# RECLAMATION
*Managing Water in the West*

U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
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***Fax Cover***

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Course Information you requested

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## The Instructors

***FREDERICK P. STRACCIA** has over twenty-five years practical health physics experience. He holds a B.S. Degree in Radiological Health Physics from the University of Lowell. Mr. Straccia has been responsible for training Radiation Protection Technicians in commercial nuclear power plants. He has also worked at a large industrial Technical Center, and was responsible for all aspects of their broad scope NRC license, including RSO training course development and instruction.

***ERIC L. DAROIS** holds an M.S. Degree in Radiological Sciences and Protection from the University of Lowell with over twenty-five years of experience. He has held various health physics positions including Health Physics Supervisor at a commercial nuclear power plant and Senior Scientist at a major environmental laboratory. Mr. Darois has provided training for health physics technicians at commercial nuclear power plants and short courses in instrument calibration. He has extensive experience in instrument design and applications.

***JAMES P. TARZIA** holds an M.S. Degree in Radiological Sciences and Protection from the University of Lowell. He has over twenty years of experience in both research and commercial reactor facilities and has worked on DOE contracts. His areas of concentration include internal and external dosimetry, instrumentation, and health physics computer applications. Mr. Tarzia has provided health physics instruction for health physics technicians, undergraduate-level college classes, and radiation safety officers.

**These instructors are Comprehensive Certified Health Physicists. As RSCS principals, they operate a nuclear instrumentation calibration facility and analytical measurement laboratory and perform consulting for Radioactive Material Licensees.*

RSCS
Radiation Safety Control Services, Inc.

## Course Descriptions

**5 - DAY RSO COURSE**

This comprehensive 40-hr. course provides students with a balance of technical theoretical information and practical applications of radiation safety. Fundamental concepts are presented in a logical progression, providing a sound basis for understanding the day-to-day requirements of the Radiation Safety Officer. An optional exam for RSO's whose programs require testing is also provided. Several software programs and internet sites are showcased allowing improvement in efficiency and effectiveness of your Radiation Protection Program.

**3 - DAY ADVANCED RSO COURSE**

This 3 day course includes a review of basic theoretical concepts and in-depth discussions of operational programs, licensing issues, and regulatory considerations. Several NRC positions, Regulatory Guides, and NUREGs will be presented. This course also provides the participants an opportunity to discuss their specific license issues. We encourage you to send us a copy of your license, program documents, and tie-down letters so we may include them in the course materials.

This course includes several workshop sessions to allow for detailed discussions that focus on your particular needs. During workshop sessions, several software programs and internet sites will be showcased that will allow you to improve the efficiency and effectiveness of your radiation protection program.

## Who Should Attend

These courses were developed for Radiation Safety Officers and other personnel responsible for radiation safety within their facility. Particular emphasis will be placed on research and development facilities, industrial licensees, and educational facilities. (NOTE: References from past students available upon request.)

The 5 day RSO course provides a comprehensive review of fundamental concepts and 10CFR20 compliance.

The 3 day advanced RSO course includes a brief review of the fundamentals along with a focus on 10CFR20 and 10CFR30 licensing issues.

## Handout Materials

The comprehensive **RSO Course** Manual contains over 600 pages including instructional aids, Regulatory Guides, NUREGS and NRC notices & references. Also included in the course is the 933 page hard cover reference book entitled "The Health Physics and Radiological Health Handbook," revised edition. Each student in the RSO course will also receive a scientific calculator necessary for the practical problem solving sessions. Several example Radiation Protection Programs and Standard Operating Procedures will also be provided on CD.

The **Advanced RSO Course** manual includes instructional aides, Reg. guides, NUREGS, NRC Notices and references. Valuable software files and applications to help solve various radiological issues will also be discussed.

## Course Schedules

**RSO Course** registration will be held Monday from 8:00 to 8:30 a.m. Class will run from 8:00 to 5:00 each day and will end at noon on Friday. An optional exam will be offered Friday afternoon. Optional evening sessions will be held Tuesday and Thursday from 7:00 to 9:00 p.m. RSCS will provide lunch and a 5:00 p.m. catered social hour on Monday.

**Advanced RSO Course** registration will be held Monday from 8:00 to 8:30 a.m. Classes will run from 8:00 to 5:00 each day. RSCS will provide lunch and a 5:00 p.m. catered social hour on Monday.

## Continuing Education Credits

The American Academy of Health Physics has granted the RSO class and the ARSO class 16 Continuing Education Credits each. The American Society of Radiological Technologists (ASRT) has approved the RSO course for 40 hours and the ARSO course for 24 hours of Category A continuing education credit. The American Board of Industrial Hygiene (ABIH) will award 5 Industrial Hygiene CM points for the 5-day RSO course.

**Radiation Safety & Control Services, Inc.**

Advanced Radiation Safety Officer Training Course

Formal NRC Radiation Safety Training Equivalent Hours

| | TRAINING CATEGORY | I | II | III | IV |
|---|---|---|---|---|---|
| **Monday AM** | Theory Review | 2 | | | 2 |
| | Atomic and Nuclear Principles | | | | |
| | Radioactive Decay | | | | |
| | Radiation Interactions | | | | |
| | Biological Effects | | | | |
| **Monday PM** | Radiological Hazards Review | | 2 | | |
| | External Radiation Dose | | | | |
| | Internal Radiation Dose | | | | |
| | Radiation Detection | | | | 2 |
| | Review of Detection Principles | | | | |
| | Commercially Available Instrumentation | | | | |
| **Tuesday AM** | Radiological Hazards | | 4 | | |
| | Exposure Controls | | | | |
| | Radioactive Material Control | | | | |
| | Surveys | | | | |
| | Effluents | | | | |
| | Waste Management | | | | |
| | Program Oversight and Audits | | | | |
| | Records | | | | |
| | Radiation Protection Organization | | | | |
| **Tuesday PM** | Radiation Protection Workshop | | 4 | | |
| | License Reviews | | | | |
| | Commitments and "tie down" letters | | | | |
| | Break-Out Sessions (Medical, Industrial, Research) | | | | |
| **Wednesday AM** | Regulatory Control and Compliance | | 4 | | |
| | Review of 10CFR19, 10CFR20 | | | | |
| | Regulatory Guides and NUREG's | | | | |
| | Review of NRC HP "Position" Papers | | | | |
| | Efficiency Dealing with Regulators | | | | |
| **Wednesday PM** | Licensing | | 4 | | |
| | Review of 10CFR30 | | | | |
| | Review of Licensing Reg. Guides | | | | |
| | Licensing Workshops (Medical, Industrial, Research) | | | | |
| | *Totals* | 2 | 18 | 0 | 4 |

Category I: Radiation Physics and Instrumentation
Category II: Principles and Practices of Radiation Protection
Category III: Mathematics Pertaining to the Use and Measurement of Radioactivity
Category IV: Biological Effects of Radiation

# Advanced Radiation Safety Officer Training Course Outline:
# RSCS Inc.

- Theory Review
  - Atomic Structure
  - Nucleus
  - Fundamental Properties
    - Mass, Charge, Energy, Force
    - Electrical & Chemical
  - Nuclear Force
  - Radiation
    - Definition
    - Types of Radiation
  - Radioactivity
    - Definition
    - Units of Measure
    - Half Life & Decay Law
  - Interaction of Radiation with Matter
    - Penetrating Radiation
    - Non-Penetrating Radiation
      - Charged Particle Interactions
      - Coulomb Forces
      - Radiative Losses
    - Gamma & X-Ray Interactions
      - Photoelectric Effect
      - Compton Scattering
      - Pair Production
  - Radiation Exposure and Dose
    - Exposure
    - Absorbed Dose
    - Dose Equivalent
    - Total Effective Dose Equivalent, TEDE
    - Committed Effective Dose Equivalent, CEDE
    - Deep Dose Equivalent, DDE
  - Background Radiation Exposure
    - Natural Sources
    - Technologically Enhanced Sources
  - Biological Effects of Radiation
    - Background
    - Sequential Patterns of Biological Effects
    - Cellular Effects
    - Types of Exposure
    - Acute
    - Chronic

## Advanced Radiation Safety Officer Training Course Outline:
## RSCS Inc.

- Types of Biological Effects
- Short Term Effects
- Long Term Effects
- Genetic Effects
- Federal Exposure Limits and Risk Estimates
- X-Ray Machines
  - Components
  - Basics (kVp, mA, time, phototimers)
  - Safety Tests (filtration, collimation, alignment, reprducibility, accuracy, exposure at skin entrance)

Radiological Hazards Review

- External Radiation Dose
  - Penetrating (gamma)
  - Non-Penetrating (beta)
  - Rules of Thumb
  - Time, Distance, Shielding
- Internal Radiation Dose
  - Units of Measure
  - Fixed vs Removable Contamination
  - Internal Hazards and Entry Routes
  - Airborne Radioactivity
  - Protection Methods

Radiation Detection Review

- Basic Principles
  - Gas Filled Detectors
  - Scintillation Detectors
  - Solid State Detectors
- Applications
  - Detector Efficiency
  - Counting Statistics
  - Minimum Detectable Activity
- Dose and Dose Rate Measurements
  - Dose Rate Meters
  - Dosimeters
- Contamination Measurements
  - Direct Methods (Friskers)
  - Indirect Methods
  - Swipes
  - Laboratory Instruments

Licensing of Radioactive Material

- Exempt, General Licenses, Specific Licenses

## Advanced Radiation Safety Officer Training Course Outline:
## RSCS Inc.

- 10CFR30 – General Applicability to Domestic Licensing
  - Decommissioning Funding Plans
  - Licensing process (initial application, amendments, renewals, change of name/ownership)
- 10CFR31 – General Licenses
- 10CFR32 – Specific Licenses to Manufacture or Transfer
- 10CFR33 – Broad Scope
- 10CFR34 – Industrial Radiography
- 10CFR35 – Medical Uses
- 10CFR36 – Irradiators
- 10CFR39 – Well Logging
- 10CFR40 – Licensing of Source Material
- Reciprocity
- Sealed Source and Device Evaluations

Radioactive Material Licenses

- Types
- Regulatory Agencies
- Agreement States
  - Compatibility
- License Conditions
  - Name, address, expiration date, license number,
  - Radioactive material, chemical/physical form, possession limits, authorized uses
  - Location of use, authorized users, RSO, leak test requirements, inventories, prohibitions & authorizations
  - Tie-down Condition
- Example Licenses and Workshop Session

Regulatory Control and Compliance

- 10CFR19
  - Posting of Notices to Workers
  - Instructions to Workers
  - Notifications and Reports to Individuals
  - Inspections
- 10CFR20 – Radiation Protection Standards
  - Radiation Protection Programs and Audits
  - Occupational Dose Limits
  - Dose Limits for Members of the Public
  - Surveys and Monitoring
  - Control of External Exposure
  - Respiratory Protection
  - Waste Disposal
  - Records & Reports
  - Regulations Workshop Session

# Advanced Radiation Safety Officer Training Course Outline:
# RSCS Inc.

- Operational Radiation Safety Programs
  - Organization
  - Facility Design
  - Radiation Safety Program Goals
  - General Public
  - Radiation Workers
  - Personnel Monitoring
  - ALARA
  - Radioactive Material Control
  - Access Control
  - Surveys and Facility Monitoring
  - Effluent Monitoring and Control
  - Waste Disposal and Effluent Releases
  - Annual Radiation Protection Program Audits
    - Purpose of Assessments
    - Types of Assessments
    - Preparations for Assessments
    - Conducting Assessments
    - Documentation
    - Lessons Learned
  - Emergency Plans
  - The Role of Federal, State, and Local Agencies
  - General Rules for Health Physicists and RSOs
  - Transportation of Radioactive Material
    - Title 49 - Department of Transportation
- Reference Materials
  - NRC Homepage
  - NRC Information Notices List
    - Examples provided depend on class attendees and their license type
  - NRC Regulatory Guides
    - Examples provided depend on class attendees and their license type
  - Examples Sealed Source and Device listings
  - NRC Health Physics Position Papers
  - NRC 10CFR20 Questions and Answers(Nurcg/CR-6204)
  - Optional Textbook – Handbook of Health Physics and Radiological Health

# Radiation Safety Officer Training Course

## June 11-15, 2007

# EXAMINATION

**Name (print):** _____ **Signature:** _____

**Date:** _____

Instructions: You are allowed to use your Radiological Health Handbook, your RSCS RSO Handout (three-ring binder), and a scientific calculator. You are not allowed to use any answer sheets from practice problems provided during the class.

Please read all questions fully before answering. For multiple-choice questions, there is only one answer; choose the best response. For other problems, state your assumptions and show all work. Partial credit will be allowed where applicable. A grade of 80% is required to pass this examination. Good luck!

1. Express the following numbers in scientific notation:

   A. 423,000,000,000

   B. 0.00000000015

   C. 2344,567,465,873,567,234.2

2. Convert 1000 cubic inches to liters, given 1 l = 1000 $cm^3$, and 1 inch = 2.54 cm.

3. Atoms are made up of the following components?

   A. Electrons orbiting around a nucleus of protons and neutrons
   B. Neutrons orbiting around a nucleus of electrons and protons
   C. Protons orbiting around a nucleus of electrons and neutrons
   D. None of the above

4. Given the following isotope, select the best choice:

$$^{60}_{27}\mathrm{Co}$$

A. There are 60 protons and 27 neutrons in the nucleus
B. There are 27 neutrons and 33 protons
C. There are 60 neutrons and 27 protons
D. There are 33 neutrons and 27 protons
E. There are 60 neutrons and 33 protons

5. Define the term "radiation".

6. Which will travel farther in air, a 3 MeV alpha particle or a 3 MeV beta particle? Why?

7. How are X-rays and gamma rays similar? How are they different?

8. Bremsstrahlung radiation may best be described as

A. Neutrons ejected when a photon interacts with a nucleus
B. Neutrons ejected when a proton interacts with a nucleus
C. Photon radiation produced when a beta particle loses energy after interaction with the electric field of a nucleus
D. The scattered photon produced via the Compton interaction.

9. Which energy photons are emitted after an annihilation event?

A. 0.511 MeV
B. 0.800 MeV
C. 1.02 MeV
D. 6.02 MeV

10. Calculate the Total Effective Dose Equivalent (TEDE) given the following information:

DDE = 30 **mrem**
CDE (thyroid) = 100 **rem**

11. The average annual radiation dose received from all background sources by individuals living in the United States is:

A. 200 mrem
B. 0.250 rem
C. 500 mrem
D. 0.360 rem

12. Our current radiation standards assume:

A. All radiation may be harmful
B. Most radiation is harmful
C. Sometimes radiation is harmful
D. Radiation is only harmful if you are not wearing a lead suit

13. Calculate the ***increase in risk*** of cancer death to an individual given the following information:

Lifetime risk = 0.04% per rem
Exposure = 50 rem
Initial risk of cancer (no exposure) = 20%

14. How many half-value layers does it take to reduce the radiation exposure by a factor of 32?

15. The radiation interaction mechanisms responsible for gamma buildup in a shield are:

A. Photoelectric effects
B. Compton effects
C. Pair Production events
D. Gamma Absorption effects

16. The three methods used to protect against external radiation are _____, _____, _____, and _____.

17. An individual who inhaled an airborne concentration of radioactive material of 1.5 DAC for 8 hours would receive a CEDE dose of;

A. 12 mrem
B. 1.5 mrem
C. 30 mrem
D. 120 mrem

18. With all parameters equal, the type of gas-filled detector that operates at the lowest operating voltage is the:

A. Recombination Detector
B. Smoke Detector
C. Ionization Detector
D. Proportional Detector

19. GM Detectors:

A. can operate an any voltage.
B. cannot electronically discriminate between different types of radiation.
C. must be turned off occasionally to allow the quench gas to re-charge.
D. none of the above.

20. A counter has a background of 200 counts for 10 minutes. A sample is counted for 5 minutes on this counter and yielded a gross count of 420 counts. Calculate the sample activity in dpm if the detection efficiency is 24%.

21. Given a background count rate of 250 cpm, sample and background count times of 5 minutes, and a counting efficiency of 18%, calculate the system MDA in dpm and in uCi.

22. Scintillation detectors may be used for:

A. survey instruments.
B. beta particle spectroscopy instruments.
C. gamma ray spectroscopy instruments.
D. all of the above.

23. An instrument dead time:

A. can be ignored because this is the period of time that an instrument doesn't work.
B. may be an important consideration for some instruments at high count rates.
C. none of the above.
D. Both A and B.

24. *Routine facility radiological surveys:*

A. need only be documented when abnormal condition is found.
B. should identify the individual performing the survey and the instrument used.
C. should be performed on the same day of the week.
D. all of the above.

25. Survey instrument calibrations are required:

A. when a malfunction occurs.
B. semi-annually.
C. as specified in the radioactive materials license or specific regulation.
D. when the instrument is dropped.

26. 10CFR19 requires the following people to receive radiation protection training:

A. all individuals accessing the restricted area.
B. all individuals working with radioactive material.
C. all declared pregnant females.
D. all individuals likely to receive greater than 100 mrem in a year.

27. It is required by 10CFR20 to require documentation of each personnel access to the restricted area:

A. True
B. False

28. For a package arriving at your facility, an incoming radiological survey is required:

A. within 3 hours of package receipt during normal and off-hours.
B. if you suspect that it may contain radioactive material.
C. if it is damaged.
D. if it is "labeled" (white I, yellow II, or yellow III) or damaged and known to contain radioactive material.

29. Immediate response to a radiological incident should consider:

A. shutting down ventilation systems.
B. saving samples of blood, clothing, urine, etc. for later analysis.
C. evacuating and segregating personnel from the immediate area and controlling access.
D. all of the above.

30. A posting within your facility for emergency call-out telephone numbers should include

A. the RSO.
B. local fire department
C. local police
D. all of the above.

31. 10CFR20 Subpart M requires that the NRC be immediately notified if:

A. an individual receives an exposure in excess of the applicable limits.
B. an individual receives an intake in excess of 5 ALI.
C. loss of any radioactive material.
D. none of the above.

32. The 10CFR20 annual dose limits for occupationally exposed adult workers are:

TEDE =

SDE =

LDE =

$SDE_{ME}$ =

33. Licensees shall conduct operations so that the TEDE to individual members of the public from the licensed operation does not exceed _____ in a year.

A. 10 mrem
B. 50 mrem
C. 100 mrem
D. 500 mrem

34. Unless specific exemptions apply, containers of licensed material shall be labeled with the radiation symbol and the words:

A. "CAUTION RADIATION MATERIAL"
B. "CAUTION LICENSED MATERIAL"
C. "CAUTION CONTAMINATED MATERIAL"
D. "CAUTION RADIOACTIVE MATERIAL"

35. Each licensee shall post current copies of the following document(s) in accordance with 10CFR19:

A. 10CFR19 and 10CFR20
B. The license and license conditions
C. The licensees operating procedures applicable to licensed activities
D. All of the above

36. According to 10CFR20, Appendix B, the monthly average concentration limit for the release of Co-60 to the sewer is_____.

37. TRUE or FALSE: Minors are not allowed to received occupational exposure under the provisions of 10CFR20.

38. Radioactive material that cannot meet SPECIAL FORM requirements is designated as:

A. USUAL FORM
B. NON-SPECIAL FORM
C. NORMAL MATERIAL
D. NORMAL FORM

39. The dimensionless number determined by expressing the maximum radiation level in millirem per hour at one meter from the external surface of a package is called the _____ index.

A. Transfer
B. Package
C. Transport
D. Total

40. TRUE or FALSE: The radiation level at any point on the external surface of Limited Quantity or White I labeled packages must be less than or equal to 0.5 mrem/hr.