Amendment No. 01

MATERIALS LICENSE

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974 (Public Law 93-438), and Title 10, Code of Federal Regulations, Chapter I, Parts 30, 31, 32, 33, 34, 35, 39, 40 and 70, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess, and transfer byproduct, source, and special nuclear material designated below; to use such material for the purpose(s) and at the place(s) designated below; to deliver or transfer such material to persons authorized to receive it in accordance with the regulations of the applicable Part(s). This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and is subject to all applicable rules, regulations and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

Licensee	
1. American Red Cross	In accordance with application dated April 11, 1997 3. License number 25-27425-01 is amended in its entirety to read as follows:
2. 1300 28th Street South Great Falls, Montana 59403	4. Expiration date July 31, 2002
	5. Docket or Reference No 030-32627

6. Byproduct, source, and/or special nuclear material	7. Chemical and/or physical form	8. Maximum amount that licensee may possess at any one time under this license
A. Cesium-137	A. Sealed Source (Isomedix Model [illegible]-1000)	A. 2,880 curies (4 sources of 720 curies each)

9. Authorized use

A. To be used in a Nordion International, Inc. Model Gammacell 1000 Elite-D irradiator for the irradiation of human blood and blood products.

CONDITIONS

10. Licensed material shall be used only at 1300 28th Street South, Great Falls, Montana.

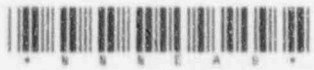
11. Licensed material shall be used by, or under the supervision of Kendra D. Boland.

12. The Radiation Safety Officer for this license is Kendra D. Boland.

13. A. Sealed sources and detector cells shall be tested for leakage and/or contamination at intervals not to exceed 6 months or at such other intervals as specified by the certificate of registration referred to in 10 CFR 32.210.

B. Notwithstanding Paragraph A of this Condition, sealed sources designed to emit alpha particles shall be tested for leakage and/or contamination at intervals not to exceed 3 months.

150014



OFFICIAL RECORD COPY

MLA0

C. In the absence of a certificate from a transferor indicating that a leak test has been made within 6 months prior to the transfer, a sealed source or detector cell received from another person shall not be put into use until tested.

D. Sealed sources need not be leak tested if:

(i) they contain only hydrogen-3; or

(ii) they contain only a radioactive gas; or

(iii) the half-life of the isotope is 30 days or less; or

(iv) they contain not more than 100 microcuries of beta and/or gamma emitting material or not more than 10 microcuries of alpha emitting material; or

(v) they are not designed to emit alpha particles, are in storage, and are not being used. However, when they are removed from storage for use or transferred to another person, and have not been tested within the required leak test interval, they shall be tested before use or transfer. No sealed source or detector cell shall be stored for a period of more than 10 years without being tested for leakage and/or contamination.

E. The leak test shall be capable of detecting the presence of 0.005 microcurie of radioactive material on the test sample. If the test reveals the presence of 0.005 microcurie or more of removable contamination, a report shall be filed with the U.S. Nuclear Regulatory Commission in accordance with 10 CFR 30.50(b)(2), and the source shall be removed immediately from service and decontaminated, repaired, or disposed of in accordance with Commission regulations. The report shall be filed within 5 days of the date the leak test result is known with the U.S. Nuclear Regulatory Commission, Region IV, 611 Ryan Plaza Drive, Suite 400, Arlington, Texas 76011, ATTN: Director, Division of Nuclear Materials Safety. The report shall specify the source involved, the test results, and corrective action taken.

F. The licensee is authorized to collect leak test samples for analysis by Suntrac Services, Incorporated. Alternatively, tests for leakage and/or contamination may be performed by persons specifically licensed by the Commission or an Agreement State to perform such services.

14. The licensee shall not perform repairs or alterations of the irradiator involving removal of shielding or access to the licensed material. Removal, replacement, and disposal of sealed sources in the irradiator shall be performed by a person specifically licensed by the Commission or an Agreement State to perform such services.

MATERIALS LICENSE
SUPPLEMENTARY SHEET

License Number 25-27425-01

Docket or Reference Number 030-32627

Amendment No. 01

15. Sealed sources or detector cells containing licensed material shall not be opened or sources removed from source holders by the licensee.

16. The licensee shall conduct a physical inventory every 6 months to account for all sources and/or devices received and possessed under the license.

17. In addition to the possession limits in Item 8, the licensee shall further restrict the possession of licensed material to quantities below the minimum limit specified in 10 CFR 30.35(d) for establishing decommissioning financial assurance.

18. Except as specifically provided otherwise in this license, the licensee shall conduct its program in accordance with the statements, representations, and procedures contained in the documents, including any enclosures, listed below. The Nuclear Regulatory Commission's regulations shall govern unless the statements, representations, and procedures in the licensee's application and correspondence are more restrictive than the regulations.

A. Application dated December 30, 1991
B. Letter dated July 24, 1992

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

Date APR 30 1997

By Jacqueline D. Cook
Nuclear Materials Licensing Branch
Region IV
Arlington, Texas 76011

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
611 RYAN PLAZA DRIVE, SUITE 400
ARLINGTON, TEXAS 76011-8064

April 30, 1997

American Red Cross
ATTN: Stephen J. Brown
Chief Executive Officer
1300 28th Street South
Great Falls, MT 59403

SUBJECT: LICENSE AMENDMENT

Please find enclosed License No. 25-27425-01. You should review this license carefully and be sure that you understand all conditions. If you have any questions, you may contact the reviewer who signed your license at 817-860-8132.

NRC expects licensees to conduct their programs with meticulous attention to detail and a high standard of compliance. Because of the serious consequences to employees and the public which can result from failure to comply with NRC requirements, you must conduct your program involving radioactive materials in accordance with the conditions of your NRC license, representations made in your license application, and NRC regulations. In particular, note that you must:

1. Operate in accordance with NRC regulations 10 CFR Part 19, "Notices, Instructions and Reports to Workers: Inspection and Investigations," 10 CFR Part 20, "Standards for Protection Against Radiation," and other applicable regulations.

2. Possess radioactive material only in the quantity and form indicated in your license.

3. Use radioactive material only for the purpose(s) indicated in your license.

4. Notify NRC in writing of any change in mailing address (no fee required if the location of radioactive material remains the same).

5. Request and obtain written NRC consent before transferring your license or any right thereunder, either voluntarily or involuntarily, directly or indirectly, through transfer of control of your license to any person or entity. A transfer of control of your license includes not only a total change of ownership, but also a change in the controlling interest in your company whether it is a corporation, partnership, or other entity dition, appropriate license amendments must be requested and obtained fo other planned changes in your facility or program that are contrary to your license or contrary to representations made in your license application, as well as supplemental correspondence thereto, which are incorporated into your license. A license fee may be charged for the amendments if you are not in a fee-exempt category.

6. Maintain in a single document decommissioning records that have been certified for completeness and accuracy listing all the following items applicable to the license:

   - Onsite areas designated or formerly designated as restricted areas as defined in 10 CFR 20.3(a)(14) or 20.1003.

   - Onsite areas, other than restricted areas, where radioactive materials in quantities greater than amounts listed in Appendix C to 10 CFR 20.1001-20.2401 have been used, possessed, or stored.

   - Onsite areas, other than restricted areas, where spills or other unusual occurrences involving the spread of contamination in and around the facility, equipment, or site have occurred that required reporting pursuant to 10 CFR 30.50(b)(1) or (b)(4), including areas where subsequent cleanup procedures have removed the contamination.

   - Specific locations and radionuclide contents of previous and current burial areas within the site, excluding radioactive material with half-lives of 10 days or less, depleted uranium used only for shielding or as penetrators in unused munitions, or sealed sources authorized for use at temporary job sites.

   - Location and description of all contaminated equipment involved in licensed operations that is to remain onsite after license termination.

7. Submit a complete renewal application with proper fee, or termination request at least 30 days before the expiration date on your license. You will receive a reminder notice approximately 90 days before the expiration date. Possession of radioactive material after your license expires is a violation of NRC regulations.

8. Request termination of your license if you plan to permanently discontinue activities involving radioactive material.

You will be periodically inspected by NRC. Failure to conduct your program in accordance with NRC regulations, license conditions, and representations made in your license application and supplemental correspondence with NRC will result in enforcement action against you. This could include issuance of a notice of violation; imposition of a civil penalty; or an order suspending, modifying, or revoking your license as specified in the "General Statement of Policy and Procedure for NRC Enforcement Actions" (Enforcement Policy), 60 FR 34381, June 30, 1995.

Thank you for your cooperation.

Sincerely,

Jacqueline D. Cook

Jacqueline D. Cook
Health Physicist
Nuclear Materials Licensing Branch

Docket: 030-32627
License: 25-27425-01
Control: 466371

Enclosures: As stated

DOCUMENT NAME: P:\MLCOVER\LETTER\AMERREDX.MLC

To receive a copy of this document, indicate in the box "C" - Copy without attachment/enclosure "E" - Copy with attachment/enclosure "N" - No Copy

RIV:NMLB	N						
JDCook							
04/30/97							

OFFICIAL RECORD COPY

BETWEEN:

License Fee Management Branch, ARM
and
Regional Licensing Sections

(FOR LFMS USE)
INFORMATION FROM LTS

Program Code: 03510
Status Code: 0
Fee Category: 3E
Exp. Date: 20020731
Fee Comments:
Decom Fin Assur Reqd: N

1997 APR 22 PM 3:37

LICENSE FEE TRANSMITTAL

A. REGION IV

1. APPLICATION ATTACHED
Applicant/Licensee: AMERICAN RED CROSS
Received Date: 970421
Docket No: 3032627
Control No.: 466371
License No.: 25-27425-01
Action Type: Amendments

2. FEE ATTACHED
Amount: $360.00
Check No.: 88233

3. COMMENTS

Signed Billie Garde
Date 4/21/97

RECEIVED
APR 29 1997
REGION IV

B. LICENSE FEE MANAGEMENT BRANCH (Check when milestone 03 is entered) LC

1. Fee Category and Amount: 3E $360

2. Correct Fee Paid. Application may be processed for:
Amendment
Renewal
License

3. OTHER

Signed Rita Messer
Date 4/23/97

Log Amp 3 IV
Remitter
Check No. 88060
Amount $360
Fee Category 3E
Type of Fee Amd
Date Check Rec'd.
Date Completed 4/23/97
By: Ken

NRC FORM 313
(9-88)
10 CFR 30, 32, 33, 34, 35 and 40

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED BY OMB
3150-0120
Expires: 6-30-90

APPLICATION FOR MATERIAL LICENSE

INSTRUCTIONS: SEE THE APPROPRIATE LICENSE APPLICATION GUIDE FOR DETAILED INSTRUCTIONS FOR COMPLETING APPLICATION. SEND TWO COPIES OF THE ENTIRE COMPLETED APPLICATION TO THE NRC OFFICE SPECIFIED BELOW.

APPLICATIONS FOR DISTRIBUTION OF EXEMPT PRODUCTS FILE APPLICATIONS WITH:

U.S. NUCLEAR REGULATORY COMMISSION
DIVISION OF INDUSTRIAL AND MEDICAL NUCLEAR SAFETY, NMSS
WASHINGTON, DC 20555

ALL OTHER PERSONS FILE APPLICATIONS AS FOLLOWS. IF YOU ARE LOCATED IN:

CONNECTICUT, DELAWARE, DISTRICT OF COLUMBIA, MAINE, MARYLAND, MASSACHUSETTS, NEW HAMPSHIRE, NEW JERSEY, NEW YORK, PENNSYLVANIA, RHODE ISLAND, OR VERMONT, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION I
NUCLEAR MATERIALS SAFETY SECTION B
475 ALLENDALE ROAD
KING OF PRUSSIA, PA 19406

ALABAMA, FLORIDA, GEORGIA, KENTUCKY, MISSISSIPPI, NORTH CAROLINA, PUERTO RICO, SOUTH CAROLINA, TENNESSEE, VIRGINIA, VIRGIN ISLANDS, OR WEST VIRGINIA, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION II
NUCEAR MATERIALS SAFETY SECTION
101 MARIETTA STREET, SUITE 2900
ATLANTA, GA 30323

IF YOU ARE LOCATED IN:

ILLINOIS, INDIANA, IOWA, MICHIGAN, MINNESOTA, MISSOURI, OHIO, OR WISCONSIN, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION III
MATERIALS LICENSING SECTION
799 ROOSEVELT ROAD
GLEN ELLYN, IL 60137

ARKANSAS, COLORADO, IDAHO, KANSAS, LOUISIANA, MONTANA, NEBRASKA, NEW MEXICO, NORTH DAKOTA, OKLAHOMA, SOUTH DAKOTA, TEXAS, UTAH, OR WYOMING, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION IV
MATERIAL RADIATION PROTECTION SECTION
611 RYAN PLAZA DRIVE, SUITE 1000
ARLINGTON, TX 76011

ALASKA, ARIZONA, CALIFORNIA, HAWAII, NEVADA, OREGON, WASHINGTON, AND U.S. TERRITORIES AND POSSESSIONS IN THE PACIFIC, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION V
NUCLEAR MATERIALS SAFETY SECTION
1450 MARIA LANE, SUITE 210
WALNUT CREEK, CA 94596

RECEIVED
APR 21 1997
REGION IV

PERSONS LOCATED IN AGREEMENT STATES SEND APPLICATIONS TO THE U.S. NUCLEAR REGULATORY COMMISSION ONLY IF THEY WISH TO POSSESS AND USE LICENSED MATERIAL IN STATES SUBJECT TO U.S. NUCLEAR REGULATORY COMMISSION JURISDICTION.

1. THIS IS AN APPLICATION FOR *(Check appropriate item)*

- [ ] A. NEW LICENSE
- [X] B. AMENDMENT TO LICENSE NUMBER 25-27425-01
- [ ] C. RENEWAL OF LICENSE NUMBER _____

2. NAME AND MAILING ADDRESS OF APPLICANT *(Include Zip Code)*

American Red Cross Blood Services
1300 28th St. So.
Great Falls, MT 59405

3. ADDRESS(ES) WHERE LICENSED MATERIAL WILL BE USED OR POSSESSED.

American Red Cross Blood Services
1300 28th St. So.
Great Falls, MT 59405

4. NAME OF PERSON TO BE CONTACTED ABOUT THIS APPLICATION

Kendra Boland

TELEPHONE NUMBER: 406-727-2212

SUBMIT ITEMS 5 THROUGH 11 ON 8½ x 11" PAPER. THE TYPE AND SCOPE OF INFORMATION TO BE PROVIDED IS DESCRIBED IN THE LICENSE APPLICATION GUIDE.

5. RADIOACTIVE MATERIAL
a. Element and mass number, b. chemical and/or physical form, and c. maximum amount which will be possessed at any one time.

6. PURPOSE(S) FOR WHICH LICENSED MATERIAL WILL BE USED.

7. INDIVIDUAL(S) RESPONSIBLE FOR RADIATION SAFETY PROGRAM AND THEIR TRAINING AND EXPERIENCE.

8. TRAINING FOR INDIVIDUALS WORKING IN OR FREQUENTING RESTRICTED AREAS.

9. FACILITIES AND EQUIPMENT.

10. RADIATION SAFETY PROGRAM.

11. WASTE MANAGEMENT.

12. LICENSEE FEES *(See 10 CFR 170 and Section 170.31)*
FEE CATEGORY: 3E
AMOUNT ENCLOSED: $360.00

13. CERTIFICATION. *(Must be completed by applicant)* THE APPLICANT UNDERSTANDS THAT ALL STATEMENTS AND REPRESENTATIONS MADE IN THIS APPLICATION ARE BINDING UPON THE APPLICANT.

THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATION ON BEHALF OF THE APPLICANT, NAMED IN ITEM 2, CERTIFY THAT THIS APPLICATION IS PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PARTS 30, 32, 33, 34, 35, AND 40 AND THAT ALL INFORMATION CONTAINED HEREIN, IS TRUE AND CORRECT TO THE BEST OF THEIR KNOWLEDGE AND BELIEF.

WARNING: 18 U.S.C. SECTION 1001 ACT OF JUNE 25, 1948, 62 STAT. 749 MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTER WITHIN ITS JURISDICTION.

SIGNATURE - CERTIFYING OFFICER	TYPED/PRINTED NAME	TITLE	DATE
Stephen J. Brown	STEPHEN J. BROWN	CHIEF EXECUTIVE OFFICER	4/11/97

FOR NRC USE ONLY

TYPE OF FEE	FEE LOG	FEE CATEGORY	COMMENTS

AMOUNT RECEIVED	CHECK NUMBER

APPROVED BY

DATE: 466371

NRC FORM 313 (9-88)

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 7.5 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE RECORDS AND REPORTS MANAGEMENT BRANCH (P-530), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555, AND TO THE OFFICE OF INFORMATION AND REGULATORY AFFAIRS, OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

American Red Cross

Montana Blood Services
Lewis and Clark Region
P.O. Box 2406
Great Falls, Montana 59403
(406) 727-2212
Fax (406) 452-5427

AMENDMENT TO LICENSE #25-27425-01
BLOOD IRRADIATOR MACHINE

RADIOACTIVE MATERIAL

1. Element Cesium; mass number 137
2. Chemical and/or physical form; Cesium Chloride
   Source Manufacturer
   Nordion International Inc.
   447 March Road
   Kanata, Ontario, Canada K2K1X8

   Sealed Source Model
   Gammacell 1000 Blood Irradiator

3. Maximum amount which will be possessed at any one time
   Amount of Isotope
   4 pencils not to exceed 720 Curies each

   Loading Tolerance
   Maximum amount 2880 curies

   Safety information on Gammacell 1000 Blood Irradiator has been registered with the Nuclear Regulatory Commission.

PURPOSE(S) FOR WHICH LICENSED MATERIAL WILL BE USED

Irradiation of human blood and blood products

INDIVIDUAL(S) RESPONSIBLE FOR RADIATION SAFETY PROGRAM; THEIR TRAINING AND EXPERIENCE

Please change name of Radiation Safety Officer from Geraldine Janas to Kendra Boland.

Kendra Boland has completed a course in Radiation Safety given March 24, 1997 by the University of Washington, and will be designated Radiation Safety Officer (RSO). See curriculum, Attachment I.

The designated RSO has had 5 years of hands-on experience with our Gammacell Blood Irradiator and thyroid and drug testing experience utilizing I-125 radionuclide and various gamma counters from 1979 to 1989.

University of Washington

Department of
Environmental Health and Safety

CERTIFICATE OF TRAINING

This is to certify that

KENDRA D. BOLAND

Successfully completed a program of instruction in

SEALED SOURCES AND IRRADIATORS

In

MARCH 1997

This is a five day course including formal class presentations and practical laboratory excercises. The course covers Basic Radiation Physics, Biological Effects of Radiation, Radiation Surveys, Radiation Protections Procedures, and Regulatory Rules and Regulations.

Stanley J. Addison, Radiation Safety Officer

April 1, 1997
Date

RSO Form 26 (11/96) (an...\c ata\wpwin\train\form26

UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON 98195

Environmental Health & Safety
201 Hall Health Center, GS-05
Radiation Safety Office, (206) 543-0463

University of Washington
RADIATION SAFETY COURSE FOR
SEALED SOURCE AND IRRADIATOR USERS
1997

The University of Washington's Department of Radiation Safety offers radiation safety training for a variety of radiation users. These courses are generally for users at the University, but individuals from other institutions may participate for a nominal fee.

A special training course is offered for individuals intending to apply for a Radioactive Materials License to use sealed sources or gamma irradiators. This course is for individuals in management or radiation safety who will be responsible for the safety of radiation workers. It is recommended that interested parties submit the course outline to the NRC or appropriate Agreement State agencies to verify that it will meet their needs. It is an intensive three day course which is given in conjunction with the "Radiation Safety Training Course" (RSTC) offered 9 times yearly. The special course for sealed source and irradiator users is provided on an individual request basis and must be scheduled in advance at a time that will coincide with the RSTC.

The **Radiation Safety Course for Sealed Source and Irradiator Users** is comprised of four half day sessions covering; Basic Radiation Physics, Biological Effects of Ionizing Radiation, Radiation Instruments and Surveys, and Rules and Regulations. A final full day session is devoted to field exercises on sealed sources, irradiators, and surveys. Special attention will be given to the needs of the individuals attending the course. A final examination is given to evaluate the student's comprehension of the material presented.

An outline for the sealed source/irradiator course accompanies this document. The class is taught by Stanley J. Addison, M.S., C.H.P., Brian Pankow, B.S., and various other radiation safety and technical staff as available. For registration or other information regarding the offering, please contact the Radiation Safety Office at the University of Washington.

University of Washington
RADIATION SAFETY COURSE FOR
SEALED SOURCE AND IRRADIATOR USERS
Revised Schedule
1997

Day 1, **BASIC RADIATION PHYSICS**

15 min

- History
  - Discovery of X-rays
  - Discovery of Radioactivity

45 min

- Structure of the Atom
  - Define Proton, Neutron, Electron
  - Relative Sizes of Proton, Neutron, Electron
  - Simplified/Conceptual Atomic Structure
  - Nuclear Structure
  - Electron Shell Structure
- Electromagnetic Spectrum
  - Light Spectrum from Atoms
  - Quantum Theory
  - Light/X-ray Production from Electron Jumps
  - Bremsstrahlung
  - Other Electromagnetic Radiations

1 hour

- Radioactive Decay
  - Definition
  - Overview of Common Decay Modes (Alpha, Beta, Gamma)
  - Nuclides versus Isotopes
  - Atomic Number and Atomic Mass Number
  - Chart of the Nuclides/Line of Stability
  - Nuclides with Excessive Mass
    - Alpha Emission
    - The Alpha Particle
  - Nuclides with Excessive Neutrons
    - Beta Emission
    - Average versus Maximum Beta Energy

Outline (continued)

- Nuclides with Deficient Neutrons
  - Positron Emission
  - Electron Capture

1 hour

- Gamma Emission
  - Examples of Decay Schemes
  - Overview of Gamma Emitters used for Sealed Sources

30 min

- Radiation Interaction With Matter
  - Excitation
  - Ionization
    - Charged Particle Interaction
      - Alpha Interaction
      - Beta Interaction
    - Electromagnetic Radiation Interaction
      - Photoelectric Effect
      - Compton Interaction
      - Pair Production
      - Attenuation/Half Value Layer

1 hour

- Radioactivity
  - Unique Decay Probability for Each Radionuclide
  - Activity = Decay Probability X # Atoms Present
  - Units of Radioactivity
  - Decay Equations
  - Half Life
  - Relation between Half Life and Decay Constant

30 min

- Dosimetry
  - External Dosimetry
    - Early History of Radiation Dosimetry
    - Exposure
      - Units (SI and traditional)
      - Measurement of Exposure
      - Ionization Chambers
    - Absorbed Dose
      - Units (SI and traditional)

- Used for all Radiations and Energies
- Dose Equivalent
  - Units (SI and Traditional)
  - Quality Factors
- Approximate Equivalence of Traditional Units
  - (in soft tissue, low Energy Gamma & X-ray)

30 min

- Inverse Square Law
- Specific Gamma Ray Constant

30 min

- Internal Dosimetry
  - Important Factors
    - When Uptake Occurred
    - How Nuclide was Absorbed
    - Organ of Uptake
    - Elimination Rate/Mode
    - Radionuclide Characteristics
  - Effective Half Life
  - Annual Limit on Intake

BIOLOGICAL EFFECTS OF IONIZING RADIATION

30 min

- Description of Some Radiation Accidents

1 hour

- Radiation Exposure to Humans
  - Misconceptions
- Acute Effects of Radiation Exposure
  - Identification of Acute Radiation Injury
  - General Rules of Radiosensitivity
  - Relative Radiosensitivity of Some Cell Systems
  - Acute Whole Body Radiation Syndromes
    - Bone Marrow Syndrome
    - GI Syndrome
    - CNS Syndrome
  - Modifiers of Acute Radiation Injury
    - Dose Rate Effect

Outline (continued)

Oxygen Effect
Extent of Organ or Organism Irradiated

30 min

Summary and discussion of first day's material.

Day 2, **BIOLOGICAL EFFECTS OF IONIZING RADIATION (cont.)**

1 hour

Chronic Effects of Radiation Exposure
Radiation Injury to Early Radiographers
Risk of Low Level/Chronic Radiation Exposure
Risks Based on Effects at Higher Doses
BEIR V Report
Change in Risk Estimates
Abnormalities in the Exposed Fetus
Genetic Effects
Cancer in the Exposed Individual

1 hour

Dose limits
Established Occupational Dose Limits
Dose Limits for the General Public
Typical Doses for Groups of Radiation Workers
Proposed Changes in Dose Limits
ICRP 1990 Recommendations
New 1991 NRC Dose Limits
Stochastic Limits, Summation of Internal and External
Nonstochastic Limits, Individual Organs
1991 NRC Limits for General Public

30 min

Natural Background Radiation
Cosmic Radiation
Terrestrial Radiation
Radiation from Internal Sources
Cancer Rates versus Areas of High Background

30 min

Internal/External Hazards from Certain Radionuclides
(Addresses radionuclides used by individuals

attending course.)

30 min

- Methods of Reducing Radiation Dose
  - Decreasing Working Time
    - Dry Runs
    - Do Thinking/Conversing away from Source
  - Increasing Working Distance
    - Inverse Square Law
    - Use Tools/Stands/Clamps
  - Shielding
    - Best When Close to Source
    - Know Where Edges Are
    - Lead or Concrete for Gammas

1 hour

- Calculations for Shielding Sources
  - Calculations Using Specific Gamma Ray Constant
  - Calculations Using Mass Attenuation Coefficients
  - Buildup Factors

RADIATION INSTRUMENTS AND SURVEYS

15 min

- Introduction
  - How Instruments Work
  - Calibration
  - Record Keeping
  - Problems/Inspections/Violations

1 hour

- Counters
  - Liquid Scintillation Counter
    - Description of System Function
    - Advantages
    - Problems
  - Sodium Iodide/Solid Scintillator
    - Crystal Scintillator
    - Photomultiplier Tube
  - Geiger Counter

- Gas Filled
- Quenching Mechanisms
- Advantages
  - Thin Windows Good for Betas
  - Has Some Applications for Alphas and Gammas
- Problems
  - Low Efficiency for Gammas
  - No Energy Information
  - Dead Time

15 min

- Ionization Chambers
  - Gas Filled
  - Measures Exposure

1 hour

- Survey Methods/Techniques
  - Overview of Leak Tests/Inventories/Surveys
  - When to Use Counters Versus Exposure Meters
  - Using Exposure and Counting Instruments
  - Leak Tests/Counters
    - Taking Wipe Samples
    - Liquid Scintillation Counter
    - Gamma Cou[illegible]rs

30 min

- Portable Counters
  - Application
  - Disadvantages
- Basic Counting Statistics
  - Poisson Distribution
  - Standard Deviation of Count/Count Rate
  - Lower Limit of Detection

30 min

Summary and discussion of second day's material.

Outline (continued)

Day 3, **RADIATION INSTRUMENTS AND SURVEYS (cont.)**

1 hour

- Exposure Survey Procedures
  - Where to Survey
  - Survey With Source Exposed and Retracted
  - Draw Map and Record Locations Surveyed
  - Finding Pinhole Leakage
    - Count Rate Meters
    - Autoradiography
- Calibration
  - National Institute of Standards and Technology
  - Secondary Calibration Laboratories
  - Standard Solutions
  - NIST Traceable Sources and Solutions

30 min

- Personnel Dosimetry
  - Integrated Exposure
  - Does Not Protect from Radiation
  - Film Badges
    - Description
    - Permanent
  - TLD
    - Description
    - Not Permanent
    - Useful for Extremity Exposure

RULES AND REGULATIONS

1 hour

- Radioactive Materials Licenses
  - NRC
  - Agreement States
  - Types of Licenses
  - Radiation Safety Officer/Radiation Safety Office
  - Radiation Workers

- Application
- Typical License Conditions
- Radiation Safety Manual
- Operating Procedures/Handbooks
- Inspections

1 hour

- Responsibilities of RSO/Management
  - Worker Instruction
  - Control Radiation Use/Security
  - Provide Instruments/Safety & Warning Devices
  - Labeling/Posting
  - Notify RSO of Incidents/Transfer
  - Comply with License/Authorization Conditions
  - Comply with NRC/Local Codes
- Posting of Notices to Workers
  - NRC 10 CFR Parts 19 and 20
  - License/License Conditions/Other Documents
  - Special Operating Procedures
  - Notices of Violation
  - "Notice To Employees" (NRC-3 or State Equivalent)
    - Display Form
    - Describe Contents
    - Notification of Exposure
    - Exposure History Availability

30 min

- Instructions to Workers
  - Informed of Storage, Use, and Transfer of RAM
  - Informed of Health Protection Considerations
  - Informed of Protective Devices
  - Instructed to Observe Notice to Employees Form
  - May Request Inspection
  - Cannot be Discriminated Against
  - Advise Supervisor or RSO of Possible Problems
  - Instructed to Follow Appropriate Warnings
  - Informed of Radiation Exposure

1 hour

- Standards for Protection Against Radiation

Exposure of Minors
Radiation Levels in Unrestricted Areas
Surveys
Appropriate Personnel Monitoring
Caution Signs, Labels, Signals and Controls
Procedures for Receiving/Opening Packages
Records, Reports, Notifications
Exceptions/Enforcement

1 hour

Special Requirements related to Sealed Sources/Irradiators
10 CFR Part 34 or State Equivalent

1 hour

License Preparation Reg. Guides Div. 10 or Equivalent

30 min

Overview of Complexity of Waste Disposal/Transport Regs.

30 min

Review and discussion of third day's material.

Days 4 and 5, **FIELD EXERCISES, SEALED SOURCES/SURVEYS**

(Sealed source and irradiator field exercise is tailored to the interests and needs of course attenders. Included in this section of instruction is an opportunity for the students to use survey meters, practice survey techniques, and count wipe test samples.)

Sources available for laboratory use:

Sealed sources;
Brachytherapy Cs-137
Instrument Calibration Sources
Mossbauer Sources
Neutron Producing Sources

Irradiators; (Cesium-137)
Shepherd Model 22
Shepherd Model 6810
Gammacell 40
Picker Teletherapy Model 6152

Exercises and Topic Presented:

- Taking Leak tests on Sources and Irradiators
- Design and Operation of Irradiators
- Maintenance and Safety Testing of Irradiators
- Written Procedures for Safe Irradiator Use
- Emergency Procedures
- Posting of Notices and Radiation Warning Signs
- Exposure Monitoring and Safety Surveys
- Permissible Levels of Radiation in Unrestricted Areas

(The course attenders will demonstrate competence in the use of survey instruments, safe use of sources or irradiators, and knowledge of emergency procedures.)

FINAL EXAMINATION

(Students take an examination consisting of 25 questions. A passing score is 80% or greater.)