



## **8-Hours**

# **Basic Radiation Protection Training for Authorized Users of Fixed and Portable Gauges**

## **SYLLABUS**

PRESENTED BY:  
Applied Environmental Consulting, Inc.

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### **COURSE OVERVIEW**

History of Radiation  
Fundamentals of Radiation  
Radioactivity Measurements  
Half-Life  
Interaction with Matter and Biological Effects  
Dose and Dose Risks  
Radiation Protection Techniques  
Radiation Detection and Instrumentation  
Regulatory Authorities  
Ensuring Compliance  
Role of Personnel  
What are Gauges and How do they Work?  
Tasks to Perform on Gauges  
Radiation Work Permit (RWP) for Gauges  
Radiation Safety Concerns Regarding Gauges  
Record Keeping  
Transporting and Shipping Gauges  
Test

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## HISTORY OF RADIATION DISCOVERY, HISTORICAL EVENTS & EMERGENCE OF REGULATORY AGENCIES

The Beginning

Discovery of Radiation

Henri Becquerel  
Wilhelm Roentgen  
Madam Curie  
(Plus others)

Development of Nuclear Technology

Manhattan Project  
Albert Einstein  
Enrique Fermi  
Development of the Nautilus  
Development of the Atomic Energy Act

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## RADIATION FUNDAMENTALS

Atomic Structure

Nuclear  
Proton  
Neutron: Extra-nuclear  
Electron: Classification

Atomic Number  
Atomic Weight

Unstable Atoms & Emissions

Characteristics of Radioactive Materials

Unstable  
Detectable  
Spontaneous Emission  
Emission from nucleus of atoms  
Photons: Gamma  
Particles: Alpha, Beta, Neutron  
Emissions from outer shells of atoms  
Photons: X-ray

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## RADIOACTIVITY AND HALF-LIFE

### Units for Disintegrations

Radioactivity  
Disintegration  
Disintegration per Unit Time (dps, dpm)  
Curie  
Becquerel  
Total Activity  
Specific Activity/Activity Concentration

### Half-Life

Carbon-14 Dating  
Radioactive Decay

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## INTERACTION OF RADIATION WITH MATTER

### Energy Disposition in the Body

REM  
Sievert  
Dose rates

### Energy Disposition in Air

Interactions  
Ionizations  
Excitation  
Energy Deposition in Air  
Roentgen  
Exposure Rates

### Energy Disposition in Matter

Gray  
Relative Biological Effectiveness (RBE)  
Linear Energy Transfer (LET)

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## RADIATION IN BIOLOGY

### Sources of Dose

- External
- Internal
- Man-made and Natural

### Types of Dose

- Acute
- Fractionated
- Chronic

### Types of Dose Effects

- Somatic
- Genetic
- Teratogenic

### Variable in Dose Effects

- Amount of Dose
- Critical Organ
- Type of Radiation
- Individual Biological Variations
- Radio sensitivity and Radio resistance

### Types of biological effects in The Cell

- Types of Biological Variations
- Radio sensitivity and Radio resistance

### Types of Risks

- Definition
- Comparisons with other types of risks

### Causes of dose

- Stochastic
- Non-Stochastic

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## RADIATION PROTECTION

### Principles of Exposure Control

- Time
- Distance (Inverse Square Law)
- Shielding
- As Low As Reasonably Achievable (ALARA)

### Shielding

- Administrative Controls and Levels

- Administrative Controls
  - Establishing administrative limits
  - Engineering (Mechanical) Controls
  - Signs, labels and postings
- Radiation Dose Limits
  - Radiation Workers
  - Members of the Public (MOP) study
- Monitoring External dose
  - Personnel Monitoring Devices
  - OSLDs/TLDs/Film Badges
  - Pocket Dosimeters
  - Active Monitors (reading real time)
  - Pocket Ion Chamber

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## PORTABLE SURVEY METERS

Types

Geiger-Mueller (GM)

Scintillation

Reading Results

Comparing instrumentation for hazards:  
BIOLOGICAL, CHEMICAL and RADIOLOGICAL

CPM vs. DPM

Scales and displays

Radiation Levels

Efficiency and Calibration

Efficiency

Calibration

Operating a Survey Meter

Battery check/Calibration check/Check source

Establish Background

cpm vs. mR/hour

High to Low scales

End window

LAG Time (GM)

Use & Care

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## IMPLEMENTING A RADIATION PROTECTION PROGRAM

- Establish a Radiation Protection Manual (RPM)
  - Scope of Authorized Work
  - Role of Personnel
    - Radiation Safety Officer (RSO)
    - Advanced Authorized User (40-hour)
    - Authorized User (less than 40-hour, usually 8-hour)
    - Ancillary workers
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## REGULATORY AUTHORITY

- Non-Federal Agencies
  - Agreement States and Licensing States
  - Regulate:
    - Naturally-Occurring Radioactive Materials
    - Naturally-Occurring and Accelerator Produced Radioactive Materials (NARM)
- The Radioactive Materials License
  - Specific License and General License
  - Authorized Materials
  - Inspections
- Role of Regulatory Agencies
  - Issue License
  - Inspect
  - Sealed Source and Device Registry
- ALARA Review
  - Notice To Employees
  - New Personnel and Refresher Training Requirements

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## FIXED AND PORTABLE DENSITY GAUGES

- Fixed Gauges
  - Parts of the Gauge
  - Operating Principle
- Portable Gauges
  - Types of Gauges
  - Types of Radiation Materials
  - Concerns and Requirements



Shutter Operations    Operation  
                                  Checks  
                                  Lock Out/Tag Out  
Gauge Condition        Categories  
                                  Survey  
                                  Leak Testing Procedures  
Gauge Care and Maintenance  
                                  Confined Spaces Tasks

Personnel and Roles  
Radiation Work Permit for Gauges  
                                  How it is applied to gauges?  
                                  Pros and Cons

Installation and Relocation  
                                  What is it?  
                                  Who can do it?  
                                  How, When and Who?

Transportation        Procedures  
                                  Labels  
                                  Overpack  
                                  General & Specific Licensees  
                                  Placarding

Activation Analysis    Procedures  
                                  Cf-252 Characteristics  
                                  Cf-252 Operating Principle

**TEST**

**50 Questions**

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**MATH REVIEW** (Available for students to peruse and update their math skills)

Basic Math  
Algebra Review  
Scientific Notation  
Exponents and Logarithms  
Using Your Calculator

Radiation Math  
Radioactivity  
Half-Life  
Time, Distance and Shielding  
Radiation Work Permit (RWP)