Radiation Safety Officer Training
For Industrial Gauge Users
40-Hours

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)