



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 MONITORING 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/calendar.html>, or contact us at 860.228.0487.

