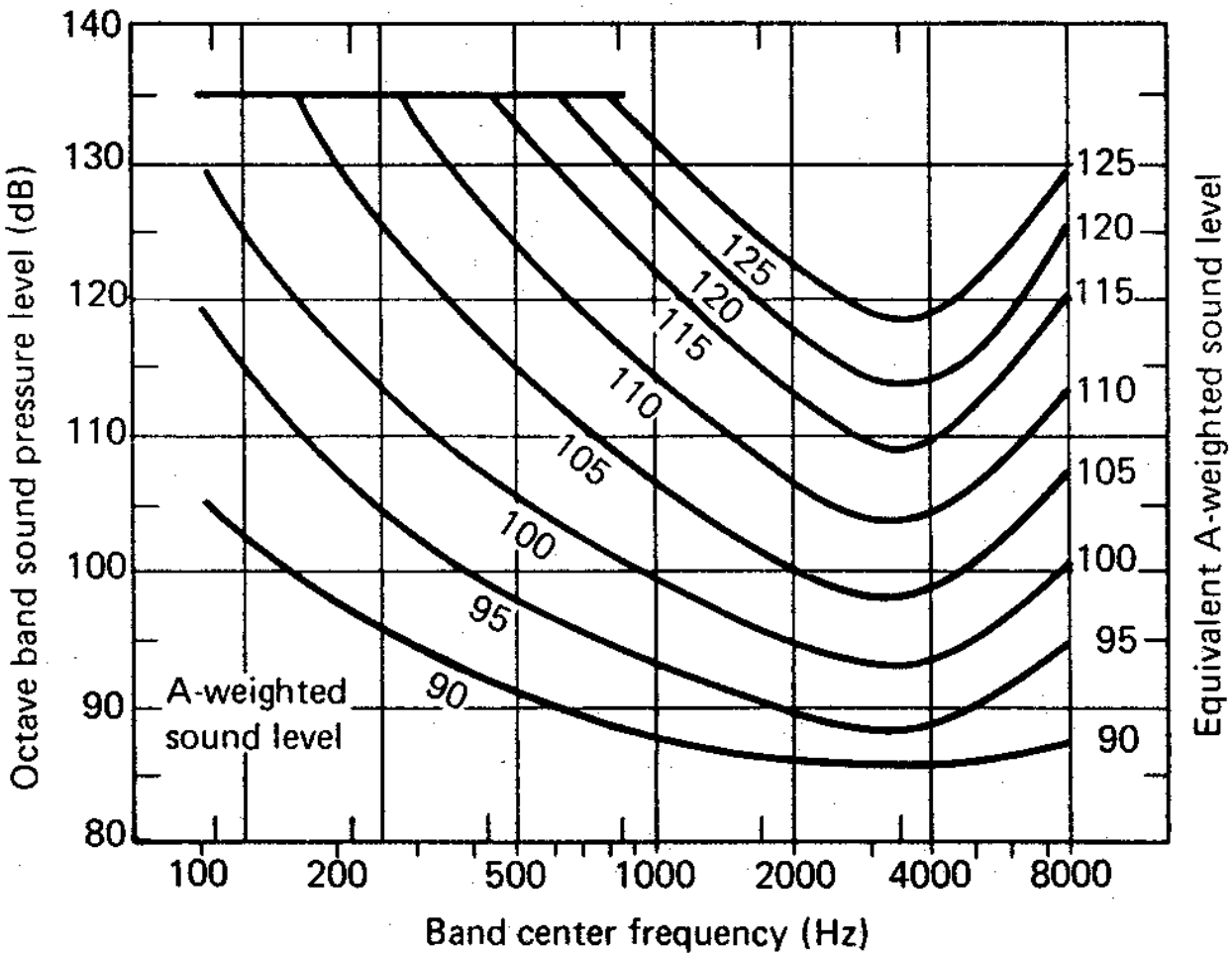
- The most important frequencies for speech understanding: 500 to 2000 Hz.
- For young person: 16 to 20,000 Hz.
- Hearing losses are greater for the higher frequencies than for the low frequencies.
- No damage potential, even with long-term exposure when ≤80dB

Accumulated Hearing



* Willie Hammer, Occupational safety management and Engineering, 3rd ed.,1985

OSHA Standards



OSHA Standards

Table

Permissible Noise Exposures

Duration per day (hours)	Sound level (dBA)
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
1/2	110
1/4 or less	115

Impulsive Noise

- Impulsive noise ⟹ most of the mechanisms of the ear are incapable of self-protection.
- Loud impulsive sound ⟹ Ringing in the ear & immediate loss of hearing sensitivity.
  - ⟹ Tightening of the blood vessels.
  - ⟹ Fatigue and headaches.

OSHA standards stipulate that personnel exposure to impulsive or impact noise ≤ 140-dB peak-sound-pressure-level fast response.

Annoyance, Distraction & Other Disorders

- Noise annoys people.
- The same types of sounds which annoy persons can also distract them.
- There are other sounds which may not annoy but can distract.
- Nervousness, psychosomatic illness, and inability to relax.

Measuring Sound Levels

- **Weighted Sound-Level Meters:**
  - » **Three weighting circuits (A, B, C) are incorporated into the standard sound level meters.**
- **Octave-Band Analyzers**

Ear Protection

- When noise levels exceed the OSHA standards, protection must be provided:
  - Wool/cotton plugs
  - Plugs: rubber or plastic devices.
  - Muffs

Eliminate Vibration & Noise

- Equipment operation/process selection
- Mount equipment on firm, solid foundation
- Keep velocity of fluids at lowest speeds possible
- Avoid using quick-acting valves in liquid system
- Avoid pipe rattling
- Locate noise activities/equipment far from other operation

Isolate

- **Isolate Sources of Vibration & Noise**
  - » **Mount equipment on vibration isolators**
  - » **Keep Floor, wall et al do not vibrate/transmit vibrations**
  - » **Sound-absorbing enclosures**
- **Isolate Personnel:**
  - » **Isolate or enclose workers**
  - » **Use protection devices**
  - » **Arrange work schedules**
  - » **Check noise levels as often as reasonable**

Hazards checklist-Vibration and Noise

Possible effects

On personnel:

- Fatigue
- Involuntary reaction to sudden loud noise
- Injury to hearing ability
- Interference with communication

Possible causes

- Irregular motion of rotating parts
- Bearing deterioration/misalignment
- Irregular or cyclic motion
- loose or undersized mountings
- Pump or blower cavitation
- Lack isolators
- Scraping of hard surface

Hazards checklist-Vibration and Noise

Possible effects

Damage to equipment:

- Metal fatigue
- Loosening of bolts
- Crazing and flaking

Operational effects:

- Loss of calibration
- Chattering of spring-type contact, valves, and pointers

Possible causes

- Bottoming or failure of shock mounts or absorbers

Fluid dynamics:

- Escaping high-velocity gas
- Jet engine exhaust
- Explosions or other violent ruptures