



Radiation Safety Associates, Inc.

HEALTH PHYSICS TECHNICIAN LEVEL II -- ADVANCED

COURSE OUTLINE

BASIC MATHEMATICS & SCIENCE REVIEW

Mathematics review
Scientific notation
Significant figures
Consistency of units
Graphing practices
Power functions
Exponential functions
Trigonometric functions
Basic physics review
Structure of matter
Newtonian mechanics
Electricity
Electronics
Other sciences
Biology
Chemistry

THEORY OF RADIOACTIVITY

Atomic structure
Thomson model
Rutherford model
Bohr model
Nuclear structure
Nuclear model
Nuclear stability
Binding energy
Nuclear decay processes
Radioactivity
Alpha decay
Beta decay
Gamma ray emission
Fission decay
Radioactive decay law

INTERACTIONS OF RADIATION WITH MATTER

Neutron interactions
Introduction
Slow neutron interactions
Fast neutron interactions
Photon interactions
Introduction
Photoelectric effect
Compton scattering
Pair production
Absorption & attenuation
Coefficients
Charged particle interactions

Energy loss mechanisms
Stopping power
Specific ionization
Range of a charged particle
Linear energy transfer

BIOLOGICAL EFFECTS OF RADIATION

Radiation effects on water
Primary reactions
Secondary reactions
Pre-irradiation chemical protection
Radiation effects on cells
Cell structure
Radiation effects
Human biodosimetry techniques
Cell radiosensitivity theories
Relative biological effectiveness
Radiation effects on human organs
Blood system
Gastrointestinal system
Central nervous system
Reproductive system
Conclusions
Whole body effects in humans
Acute effects
Human late effects-genetic
Human late effects-somatic
Effects of chronic irradiation conditions
Radiation hormesis
Whole body radiation risk
Dose-effect models for radiation risk
Post-irradiation treatment of radiation injury
Radiobiological basis for ALARA

RADIATION QUANTITIES & DOSIMETRY CALCULATIONS

Radiation quantities & units
Introduction
Activity
Exposure
Absorbed dose

Dose equivalent & equivalent dose
Effective dose equivalent & effective dose
Committed dose equivalent family
Roentgen/rem conversion factors
Radiation dose calculations
Point gamma ray sources
Bragg-Gray theory
Neutron dosimetry
Skin dose from beta emitters

RADIATION SOURCES

Natural radiation sources
Introduction
External terrestrial
Internal terrestrial
Cosmic radiation
Radiation in space
Naturally occurring radioactive material (NORM)
Artificial radiation sources
Fallout
Electronic product radiation
Product radioactivity
X-ray tubes
X-ray machine applications
Nuclear radionuclide applications
Nuclear particle accelerators
Nuclear reactors
Department of Energy weapons production
Miscellaneous industrial sources
Isotopic neutron sources
Oil well logging
Radiation sterilization
Summary

RADIATION DETECTORS

Detection mechanisms
Gas-filled radiation detectors
Characteristic curve
Ion chambers
Proportional counters
Geiger counters
Liquid radiation detectors

Liquid scintillation counters
Superheated drop detectors
Solid radiation detectors
Scintillation counters
Semiconductor counters

EXTERNAL PERSONNEL DOSIMETER SYSTEMS

The ideal personnel dosimeter
Photographic badge systems
Basic principles
Film response to radiation
Film badge holder design
Thermoluminescence badge systems
Principle of
thermoluminescence
Characteristics of lithium
fluoride
Characteristics of lithium
tetraborate
Characteristics of calcium
sulfate
Neutron response of TLD
phosphors
TLD badge systems
Hybrid badges
Radiation badge performance
testing
Criticality badges
Criticality accidents
Criticality badge principles
Criticality badge holders
Special applications
U.S. regulatory requirements

INTERNAL DOSIMETRY TECHNIQUES

Bioassay techniques
Basic principles
Practical bioassay
applications
In vivo counting techniques
Basic principles
Liquid scintillation whole body
counter
Solid crystal scintillation
whole body counters
Partial body in vivo counters
Data analysis complications
Intake calculations
Single uptake events
Multiple or continuous
uptakes
Internal dosimetry calculations
Basic principles
Mathematics of clearance

The ICRP Internal Dosimetry
Models
Practical internal dose
calculations
Dose calculation for
embryo/fetus
Summation of external & internal
dose
Introduction
Compliance reporting of dose

ENVIRONMENTAL MONI- TORING PROGRAMS & EQUIPMENT

Monitoring programs
Introduction
Pre-operational & post-
operational Programs
Monitoring program
examples
Environmental Instruments
External gamma radiation
Surface deposited activity
Air sampling instruments---
particulates
Air sampling
instruments-gases
Measurements of radon gas
in buildings
Water sampling
Food sampling
Environmental problem areas
Radon & public health
Dose-reconstruction
principles
Some environmental
restoration projects

PROTECTION PRINCIPLES, SHIELDING & TRANSPORT

Basic principles
The ALARA philosophy
ALARA program planning
Control of exposure time
Exposure control through
distance
Shielding design
Gamma ray shielding
Beta ray shielding
Neutron shielding
Applied shielding examples
Nuclear reactors
Medical facilities
Industrial radiography
Nuclear particle accelerators
Transporting radioactive
packages

Introduction
Packaging
Labeling
Markings & Shipping Papers
Internal Protection
Introduction
Respirators
Fume Hoods
Glove Boxes

SURVEYS, CALIBRATIONS & DATA ANALYSIS

Principles of monitoring &
calibration
Introduction
General calibration principles
Alpha radiation monitoring
Gamma radiation fields
Beta radiation fields
Mixed beta-gamma radiation
fields
Neutron radiation fields
Removable radioactive
surface contamination
Decommissioning nuclear
facilities
Introduction
Decommissioning surveys
Survey plan
Survey techniques
Data interpretation
Counting statistics for data
analysis
Introduction
Count rate & its error
Confidence level
Background corrections
Detection sensitivity-LLD &
MDA
Interpretation of final
clearance survey results

RADIOACTIVE WASTE MANAGEMENT

Sources & disposition of
radioactive waste
Radioisotope use
The nuclear fuel cycle
Existing disposal sites
Radioactive waste management
principles
Applied processing techniques
Concentration of solids
Solidification of high level
liquids
Mixed waste
Long term storage methods

- Low level waste burial
- High level waste storage & disposal
- The politics of radioactive waste
- Nuclear waste compacts
- Proposed new LLW disposal facilities
- Retirement of past disposal facilities

HANDLING NUCLEAR EMERGENCIES

- Classification of accidents & incidents
- Introduction
- Classification by damage & dose
 - Classification by location
 - Classification by exposure conditions
- Accident phases
 - Occurrence phase
 - Emergency phase
 - Recovery phase
 - Restoration phase
- Emergency planning & response
 - Emergency plan components
 - Initial accident response
 - Emergency screening
 - Medical aspects
 - Guidance on emergency radiation doses
 - Special cases
- Review of past accidents
 - Windscale reactor core fire
 - Plutonium plant criticality accident
 - Oak Ridge plutonium dispersion
 - The SL-1 reactor accident
 - Three Mile Island accident
 - Chernobyl
 - Goiania Cs-137 dispersal
 - Contaminated scrap metal
- accident management
 - Public relations & legal aspects of nuclear incidents

RADIATION PROTECTION STANDARDS & REGULATIONS

- Standards-setting organizations
 - ICRP
 - ICRP
 - IAEA
 - NCRP
 - NRC
 - ANSI
 - Agreement states
- Types of standards
 - Regulations
 - Regulatory guide
 - Recommendation/consensus
 - License condition
- Bases for protection standards
 - ALARA
 - Biological
 - Comparable risk
 - Checks & balances
- Dose limiting regulations
 - Occupational workers
 - Members of the public
 - 10 CFR Part 20 (version of 1991)
 - 10 CFR Part 835
 - ICRP Publication 60
 - NORM regulations
 - Epilogue
- S-1 Reactor health physics
- Reactor physics
 - Physics of fission
 - Reactor period
 - Reactivity coefficients
 - Fission product poisons
 - Reactor engineering
 - Power reactor design types
 - PWR features & characteristics
 - BWR features & characteristics
 - RBMK-1000 features & characteristics
 - Power reactor startup
 - Rad waste handling systems
- Health physics aspects of power reactors
 - ALARA design features
 - ALARA operational practice
 - Radiation protection facilities & equipment
 - Performance Indicators
 - Routine operational health physics
 - Special operational situations

- Future trends for power reactors
 - Aging at US plants
 - Standard plant designs
- Research reactor operational HP
 - Introduction
 - Routine operations

- S-2 working safely with radioisotopes
 - Introduction
 - Working safely with uranium
 - Chemical & physical properties
 - Radiobiology & isotope metabolism
 - Radiation protection measurements
 - Toxicity & standards
 - Working safely with krypton-85
 - Introduction
 - Chemical & physical properties
 - Radiobiology & isotope metabolism
 - Radiation protection measurements
 - Toxicity & standards

A-1 ADDRESS LIST OF RELEVANT ORGANIZATIONS

A-2 RADIONUCLIDE DECAY INFORMATION

A-3 DATA FOR NEUTRON INSTRUMENT CALIBRATIONS

A-4 OUTLINE OF A FINAL DECOMMISSIONING SURVEY REPORT

- Answers to numerical problems

Course offered at our Hebron, Connecticut facility in rotation with other radiation safety courses. For more information, see our website at <http://www.radpro.com/training/>, or contact us at 860.228.0487.