40-Hour Radiation Safety Officer Training
For Industrial Gauge Users

SYLLABUS

PRESENTED BY:
Applied Environmental Consulting, Inc.

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
Radiation Safety Officer Duties
Types of Gauges
How Gauges Function
Tasks to be performed with gauges
How to Relocate a Fixed Gauge
Use and limitations of the Radiation Work Permit (RWP)
Transportation of Gauges

MATH REVIEW

How to use the Math Primer
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)

LESSON 1: HISTORY OF RADIATION DISCOVERY, HISTORICAL EVENTS & EMERGENCE OF REGULATORY AGENCIES

TOPIC 1	The Beginning
TOPIC 2	Discovery of Radiation
	Henri Becquerel
	Wilhelm Roentgen
	Madam Curie
	(Plus others)
TOPIC 3	Development of Nuclear Technology
	Manhattan Project
	Albert Einstein
	Enrique Fermi
	Development of the Nautilus
	Development of the Atomic Energy Act

LESSON 2: RADIATION FUNDAMENTALS

TOPIC 1	Energy Spectrum
	Ionization
	Non-Ionizing
TOPIC 2	Atomic Structure
	Nuclear
	Proton
	Neutron: Extra-nuclear
	Electron: Classification
	Atomic Number
	Atomic Weight
TOPIC 3	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

LESSON 3: RADIOACTIVITY AND HALF-LIFE

TOPIC 1 Units for Disintegrations
- Radioactivity
- Disintegration
- Disintegration per Unit Time (dps, dpm)
- Curie
- Becquerel
- Total Activity
- Specific Activity/Activity Concentration
- Background vs. Contamination

PRACTICAL EXERCISE: Problems

TOPIC 2 Half-Life
- Carbon-14 Dating
- Short/Long Half-Lives
- Half-life Formula

PRACTICAL EXERCISE: Problems

LESSON 4: INTERACTION OF RADIATION WITH MATTER

TOPIC 1 Energy Disposition in Air
- Interactions
- Ionizations
- Excitation
- Energy Deposition in Air
- Roentgen
- Exposure Rates

TOPIC 2 Energy Disposition in Matter
- RAD
- Gray
- Relative Biological Effectiveness (RBE)
- Linear Energy Transfer (LET)

TOPIC 3 Energy Disposition in the Body
- REM
- Sievert
- Dose rates

PRACTICAL EXERCISE: Problems

LESSON 5: RADIATION IN BIOLOGY

TOPIC 1	Sources of Dose
	External
	Internal
	Man-made and Natural
TOPIC 2	Types of Dose
	Acute
	Fractionated
	Chronic
TOPIC 3	Types of Dose Effects
	Somatic
	Genetic
	Teratogenic
TOPIC 4	Variable in Dose Effects
	Amount of Dose
	Critical Organ
	Type of Radiation
	Individual Biological Variations
	Radio sensitivity and Radio resistance
TOPIC 5	Types of biological effects in The Cell
	Types of Biological Variations
	Radio sensitivity and Radio resistance
TOPIC 6	Types of Risks
	Definition
	Comparisons with other types of risks
TOPIC 7	Causes of dose
	Stochastic
	Non-Stochastic

LESSON 6: RADIATION PROTECTION

TOPIC 1	Time
	Principles of Exposure Control
	Time

PRACTICAL EXERCISE: Problems

TOPIC 2 Distance (Inverse Square Law)

PRACTICAL EXERCISE: Problems

TOPIC 3 Shielding

- HVL and TVL

PRACTICAL EXERCISE: Problems

TOPIC 4 As Low As Reasonably Achievable (ALARA)

TOPIC 5 Administrative Controls and Levels

- Administrative Controls
- Establishing administrative limits
- Engineering (Mechanical) Controls
- Signs, labels and postings

TOPIC 6 Radiation Dose Limits

- Radiation Workers
- Members of the Public (MOP) study

TOPIC 7 Monitoring External dose

- Personnel Monitoring Devices
- OSLDs/TLDs/Film Badges
- Pocket Dosimeters

TOPIC 8 Monitoring Internal Dose

- Bioassays
- Direct and in vitro

TOPIC 9 Active Monitors (reading real time)

- Pocket Ion Chamber

LESSON 7: PORTABLE SURVEY METERS

TOPIC 1 Types

- Geiger-Mueller (GM)
- Scintillator
- Comparing instrumentation for hazards: BIOLOGICAL, CHEMICAL and NUCLEAR

TOPIC 2 Reading Results

- CPM vs. DPM
- Scales and displays
- Radiation Levels

TOPIC 3 Efficiency and Calibration

- Efficiency
- Calibration

TOPIC 4 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

LESSON 8: IMPLEMENTING A RADIATION PROTECTION PROGRAM

TOPIC 1	Establish a Radiation Protection Manual (RPM)
TOPIC 2	Scope of Authorized Work
TOPIC 3	Role of Personnel
	Radiation Safety Officer (RSO)
	Advanced Authorized User (40-hour)
	Authorized User (less than 40-hour, usually 8-hour)
	Ancillary workers
TOPIC 4	ALARA philosophy emphasized
	Time, Distance and Shielding
TOPIC 5	Contamination Control
	Fixed, Removable & Airborne
	Friskers, glovebox & step-off pads
TOPIC 6	Wearing of PPE & Personnel monitoring
	Protective clothing
	Protective masks
TOPIC 7	Performing Personnel Monitoring
TOPIC 8	Emergencies and Spills
	Major Spills
	Minor Spills
TOPIC 9	Storage/Disposition of radioactive wastes
TOPIC 10	Posting and Notification
TOPIC 11	Radiation Work Permit
	Tools for the RSO
	Documents task
	Can be used in lieu of personnel badges
TOPIC 12	Record Keeping

LESSON 9: REGULATORY AUTHORITY

TOPIC 1 Regulatory Agencies (Federal)

- USNRC
  - Types of radioactive materials regulated:
    - By-Product Material
    - Source Material (Source of SNM)
    - Depleted uranium
    - Special Nuclear Materials (SNM)
    - Fissionable
- USEPA
- OSHA
- FDA
- USDOE

TOPIC 2 Non-Federal Agencies

- Agreement States and Licensing States
- Regulate:
  - Naturally-Occurring Radioactive Materials (NORM) (to include TENORM)
  - Naturally-Occurring and Accelerator Produced Radioactive Materials (NARM)

TOPIC 3 The Radioactive Materials License

- Authorized Materials
- Authorized Use
- Authorized Users
- CONDITIONS
- Location
- Leak Testing
- Surveys
- Inventory
- Training
- Record keeping requirements
- “Catch all” Condition

TOPIC 4 Role of Regulatory Agencies

- Issue licenses based on:
- ENGINEERING, TRAINING, PROCEDURES
- Inspections
- Amendments
- Termination
- REGUIDE
- Sealed Source and Device Registry

LESSON 10: ENSURING COMPLIANCE

TOPIC 1	Annual ALARA review
TOPIC 2	Delegation of Authority
TOPIC 3	Facilities Management
	Record Keeping (Maintaining LOGBOOK)
	Instrument calibration
	Inventory
	Surveys
	Transfer/shipment documents
	Leak tests (for sealed sources)
TOPIC 4	Training
	Training of new personnel and refresher
TOPIC 5	Set up a Personnel Monitoring Program
TOPIC 6	Radiation Work Permit (RWP)
	Pros & Cons

LESSON 11: TRANSPORTATION

TOPIC 1	Regulations
	Items required to be trained in HAZMAT site specific to the facility to include: Type of packages: Type A, Type B, LSA, Strong-tight container
	Definition of Package
	Reportable Quantities
	Bill of Lading
	Labels, markings and placards
	Exempt quantities
	Receiving/Shipping radioactive materials
	Opening packages
	What to do for damaged items
	Roles of RSO / Authorized Users

LESSON 12: GAUGES

FIXED GAUGES

TOPIC 1	Cesium-137 & Cobalt-60
	Parts of the Gauge
	Operating Principle
TOPIC 2	Portable Gauges
	Security
	Logbook
	USDOT HAZMAT Training
	ALARA: Time, Distance & Shielding
TOPIC 3	Shutter operations
TOPIC 4	Gauge Condition: Good/Fair/Poor
	Surveys
TOPIC 5	Leak Testing
TOPIC 6	Care & Maintenance
TOPIC 7	RSO Duties
	Radiation Personnel
	Advanced Authorized User
	Authorized User
	Ancillary Worker
TOPIC 8	Radiation Work Permit (RWP)
TOPIC 9	Instrumentation Used
TOPIC 10	Transportation (USDOT HAZMAT)

Cf-252

TOPIC 11	Activation Analysis
	Continuous elemental analysis
	Produces neutrons for activation of elements
	Leak testing at 6 months by the manufacturer
	Transportation (USDOT HAZMAT)