Lecture 7
Radiation Hazards

Radiation Hazards

- Radiation hazards in the workplace fall into one of two categories:
  - Ionizing
  - Nonionizing

Ionizing Radiation: Terms and Concepts
(1 of 10)

- **Ion**
  - Electrically charged atom (or group of atoms) that becomes charged when a neutral atom (or group of atoms) loses or gains one or more electrons as a result of a chemical reaction.
    - If an electron is lost during this process—a positively charged ion is produced.
    - If an electron is gained—a negatively charged ion is produced.

Ionizing Radiation: Terms and Concepts
(2 of 10)

- To **ionize** is to become electrically charged or to change into ions.
  - Ionizing radiation is radiation that becomes electrically charged or changed into ions.

Ionizing Radiation: Terms and Concepts
(3 of 10)

- OSHA CFR 1910.1096—basic terms and concepts:
  - **Radiation**
    - Energetic nuclear particles
      - Alpha, beta, gamma rays & X-rays
      - Neutrons, high-speed electrons, and high-speed protons

Ionizing Radiation: Terms and Concepts
(4 of 10)

- **Radioactive material**
  - Material that emits corpuscular or electromagnetic emanations
    - As the result of spontaneous nuclear disintegration

Ionizing Radiation: Terms and Concepts
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- **Dose**
  - Amount of ionizing radiation absorbed per unit of mass by part of the body or the whole body
- **Rad**
  - Measure of the dose of ionizing radiation absorbed by body tissues stated in terms of the amount of energy absorbed per unit of mass of tissue
    - One rad equals the absorption of 100 ergs per gram of tissue.

Ionizing Radiation: Terms and Concepts
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- **Rem**
  - Measure of the dose of ionizing radiation to body tissue stated in terms of its estimated biological effect relative to a dose of 1 **roentgen** (r) of X-rays
- **Air dose**
  - An instrument measures the air at or near the surface of the body where the highest dosage occurs to determine the level of the dose.

Ionizing Radiation: Terms and Concepts
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- **Personal monitoring devices**
  - Worn or carried by an individual to measure radiation doses received
    - Widely used devices include film badges, pocket chambers, pocket dosimeters, and film rings.

Ionizing Radiation: Terms and Concepts
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- **Radiation area**
  - Accessible area in which radiation hazards exist that could deliver doses as follows:
    - Within one hour, a major portion of the body could receive more than 5 millirems.
    - Within five consecutive days, a major portion of the body could receive more than 100 millirems.

Ionizing Radiation: Terms and Concepts
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- **High-radiation area**
  - Accessible area in which radiation hazards exist, that could deliver a dose in excess of 100 millirems within one hour

Exposure of Employees to Radiation (1 of 2)

- Maximum doses for individuals in one calendar quarter
- Employers are responsible for ensuring that these dosages are not exceeded.

Figure 21–2
Ionizing radiation exposure limits of humans.

Body/Body Region	Rems per Calendar Quarter
Whole body	1.25
Head and trunk	1.25
Blood-forming organs	1.25
Lens of eyes	1.25
Gonads	1.25
Hands and forearms	18.75
Feet and ankles	18.75
Skin of whole body	7.50

Exposure of Employees to Radiation (2 of 2)

- Nuclear Regulatory Commission (NRC) regulations specify total internal and external dose for employees may not exceed 5 rems per year.
  - This same revision established a total exposure limit of 0.6 rem over the entire course of a pregnancy for female employees.
  - According to the NRC, the average radiation exposure of nuclear plant workers is less than 400 millirems annually.

Precautions and Personal Monitoring (1 of 3)

- OSHA requires personal monitoring precautions for employees of companies that produce, use, release, dispose of, or store sources of ionizing radiation.
  - Employers must conduct comprehensive surveys to identify/evaluate radiation hazards in the workplace.
  - Employers must provide personal monitoring devices such as film badges, pocket chambers/dosimeters, and film rings.

Precautions and Personal Monitoring (2 of 3)

- Employers must require the use of appropriate personal monitoring devices by the following:
  - Any employee who enters a restricted area where he/she is likely to receive a dose greater than 25% of the total limit of exposure specified for a calendar quarter.

Precautions and Personal Monitoring (3 of 3)

- Any employee 18 years of age or less who enters a restricted area where he/she is likely to receive a dose greater than 5% of the total limit of exposure specified for a calendar quarter.
- Any employee who enters a high-radiation area.

Caution Signs and Labels (1 of 3)

- The universal color scheme for caution signs/labels warning of radiation hazards is purple or magenta superimposed on a yellow background.

Figure 21–3
Universal radiation symbol.

Body/Body Region	Rems per Calendar Quarter
Whole body	1.25
Head and trunk	1.25
Blood-forming organs	1.25
Lens of eyes	1.25
Gonads	1.25
Hands and forearms	18.75
Feet and ankles	18.75
Skin of whole body	7.50

Caution Signs and Labels (2 of 3)

- OSHA and NRC require caution signs in:
  - Radiation areas
  - High-radiation areas
  - Airborne radiation areas
  - Areas that contain radioactive materials
  - Containers in which radioactive materials are stored or transported

Caution Signs and Labels (3 of 3)

- On containers, the label should also include:
  - Quantity of radioactive material
  - Kinds of radio-active materials
  - Date on which the contents were measured

Evacuation Warning Signal (1 of 3)

- Companies that produce, use, store, or transport radioactive materials are required to have a signal-system that can warn of the need for evacuation.

Figure 21–4
Sample warning sign.

Source: trekandshoot/Shutterstock.

Figure 21–6
Cumulative radiation exposure record.

Employee _____

Dates Covered _____

	Rems in 1st Quarter	Rems in 2nd Quarter	Rems in 3rd Quarter	Rems in 4th Quarter	Total
Whole body; head and trunk; blood-forming organs; lens of eyes; or gonads (1¼ rems max/quarter)					
Hands and forearms; feet and ankles (18 rems max/quarter)					
Skin of whole body (7½ rems max/quarter)					

Electromagnetic Fields in the Workplace
(1 of 4)

- Studies of potential effects on worker health of occupational exposure to electric and magnetic fields reported a variety of subjective complaints.
  - Problems with their cardiovascular, digestive, and central nervous systems

Electromagnetic Fields in the Workplace
(2 of 4)

- While much of the research has been inconclusive, the case for a clear link between EMFs and a variety of health problems is strong.

Electromagnetic Fields in the Workplace
(3 of 4)

- The health problems most frequently associated with EMF exposure:
  - Brain cancer
  - Acute myeloid leukemia
  - Leukemia
  - Lymphatic leukemia

Electromagnetic Fields in the Workplace
(4 of 4)

- Occupations with a higher-than-normal incidence of leukemia and brain cancer:
  - Telephone operators, electrical manufacturing workers
  - Power plant workers, electrical engineers, and line workers
  - Power station operators, electricians, and cable splicers

Cancellation Approach (1 of 2)

- **Cancellation**
  - Attenuation technique in which the magnetic fields produced by sources of electricity are, in effect, canceled out
  - Phase currents flowing through a given conductor are canceled out or drastically reduced by phase currents flowing in the opposite conductors.

Cancellation Approach (2 of 2)

- In many cases, a principal source of magnetic fields is found to be the conductor systems leading to tools or power apparatus.
  - These fields could be canceled via compaction of the conductor systems.

Shielding Approach (1 of 3)

- **Shielding**
  - Approach to decrease exposure to EMFs.
  - Requires the magnetic fields to be:
    - Diverted around the volume considered to be sensitive to the magnetic fields
    - Contained within the device that produces the fields

Shielding Approach (2 of 3)

- Effectively accomplishing shielding at either the source or the subject requires extreme care in choosing the shielding material.

Shielding Approach (3 of 3)

- Both cancellation and shielding are highly technical approaches requiring specialized knowledge.
  - It may be necessary to consult with EMF experts before attempting to implement either approach.

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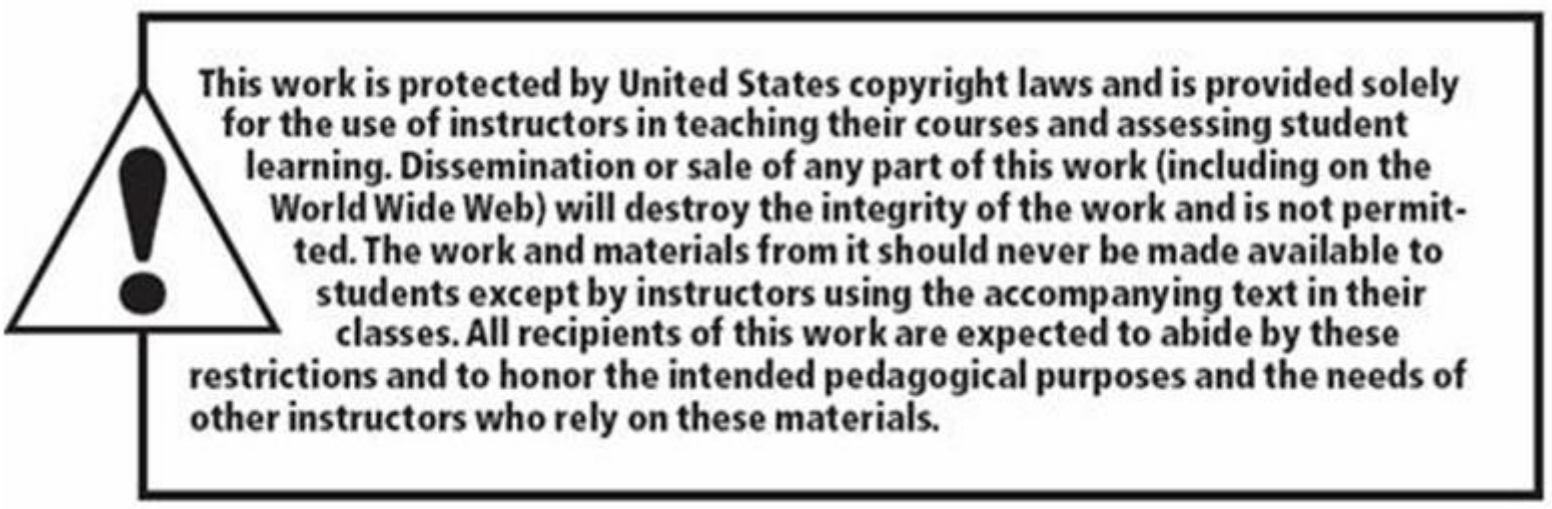

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