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Radiation Worker Training Course Instructor's Guide

July 1988

Prepared by
NUS Corporation

A.D. Holmes, DOE-SR Task Leader
P.O. Matthews, DOE-SR Task Manager

Prepared for
U.S. Department of Energy
Safety Division
Savannah River Operations Office
Aiken, South Carolina

Under Contract No. DE-AC09-87SR15107

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LESSON TITLE: Radiation Worker Training

CONTACT HOURS: 8

INSTRUCTIONAL MATERIALS:

A. Instructor Materials

1. Overhead Projector
2. Transparencies and Erasable Transparency Marker
3. Tape Deck
4. Audio Tape of Alarms
5. Protective Clothing
6. TLD
7. SRD
8. Count Rate Meter with Detector and Check Source
9. Step Off Pad
10. Barricades and Signs
11. Cardboard Radioactive Waste Box
12. Receptacle for Used Protective Clothing

B. Student Materials

1. Student Handout
2. Pen or Pencil
3. Employee Radiation Exposure History Form OSR 5-145

LEARNING OBJECTIVES

1. Define the various radiation measurement units (3.6.1.3.a)

2. State the government prescribed radiation exposure limits for whole body, extremity, and skin exposure (3.6.1.3.b)

3. Describe the mechanisms of biological injury to cells and organ systems and relate to radiation type and source of exposure (internal vs. external) (3.6.2.1.a)

4. Describe the three acute radiation syndromes and the exposure level associated with each (3.6.2.1.b)

5. Describe the possible consequences of long term exposure to radiation when the exposures received are within the annual limits (3.6.2.2.b)

6. Describe the relative risks of occupational radiation exposure and other routine risks encountered by the worker (3.6.2.2.c)

7. State management's policy for ALARA (3.6.3.4.b) (3.6.3.2.c)

8. Explain the principle reason for maintaining exposures to radiation ALARA (3.6.3.2.a)

9. State the site-specific radiation exposure limits for whole body, extremity and skin exposure (3.6.1.3.c)

10. Describe the possible risks of radiation exposure to the developing embryo and fetus (3.6.2.3.a)

11. State the pathways by which radioactive materials can enter the body (3.6.3.3.d) (3.6.2.4.c)

12. State the four basic types of radiation and describe the characteristics of each type (3.6.1.1.a)

13. Describe the properties (such as range and relative hazards) of alpha, beta, gamma, x-rays and neutrons (3.6.1.1.c)

14. List the sources of natural and man-made radiation (3.6.1.2.a)

15. Define the term contamination (3.6.3.3.a)

16. Describe the nature and locations of the major sources of radiation and the types of radioactive material at SRP (3.6.1.2.b) (3.6.2.4.a)

17. Estimate the exposure that can be received in an area based on survey information and estimated stay time (3.6.7)

18. Describe the radiation protection organization's responsibilities in the SRP radiation safety program (3.6.3.5.a) (3.6.2.5.a)

LEARNING OBJECTIVES (Continued)

19. Describe the purpose of and state the appropriate response to all warning signs and labels (3.6.5.3.a)

20. Describe the consequences of unauthorized movement of posted warning signs and labels (3.6.5.3.d)

21. Describe the worker's routine and emergency interactions with the radiation protection organization (3.6.3.5.b)

22. Describe how to obtain radiation exposure records (3.6.4.2.1.e)

23. State the importance of informing supervision of pregnancy (3.6.2.3.c)

24. State the recommendations regarding radiation exposure to a woman who could be pregnant (3.6.2.3.b)

25. Describe the work restrictions for a pregnant employee with respect to radiation exposure (3.6.2.3.d)

26. Describe the actions to be taken if a worker suspects that dose limits/administrative guidelines are being approached or exceeded (3.6.1.3.d)

27. State the actions to be taken if a dosimeter is off scale, forgotten or lost (3.6.4.2.1.d)

28. State the worker's responsibility to maintain radiation exposure ALARA (3.6.3.4.a) (3.6.3.2.b)

29. Explain how to minimize the time spent in restricted areas (3.6.3.1.a)

30. Explain how to maximize distance between the worker and the sources of radiation (3.6.3.1.b)

31. State when the use of shielding is practical and identify appropriate shielding materials for different types of radiation (3.6.3.1.c)

32. Describe how contamination control areas are identified and access is controlled (3.6.3.3.f)

33. Define the various contamination measurement units (3.6.3.3.b)

34. Identify the potential sources of contamination (3.6.2.4.b)

35. Describe how equipment is used to control airborne contamination (3.6.3.3.n)

36. Describe the difference between fixed and loose contamination (3.6.3.3.c)

LEARNING OBJECTIVES (Continued)

37. Describe the consequences of disregarding warning signs and labels (3.6.5.3.c)

38. State the purpose for wearing protective clothing (3.6.3.3.g)

39. Describe the precautions to be followed after leaving a contaminated area before eating, drinking, smoking, chewing or applying makeup (3.6.3.3.e)

40. State the facility policy on working in restricted areas with open cuts or sores (3.6.5.1.c)

41. State the reasons for avoiding contact with potentially contaminated surfaces and equipment (3.6.3.3.k)

42. Describe how contaminated equipment and tools are identified (3.6.3.3.m)

43. State how to properly handle, use and care for portable survey instruments (3.6.4.1.a)

44. State the actions to be taken in case of a personnel contamination monitoring instrument alarm (3.6.3.3.q)

45. Identify the location of the decontamination facilities (3.6.5.1.a)

46. Describe personnel decontamination methods (3.6.5.1.b)

47. State the purpose of the whole body counter (3.6.4.2.2.d)

48. State the purpose of the bioassay samples (3.6.4.2.2.c)

49. State the labeling requirements for submitting a bioassay sample (3.6.4.2.2.b)

50. State for whom and when bioassays are required (3.6.4.2.2.a)

51. State the facility policy on the use of chelation or other therapies for uptakes of radioactive material (3.6.5.1.d)

52. State the purpose and methods that can be used by each worker to minimize the generation of radioactive waste (3.6.8)

53. State the requirements that must be met before entering areas posted with prescribed warning signs and labels (3.6.5.3.b)

54. State the responsibility of each worker to comply with regulatory limits and to follow guidelines (3.6.3.4.c)

55. Identify the type of emergency warning for each type of emergency alarm (3.6.5.2.c)

LEARNING OBJECTIVES (Continued)

56. Identify the types of radiological alarms from area radiation monitors and continuous air monitors (3.6.5.2.g)

57. State the appropriate response to radiological alarms (3.6.5.2.h)

58. State the immediate responses to be taken by a worker in the event of a radiological incident or emergency (3.6.5.2.k)

59. Identify who to inform, how to inform them, and what information to report in case of a radiological incident or emergency (3.6.5.2.j)

60. State what immediate actions should be taken if a worker becomes injured while working in a controlled area (3.6.9)

61. State the pertinent requirements of the facility's emergency plan (3.6.5.2.a)

62. State the role of the radiation worker during an emergency condition (3.6.5.2.b)

63. Describe the emergency situations that might require evacuation (3.6.5.2.e)

64. Describe special precautions and limitations during emergencies including wearing protective clothing outside of the controlled areas (3.6.5.2.f)

65. State how to determine the location of the predetermined emergency assembly areas for each site area (3.6.5.2.d)

66. Demonstrate how to don protective clothing in the proper sequence (3.6.3.3.h.1)

67. Demonstrate how to properly wear personnel dosimetry devices under normal radiological conditions (3.6.4.2.1.a)

68. Demonstrate how to read all types of SRDs at SRP (3.6.4.2.1.b)

69. Demonstrate how to enter and exit a contaminated area to minimize the spread of contamination (3.6.3.3.j)

70. Demonstrate how to properly handle, use and care for radiation survey instruments (3.6.2.5.b)

71. Demonstrate how to perform personnel contamination monitoring (3.6.3.3.p)

72. Perform the preoperational checks prior to using a radiation survey instrument (3.6.4.1.b)

LEARNING OBJECTIVES (Continued)

73. Demonstrate how to remove protective clothing in the proper sequence (3.6.3.3.h.2)

74. Demonstrate the proper method of crossing step off pads when exiting an area (3.6.3.3.1)

75. Demonstrate how to record SRD results (3.6.4.2.1.c)

76. Complete forms for registering as a radiation worker (3.6.6)

Content:

Instructor's Notes:

I. PURPOSE OF INSTRUCTION

A. Inform employees
1. Radiological hazards in workplace
2. How to minimize risk from radiological hazards to
   a. Self
   b. Fellow workers
   c. Public
3. Rules related to radiation safety
4. Individual worker responsibilities
   a. Required by federal regulations to comply with safety rules
      (1) Operating contractor develops rules for areas for which they are custodian
      (2) all who enter must comply - includes federal employees and visitors
   b. Required by DOE-SR order to minimize own radiation exposure

Ask students why they are attending this training.

B. Required by
1. DOE occupational safety and health program
2. Presidential Order
3. OSHA regulations
4. Federal Law (Occupational Safety & Health Act of 1970)

II. EXPOSURE LIMITS

A. 5 rem/yr and 3 rem/quarter whole body
1. Basic units are rem, rem/hr
   a. Can be used for any type of radiation
   b. Measure of biological damage when radiation absorbed in human body tissue
   c. Millirem is 1/1,000 rem
2. Includes head, trunk, gonads, lens of eye, red bone marrow, active blood-forming organs

Ask students why exposure to radiation is limited.
TP-RWT-1
3.6.1.3.a

3.6.1.3.b
Ask students what happens to body if large exposure received in short time.

Content:

Instructor's Notes:

3. Prevents biological effects from short term exposure — TP-RWT-2
   a. Radiation sickness/death
      (1) Blood forming organ syndrome
         (a) Short term exposure > 100 rem
         (b) Caused by damage to
            • Bone marrow
            • Spleen
            • Lymphatic tissue
         (c) Symptoms
            • Hemorrhages result from loss of blood clotting ability due to
               - Capillary damage
               - Decline in platelets
            • Fatigue results from low red blood cell count due to diminished
               - Oxygen supply to other cells
               - Removal of cell wastes
            • Infections/fever from low white blood cell count
         (d) Death likely from severe bleeding or infection
            • 2 to 4 weeks after exposure > 300 rem
            • Medical treatment improves prognosis
         (e) Regeneration of blood forming organ tissue in 2 to 7 weeks
      (2) Gastrointestinal tract syndrome — TP-RWT-3
         (a) Short term exposure > 500 rem
         (b) Caused by damage to linings of stomach, intestines
         (c) Symptoms
            • Nausea and vomiting from
               - Loss of digestion ability
               - Bleeding ulcers
            • Diarrhea from lost ability of large intestine to reabsorb liquids
            • Dehydration and electrolytic imbalance from
               - Inability to absorb nutrients
               - Loss of fluid from diarrhea

Content:	Instructor's Notes:
(3) Central nervous system syndrome (a) Short term exposure > 2,000 rem (b) Caused by damage to nerve cells (c) Symptoms • Uncoordination, confusion, coma from brain damage • Convulsions, shock from inability of nervous system to control rest of body	TP-RWT-4
4. Nonfatal Effects from Short Term Exposure a. Reddening of skin at 200 - 300 rem (1) Similar to mild sunburn (2) From engorgement of blood vessels in skin b. Loss of hair from damage to follicles at > 300 rem c. Sterility (1) Temporary in females at 125 - 200 rem (2) Permanent in both sexes > 600 rem (a) Existing mature sperm cells live for 6-7 weeks (b) Surviving sperm likely to have genetic damage d. Benign tumors of thyroid at exposures > 50 rem	TP-RWT-5 Explain difference between sterility and impotence
5. Effects Based on Cell Functions a. Cells perform more than one function (1) Division for reproduction (2) Develop special functions (specialization) (3) Division to produce specialized cells b. Frequency that other functions need to be performed affects sensitivity to radiation (1) Varies directly with division rate (2) Varies directly with number of future divisions (3) Varies inversely with degree of specialization	Ask students why it takes more radiation to damage nervous system than GI tract.
6. Order of Sensitivity a. Most sensitive adult cells • White blood cells • Immature red blood cells • Immature sperm and egg cells • Skin cells	TP-RWT-6

Content: Instructor's Notes:

b. Moderately sensitive adult cells
- G-I tract lining
- Hair follicles
- Blood vessel lining
- Blood forming organs

c. Most resistant adult cells
- Mature sperm cells
- Muscle cells
- Nerve cells

d. Embryo most sensitive
- Dividing rapidly
- Maximum number of future divisions
- Least specialized

7. Method that cells are damaged changes chemistry
   a. Ionization damages molecules important to cell function — 3.6.2.1.a
      (1) Direct damage to important molecule
      (2) Other damaged molecule damages important molecule
         (a) Most likely mechanism since body mostly water
      (3) New types of molecules created
      (4) Minimum energy required
         (a) More energy damages more molecules
         (b) Non ionizing (microwaves) have energy below minimum
8. Observable effects depend on damage rate and total damage — Ask students whether length of time over which exposure received matters. 3.6.2.1.b
   a. As long as repair/replacement rate exceeds damage rate, no observable effect
   b. Other cells take over function until repair complete
   c. If excessive number damaged at one time body may replace
   d. Population decrease if repair rate + replacement rate < damage rate
   e. No observable injury unless population too low to perform function
9. Probability of biological effects from long term exposure
   a. Limited by dose limits but not eliminated
   b. Some cell damage not repaired
      (1) Not recognized
      (2) Repair mechanism damaged

Content:	Instructor's Notes:
c. Cumulative damage increases probability of effects (1) Increase in probability from radiation exposure at limits is small fraction of probability from other causes	
d. 5 rem/yr for 30 years to gonads increases probability of genetic defects in next two generations by about 0.6%	
e. At 5 rem/yr for 30 years to whole body, probability of dying from cancer increased by about 2%	3.6.2.2.b
f. 1500 rem integrated exposure can cause cataracts	
10. Cancer risk from radiation exposure compared to other risks	TP-RWT-8 TP-RWT-9
a. All risks equated to average lost days of life expectancy	3.6.2.2.c
b. Risk estimates account for (1) Treatability (2) When in lifespan effects may occur	
B. Exposures maintained ALARA below limits	Ask students why radiation exposure should be kept as low as possible below the limit.
1. Estimated probabilities for effects from long term exposure assume no threshold	TP-RWT-10
2. For individuals to minimize cancer risk	3.6.3.4.b, 3.6.3.2.c
3. For collective worker population to minimize genetic defects in offspring	
4. "Reasonably" includes technical, economic, practical considerations	Give examples of each of the three considerations. 3.6.3.2.a
C. SRP whole body exposure guidelines below DOE limits	TP-RWT-11 3.6.1.3.c
1. Established by operating contractor	
2. 0.6 rem/month and 3.0 rem/year	
3. Help to ensure ALARA policy implemented by requiring management approval to exceed	
4. Provides margin of safety to ensure DOE limits not exceeded	

Content:	Instructor's Notes:
D. Exposure to unborn child limited to 0.5 rem/gestation period	TP-RWT-12
1. More sensitive to radiation than adults	Inform students to read R.G.8.13
2. Pre-natal exposures can increase risks of birth abnormalities such as:	3.6.2.3.a
• Childhood cancer	
• Small head size at birth	
• Mental retardation	
3. Adverse effects may be statistically significant over normal incidence at exposures as low as one rem	
E. Individual organ limits	
1. Organs have different sensitivities and relative importance	
a. Whole body limit based on protecting organs most sensitive to cancer	
b. If limits to less sensitive organs only based on probability of cancer, functional damage could occur	
c. Limits to skin, forearms, extremities based on preventing functional damage, not cancer	
2. 15 rem/yr and 5 rem/qtr to skin	TP-RWT-13
3. 30 rem/yr and 10 rem/qtr to bone and forearms	
4. 75 rem/yr and 25 rem/qtr to extremities	
F. Changes to limits to be implemented in near future	TP-RWT-14
1. 5 rem annual limit for whole body changes to effective dose equivalent	
a. Estimate internal and external exposure to each organ	
(1) Weighting factor for each organ	
(a) Considers relative sensitivity	
(b) Considers relative importance to overall body	
(c) Organ exposure equated to equivalent whole body	
2. 15 rem/yr dose equivalent to lens of eye	
3. 50 rem/yr to skin, extremities, other organs	
G. Organs can receive differing exposure	Ask students how different parts of body can receive different amounts of radiation exposure.
1. Narrow radiation beams	
a. Deliberately focused (x-ray machines)	
b. Streaming through penetrations in shielding	

Content:	Instructor's Notes:
2. Source closer to specific body part	
a. External	
b. On skin or clothes	
c. Internal	
(1) Inhaled	3.6.3.3.d, 3.6.2.4.c
(2) Swallowed	
(3) Absorbed through skin	
(4) Open cuts and sores	
III. RADIATION	
A. Definition	TP-RWT-16
1. Includes light, radio waves, microwaves	
2. Commonly means ionizing radiation	
a. Produces ions in material that it strikes	
b. Ions cause chemical changes, damage	
c. Pure energy form	
(1) Gamma rays	
(2) X-rays	
d. Energetic particle form	
(1) Alpha	
(2) Beta	
(3) Neutron	
e. Each type has different hazards	
(1) Due to different characteristics	
(2) Often identified on signs	
B. Alpha radiation is charged particles with kinetic energy	TP-RWT-17 3.6.1.1.a, 3.6.1.1.c
1. Same as helium nucleus	
a. Two neutrons	
b. Two protons	
c. No electrons -- +2 electrical charge	

Content: Instructor's Notes:

2. Produced by
   a. Decay of radioactive material
   b. Fission
3. Produce x-rays when decelerated
4. High linear energy transfer
   a. Due to large mass and high charge
   b. Easily shielded -- external sources not hazardous
   c. Internal sources more hazardous than other radiation types
      (1) Energy deposited in small area
      (2) Higher local concentrations of ions, chemical changes

C. Beta radiation is charged particles with kinetic energy TP-RWT-18

1. Same mass as electron
2. $\pm$ 1 electrical charge
3. Beta + is antimatter
4. Produced by decay of radioactive material
5. Component of cosmic radiation
6. Produce
   a. X-rays when decelerated
   b. Gamma rays when annihilated
7. More penetrating than alpha particles
   a. Due to smaller mass and charge
   b. External source
      (1) Effectively shielded
         (a) 1/4" aluminum or plastic
         (b) Very thin layer of steel
      (2) Will penetrate to active skin layers
      (3) Will not penetrate to internal organs
   c. Internal source
      (1) Most energy transferred to organ containing source
      (2) Not as hazardous as alpha -- damage not as concentrated

Content:

Instructor's Notes:

D. Gamma and x-ray radiation are rays of photons — TP-RWT-19

1. Electromagnetic waves of pure energy
2. No mass
3. Gamma produced by
   a. Nuclei undergoing radioactive decay
   b. Nuclei undergoing fission
   c. Annihilation of antimatter
4. X-ray produced by deceleration of charged particles
5. Penetrate long distances through materials
   a. Due to no mass or charge
   b. External source
      (1) Shielding tenth thicknesses
         (a) 15" water
         (b) 7" concrete
         (c) 2" steel
         (d) 1" lead
      (2) Penetrates to underlying organs
   c. Internal source not as hazardous as beta or alpha
      (1) Ionization spread over larger volume
      (2) Not all energy expended in body

E. Neutron radiation is particles with kinetic energy — TP-RWT-20

1. Nuclear particle with mass but no electrical charge
2. Produced
   a. By fission
   b. When alpha or gamma absorbed by some materials
3. Component of cosmic radiation
4. Indirectly produce other types of radiation when absorbed by other materials
   a. Alpha, gamma, more neutrons if fission occurs
   b. Alpha, beta, gamma from decay of radioactive material

Content:	Instructor's Notes:
5. External source	
a. Readily penetrates lead and steel due to no charge	
b. Better shielded by hydrogenous materials (water, plastic)	
c. Higher probability of interaction with smaller nucleus	
d. High probability of interaction with water in body tissue	
e. Penetrates to active skin layers and underlying organs	
F. Sources	Ask students where radiation comes from.
1. Cosmic	TP-RWT-15
2. Unstable atoms (radioactive material)	3.6.1.2.a
a. Decay	3.6.3.3.a
b. Called contamination if in unwanted location	Ensure that all students understand
c. Both radioactive material and contamination emit radiation	the difference between radiation
3. Charged particle deceleration	radioactive material, and
4. Antimatter annihilation	contamination
G. Sources at major Savannah River facilities	3.6.1.2.b, 3.6.2.4.a
1. 300-M/235-F/Naval Reactors FMF fuel and target fabrication	TP-RWT-21 Point out locations of fabrication facilities.
a. U-235, Pu-239	
(1) Radioactive and fissionable	TP-RWT-22
(2) Alpha, x-ray emitted during decay	
(3) Facilities designed, operated to prevent fission	
b. U-238	
(1) Radioactive	
(2) Alpha, beta, x-ray emitted during decay	
c. Np-237	
(1) Radioactive	
(2) Alpha, x-ray emitted during decay	
2. 100-C, 100-K, 100-L Reactor areas	TP-RWT-21 Point out locations of reactors.
a. Fuel, targets assembled in assembly areas	
b. Loaded into reactor, fission occurs	TP-RWT-23

Content: Instructor's Notes:

c. Process water circulated through reactor, heat exchangers
   (1) Heat exchangers transfer heat to river, lake water
   (2) Tubes prevent direct contact with cooling water
   (3) Leaks in tubes can contaminate cooling water

d. Reactor is critical when significant fission occurring to sustain reaction rate
   (1) Intense gamma, neutron radiation produced
   (2) Access to areas near reactor prohibited when critical
   (3) Shielding protects persons in nearby areas
   (4) Produces radioactive fission products — TP-RWT-24
      (a) Kr-85, I-131, Xe-133, Cs-134, Cs-137 emit gamma and beta radiation during decay
      (b) Sr-89, Sr-90 emit beta radiation during decay
      (c) Fuel designed to contain inside cladding
      (d) Trace fuel on outside of cladding releases small amount into process water
      (e) Some may leak through defects in cladding, contaminate process water
   (5) Produces activation products — TP-RWT-25
      (a) When neutrons absorbed by
         - Targets
         - Process water
         - Impurities in process water
            Corrosion products
         - Structural materials
      (b) H-3
         - Emit very low energy betas during decay
         - Produced when neutron absorbed by targets, process water
      (c) Cr-51, Mn-54
         - Emit x-rays during decay
         - Produced when neutron absorbed by structural materials, suspended corrosion products in process water

Content:

Instructor's Notes:

(d) Fe-59, Co-58, Co-60, Ni-65
- Emit beta and gamma during decay
- Produced when neutron absorbed by structural materials, suspended corrosion products in process water

(e) Np-237, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Am-243, Cf242, Cf-244
- Emit alpha, x-rays during decay
- Produced when neutron absorbed by target, fuel assemblies

e. Portion of process water flow diverted to purification area
(1) Reactor cleanup system
(a) Filters, resins, distillation columns, evaporator
(b) Removes most radioactive contaminants
(c) Tritium not removed
(2) Wastes sent to high level waste tank forms or low level waste burial grounds

f. Spent fuel, targets stored underwater in disassembly area
(1) Gamma exposure rate near spent fuel >1,000,000 rem/hr
(a) Shielded by water
(2) Disassembly disturbs, releases crud into basin water
(3) Fission products may enter pool water if clad is damaged
(4) Basin water recirculated
(a) Through filters, ion exchangers to remove crud, fission products
(b) Through heat exchangers to remove heat

g. R reactor permanently shut down - residual activation products

Content:	Instructor's Notes:
4. 200-F and 200-H separations areas a. Plutonium, uranium from spent depleted uranium targets separated from fission and undesireable activation products in 221-F canyon (1) Plutonium further processed in FB-Line (2) Uranium further processed in A-Line b. Plutonium, uranium, neptunium from spent fuel separated from fission and undesireable activation products in 221-H canyon (1) Savannah river reactor spent fuel and targets (2) Naval reactors and overseas spent fuel temporarily stored at RBOF (3) Plutonium, neptunium further processed in HB-Line (4) Uranium processed off site c. Liquid waste carrying fission products sent to high level waste tank farms for underground tank storage d. Process samples analyzed in 772-F and 772-1F production control facilities	TP-RWT-21 Point out locations of separations areas.
5. Solid low level waste stored in 643 burial grounds a. LLW (1) 95% of buried volume (2) 1-2% of buried activity (3) Usually packaged in yellow metal boxes (a) Exposure rate @ 3" marked on outside of container (b) Seldom exceeds 300 mrem/hr b. Intermediate level waste (1) 5% of volume buried (2) 98-99% of buried activity (3) Buried in separate trenches (4) Various packaging to suit material	TP-RWT-21 Point out location of burial grounds
6. Savannah river laboratory used for process development a. Materials handled vary from time to time b. Both fissionable and radioactive materials may be present	TP-RWT-21 Point out location of SRL
7. CMX, TNX production and design test facilities may contain both radioactive, fissionable materials	TP-RWT-21 Point out location of TNX and CMX areas

Content:	Instructor's Notes:	
8. 400-D reactor process water purification facilities	TP-RWT-21	Point out location of 400-D area
a. High levels of tritium contamination		
b. Lower levels of fission products, activation products		
9. 200-S area DWPF		
of DWPF.		
a. Adjacent to separations areas		
b. Will solidify liquid high level waste for offsite shipment		
c. Fission products requiring less isolation converted to saltstone, will be stored at 200-Z area		
10. CS-area central shops radiography facility		
a. X-ray machines in shielded rooms		
b. Machines interlocked to prevent entry to room when beam on		
IV. EXPOSURE CONTROL		
A. Exposure estimated from rate and time	TP-RWT-26	Work through several examples.
B. Exposure rates measured periodically by Health Protection	3.6.7	
	3.6.3.5.a	
1. Areas posted with signs if exposure rate > natural background	TP-RWT-27	
a. Installed at access to areas	3.6.5.3.a, 3.6.5.3.d	
(1) Doors, gates		
(2) Fences, barricades		
b. Black or magenta letters, symbols on yellow background		
c. Trifoil		
d. Signs give area designation by general hazard level		
(1) Regulated Area is where radiation or radioactive materials present above natural background		
(2) Radiation Zone is where exposure rate > 300 mrad/hr β-γ or 50 mR/hr γ	TP-RWT-28	
e. Actual exposure rate or range may be written on sign	TP-RWT-29	
(1) Usually posted in same units as instrument readout		
(a) Can be used to distinguish radiation type		
(b) R/hr or mR/hr for gamma and x-ray, 1 R approximately = to 1 rem, unit for measuring exposure in air		
(c) rad/hr or mrad/hr for beta, 1 rad approximately = 1 rem, unit for measuring absorbed energy		
(d) mrem/hr for neutron		

Content:	Instructor's Notes:
(2) If mixed radiation field more than one exposure rate posted	
f. Exposure rate written on tags or labels	TP-RWT-30
(1) Attached to items, equipment, barricades	
(2) Exposure rate significantly differs from general area	
g. New signs to replace old over next few years	TP-RWT-31
(1) Controlled Area is where radiation or radioactive materials present > natural background	
(2) Radiation Area is within controlled area where exposure rate > 2 mrem/hr but < 100 mrem/hr	
(3) High Radiation Area is within controlled area where exposure rate > 100 mrem/hr but < 5 rem/hr	
(4) Very High Radiation Area is within controlled area where exposure rate > 5 rem/hr	
(5) Actual exposure rate or range may be written on signs	
2. Exposure rates posted on status boards	TP-RWT-32
a. Used where exposure rates vary widely or change frequently	
b. Floor plans with exposure rates written in	
c. Survey frequency, date of latest survey written at bottom	
d. Don't use if survey out of date	
3. Contact area Health Protection for exposure rate information	3.6.2.5.a, 3.6.3.5.b
a. When specified by procedure or job plan	
(1) Before entering area	
(2) All entries require procedure	
b. When exposure rate not on sign or status board or status board out of date	
c. Erased status board means area is locked	
d. When "contact HP" is written across status board	
(1) Conditions vary widely or changing very rapidly	
(2) May be accompanied into area by HP	
C. Exposure measured by dosimetry	
1. TLD's used to measure beta, gamma, x-ray exposure	TP-RWT-33
a. Crystals absorb, retain energy from radiation	
b. Emits light proportional to radiation absorbed when heated	

Content: Instructor's Notes:

c. Light output measured by separate instrument
d. Whole body TLD's
   (1) Required to be worn
      (a) By all who enter regulated areas
      (b) On outside of personal clothing
      (c) Between waist and shoulders
   (2) Crystal type, quantity, shields selected for accurately measuring exposure to specific radiation types
      (a) SRP TLD badge assigned to all who don't enter transuranic facilities
      (b) B Line TLD badge assigned to those who enter B Lines or transuranic facilities — TP-RWT-34
         - Contains different crystals, shielding
         - Measures exposure from low energy x-rays more accurately
      (c) Only one of above 2 types worn at one time
   (3) Exercise care in handling
      (a) Don't poke objects in beta window
      (b) Don't remove from case
   (4) Permanently assigned TLD badge
      (a) Obtain by contacting DOE Rad Safety in 703-41A
      (b) Stored in rack — TP-RWT-35
         - Lower level 703-A D wing if normally work in A area
         - In area security building if normally work in other area
         - Leave in rack when not needed
         - Return to rack at end of shift
         - Additional green label TLD's monitor background at rack
      (c) Two assigned to each person
         - Yellow, white labels
         - Changed last day of month on 4-12
         - Not replaced if missing from rack

Content: Instructor's Notes:

(5) Temporary TLD's (Orange label)
(a) Assigned to visitors, persons who infrequently enter regulated areas
(b) Escort responsible for ensuring visitor has TLD - Both visitor and escort must sign form
(c) Obtained in 703-A lobby

e. Supplementary TLD's
(1) Ring mounted or additional chest type badges TP-RWT-36
(a) If exposure information needed more than once a month
(b) If parts of body may receive exposure different from chest
(c) If exposure to specific part of body of special interest (special studies)
(2) Always worn in addition to chest TLD TP-RWT-37
(3) When, how worn specified in procedures, job plans or by HP
(4) Obtained from area HP

2. SRD's used to measure x-ray, gamma, neutron exposure TP-RWT-38
a. Exposure can be read by user
(1) Chamber charged
(2) Like charge causes fiber to move away from electrode
(3) Radiation produced ions neutralize charge
(4) Fiber moves closer to electrode
(5) Position of fiber viewed through end on scale calibrated in exposure units
b. Three types in use at SR
(1) Most commonly used measures gamma exposure
(a) Heavy stainless steel case prevents accurate response to low energy x-rays
(b) Required when entering area > 25 mR/hr, when specified by procedure, job plan or HP
(2) Aluminum case SRD used instead of (1) above when low energy x-rays present

Content: Instructor's Notes:

(3) Thermal neutron SRD
(a) Will not respond accurately to gamma, x-ray or high energy neutron
(b) Used in areas with significant thermal neutron exposure rates

c. Always worn in addition to, side by side with TLD
d. Obtained from area HP
e. Must be returned at end of shift or job
f. Return for HP to have rezeroed if > 75% full scale
g. Delicate instruments
(1) Dropping or bumping can permanently damage or change reading
(2) If dropped or bumped read immediately, return to HP if reading has changed

3. Thermoluminescent Neutron Dosimeters used to measure neutron exposure — TP-RWT-39
a. Special crystals, shielding in semispherical stainless steel case
b. Must be worn when entering area with significant neutron exposure rate
(1) As specified in procedures, job plans or HP
(2) Attaches to belt
(3) Must be worn snug against body to respond accurately
c. Obtained from area HP
d. Must be returned at end of job or shift or as specified when issued
e. Must be processed at 735-A to determine exposure

4. Criticality Neutron Dosimeters used to measure gamma, neutron exposure from criticality accident — TP-RWT-40
a. Contain several devices to cover wide exposure range
b. Required when entering areas where fissionable material handled
c. Processed only if criticality accident occurs
(1) Collected at rally point by HP
(2) Processed at 735-A

Content:

Instructor's Notes:

d. Obtained from area HP
e. Returned only if no longer entering area where required

D. Comparing exposure to limits

1. Exposure recorded on TLD normally used for records
   a. Report prepared each time TLD's processed
      (1) Lists exposure for previous month, total for year and quarter
      (2) Sent to DOE Occupational Safety Branch
   b. Employee can request to see own exposure records any time during normal working hours — 3.6.4.2.1.e
2. Employee Radiation Dose Record card used to track exposure — TP-RWT-41
   a. Necessary to ensure exposure limits not exceeded during month
   b. Daily exposure estimate entered on card when advised to do so by HP — Explain each entry on the card shown in TP-RWT-41
      (1) Daily skin exposure estimated by multiplying daily gamma whole body by ratio from HP, add daily neutron exposure
      (2) Daily whole body gamma exposure
         (a) Use SRD reading if one was worn
         (b) If no SRD estimate from exposure rate and time
      (3) Daily whole body neutron exposure
         (a) Use neutron SRD reading if worn
         (b) If no SRD estimate from neutron exposure rate and time
      (4) Daily extremity exposure
         (a) Same as daily whole body unless in nonuniform field
         (b) If in nonuniform field consult HP
      (5) Month to date total skin -- add previous entry in column to daily
      (6) Month to date total whole body -- add previous entry in column to daily whole body gamma and neutron
      (7) Month to date total extremity -- add previous entry in column to daily extremity

Content:	Instructor's Notes:
3. Must know which of various limits your exposure is closest to	TP-RWT-42
a. Usually whole body for DOE personnel	
b. Fetus limit becomes most restrictive for female once she declares pregnancy	
(1) Must promptly decide whether or not to declare so that limit can be complied with	3.6.2.3.c
(2) Will be assigned additional TLD so exposure can be evaluated every two weeks	3.6.2.3.b
(3) May be reassigned if necessary to meet fetus limit -- career protected by Pregnancy Discrimination Act of 1978	3.6.2.3.d
E. Exposure approaching or exceeding a limit	Ask students what happens if their radiation exposure exceeds a limit.
1. If exposure by TLD very near to or above DOE limit	
a. Not permitted to enter regulated areas until new exposure period	
b. Additional 50 mrem allowed if already over 500 mrem for gestation period at time of pregnancy declaration	
2. If exposure approaches SR guideline but not DOE limit	
a. Notify supervisor	3.6.1.3.d
b. Exposure extension may be authorized if warranted	
3. If SRD lost or offscale	
a. Leave area, report to HP	3.6.4.2.1.d
b. TLD processed	
c. Exposure limit assumed to be exceeded until TLD results available -- no access to regulated areas	
F. Exposure reduction techniques	Ask students how they can reduce their radiation exposure.
1. Time, Distance, Shielding	
2. Each individual is responsible	3.6.3.4.a, 3.6.3.2.b
3. Reduce time near radiation sources	TP-RWT-43
a. Preplan each entry to regulated areas	TP-RWT-44
b. Don't enter unless really necessary	3.6.3.1.a, 3.6.3.1.b
c. Do as much of job as possible outside area	
d. Know what you are going to do in area	
e. Make sure you take everything you need with you	
f. Use standard techniques for eliminating job delays	

Content:	Instructor's Notes:
4. Maximize distance from radiation sources	TP-RWT-45
a. Know where source of radiation is	
b. Know exposure rates in specific locations	
5. Use shielding	TP-RWT-46
a. Denser materials better shields for alpha, beta, gamma	3.6.3.1.c
b. High hydrogen concentration materials (water, plastic) best shields for neutron	
c. Thickness to provide given shielding effect increases as radiation energy increases	
d. Typical shielding effectiveness	
(1) Sheet of paper, outer layer of dead skin attenuates almost all alpha	
(2) Thin sheet of aluminum or glass significantly reduces beta, low energy gamma and x-ray -- safety glasses required if present to reduce eye exposure	
e. Given thickness of lead twice as effective as steel for gamma	
f. Permanent shielding in facility design	
g. Temporary shielding for some jobs	
h. Can be implemented by individuals on daily basis	
(1) Know where source is	
(2) Keep any available material between self and source	
G. Contamination levels periodically measured by Health Protection	
1. Areas posted with signs if contamination present > background	3.6.3.3.f
a. Regulated Area if > background	TP-RWT-47
(1) Regulated area could also mean radiation or radioactive materials	
(2) Either surface or airborne or both	
b. Radiation zone if > specified in HP procedures	TP-RWT-48
(1) Different numbers used in different areas	
(2) Radiation Zone could also mean radiation > 50 mR/hr or 300 mrad/hr, or radioactive materials storage	
(3) Either surface or airborne or both	

Content:

Instructor's Notes:

c. New signs to be phased in over next few years — TP-RWT-49
   (1) Controlled Area if surface contamination > background and < 10 X background
      (a) Could also mean radiation > background
      (b) Protective clothing not normally required
   (2) Contamination Area within Controlled Area if surface > 10 X background
   (3) Airborne Radioactivity Area within Controlled Area if airborne > Derived Air Concentration
      (a) Assumes 40 hours/week, 50 weeks/year
      (b) Based on organ dose commitment of 500 mrem whole body equivalent

d. Actual contamination levels may be written on sign — TP-RWT-50 3.6.3.3.b
   (1) c/m for direct measurements of beta-gamma
   (2) mrad/hr for higher levels of beta
   (3) d/m for direct measurements of alpha
   (4) Loose measured with smears
      (a) Paper towel smear of about 1 square foot
         - Activity on towel measure with same instruments used for direct measurement
      (b) Filter paper smear of about 100 cm^2
         - Activity on smear measured in lab
         - units of d/m/100 cm^2 followed by Greek symbol for radiation type
            • α for alpha
            • β for beta
            • γ for gamma
   (5) Airborne contamination measured by drawing air through filters with pump
      (a) Activity on filter measured in lab
      (b) Units of μCi/cc followed by Greek symbol
   (6) Airborne tritium expressed as assimilation rate
      (a) μCi/hr HTO
      (b) HTO stands for tritiated water vapor
   (7) Airborne contamination occasionally expressed as percent or fraction of DAC

Content:	Instructor's Notes:
2. Contamination levels posted on status boards where used	TP-RWT-51
3. Contact area HP for contamination levels if not posted	
H. Source of Contamination is failure of or leaks from systems	Ask students where contamination comes from.
1. Processes, systems, facilities designed to contain radioactive material	TP-RWT-52 3.6.2.4.b, 3.6.3.3.n
2. Radioactive material dissolved or suspended in liquid in many processes	
3. When liquid leak/spill occurs	
a. Small portion goes airborne	
b. Most radioactive material stays with liquid	
(1) Deposited wherever liquid was when liquid dries	
(a) Some trapped in pores	
(b) Easily transferred to people, air other items if surface is smooth	
(c) Can become imbedded from walking, etc.	
(2) Fixed if imbedded, not easily removed	
(3) Loose if readily transferable to clothing, air	3.6.3.3.c
J. Internal/external personnel contamination prevented by good work practices and protective equipment	3.6.5.3.c, 3.6.3.3.g, 3.6.3.3.e
1. Don't enter areas where contamination present unless necessary	
2. Notify supervisor of open wounds or sores before entering	
a. Evaluated/treated by medical	3.6.5.1.c
b. If break in skin can't be treated and dressed to prevent contamination	
(1) No entry to areas with alpha contamination	
(2) May enter areas with beta-gamma contamination with normal protective clothing	
3. Wear protective clothing and equipment when entering	
a. Provided for all who enter potentially contaminated areas	
b. Protects skin, personal clothing	

Content:	Instructor's Notes:
c. Type, articles based on type and level of contamination and activities to be performed	TP-RWT-53
(1) Coveralls	
(2) Caps	
(3) Gloves	
(a) Rubber outside	
(b) Cloth inside	
(4) Shoe covers	
(a) Rubber outside	
(b) Cloth or plastic inside	
(5) Laboratory coats	
(6) Water resistant materials used in wet areas	
(7) Respirators require additional training, medical screening, fit test	
(a) Obtain medical screening form from P&ME	
(b) Call 729-A to schedule training, fit test	
d. Two or more layers in heavily contaminated areas	
e. Laundered and reused	
(1) Some contamination fixed in fibers	
(2) Color coded to prevent cross contamination or areas	
(a) Brown for areas with uranium, thorium only	
(b) White in all other areas	
f. To effectively protect must	
(1) Fit properly	
(a) Too small may tear or ride up	
(b) Too large interferes with work	TP-RWT-54
(2) Be in good condition	
(3) Be put on and worn properly	
(a) Proper overlap of articles	
(b) Tape joints if necessary	
(4) Durable enough to withstand conditions of use	
(a) Consider whether work is likely to damage	
(b) Special items available if needed	
4. Avoid unnecessary contact with surfaces	3.6.3.3.k
a. Contamination can penetrate protective clothing	
b. Contamination on clothing transferred to other surfaces	

Content:	Instructor's Notes:
c. Recognize, stay away from potentially heavily contaminated items	3.6.3.3.m
(1) Contamination control equipment	TP-RWT-55
(a) Mops	
(b) Vacuum cleaners	
(2) Regulated service tools and equipment	TP-RWT-56
(3) Painted orange or tagged or labeled	
5. Don't touch unprotected parts of body	
a. Gloved hands in pocket when wearing labcoat	
b. Wiping forehead on sleeve	
c. Eating, drinking, smoking, chewing, applying makeup forbidden	
6. Exit contaminated areas properly	
a. Assume protective clothing contaminated unless monitored	
(1) Required to monitor protective clothing before removing if count rate meter available at exit point	TP-RWT-57 TP-RWT-58
(a) Ensures that contamination not transferred from PC's to skin, personal clothing when removing	
(b) Will alarm if contamination above acceptable levels	
(c) Speaker with volume control -- one click for each event detected	3.6.4.1.a
(d) Probe should be as close as possible without touching monitored surface	
(e) If wearing two layers of PC's remove outer before monitoring	
(f) Monitor hands before picking up probe	
(g) Source check	
- Notify HP if no alarm	
- Source strength not representative	
(h) Move probe slowly, 1 inch per second	
(i) If increasing count rate stop moving probe, allow to stabilize	
(j) If meter alarms	
- Have someone else notify HP	3.6.3.3.q
- If no one else available	
• Put on clean gloves, shoe covers	
• Go to nearest phone to notify	

Content:	Instructor's Notes:
(2) If no meter available at contaminated area exit point	
(a) Carefully remove outer protective clothing	TP-RWT-59
- First remove items most likely to have heaviest contamination	
• Outer shoe covers	
• Outer gloves	
- Remove inner gloves last	
- Roll articles inside out	
(b) Proceed to nearest count rate meter, monitor	
b. Monitor with count rate meter or portal monitor when leaving regulated area	TP-RWT-60
(1) Required for all personnel	
(2) Portal monitors available only in certain areas	
(a) Many sensitive detectors mounted in portal	
(b) May be stop and count or walkthrough	
(c) Alarms	
- Contamination	
- Exiting before monitoring complete	
c. Use hand and foot monitor before leaving process building	TP-RWT-61
(1) Required at least when exiting last time for day	
(2) Step onto foot detectors	
(3) Put hands in detector wells, push switches	
(4) Instructions on lighted panels	
d. If skin, personal clothing in contact with known loose radioactive material notify or have someone else notify HP	
K. Skin decontamination	Ask students what will happen if they get contamination on their skin.
1. Immediately notify supervision and HP	
a. Instrument alarms while monitoring self for contamination	
b. Skin, personal clothing in contact with known radioactive material	
2. Decontamination performed carefully, methodically	
a. Exposure rate will be low unless contamination very high	
b. Absorption rate through unbroken skin slow except tritium	

Content:	Instructor's Notes:
c. Self decon if wet with moderator	TP-RWT-62
(1) Have someone else notify HP	
(2) Go to nearest shower	
(3) Remove all wet clothing except plastic suits	
(4) Shower	
(a) If not wearing plastic suit continue until HP arrives and advises	
(b) If wearing plastic suit	
- Stop after 15 minutes	
- Have someone help you out of suit	
3. Facilities	TP-RWT-63
a. In each major process area in or near HP office	3.6.5.1.a
b. For gross decon at canyon buildings	
c. 719-A medical facility if also injured	
4. Approved methods at Savannah River	3.6.5.1.b
a. Scrubbing with soap/water paste	
(1) Dissolves, emulsifies, erodes	
(2) May defat, abrade skin	
(3) Least likely method to damage skin	
b. 50% Sodium hypochlorite applied with swabs or pads	
(1) Let stand for 2 minutes, rinse with water	
(2) Dissolves hair and skin	
(3) Not used near eyes without medical approval	
c. With medical approval if other methods fail	
(1) 4% potassium permanganate/sodium bisulfite	
(a) Permanganate applied with swab	
- Converts contaminant to soluble form	
- Stains skin, will remove outer layer after about 2 minutes	
(b) Bisulfite washes away contaminant, removes stain	
(2) Titanium dioxide/water paste worked into skin	
(a) Works same as soap/water but more abrasive	
(b) Removes several layers of skin	

Content:	Instructor's Notes:
L. Detection of internal contamination	
1. Nasal mucous/oral saliva swabs if inhalation or ingestion suspected	
a. Performed by individual	
b. Counted in laboratory	
2. Whole body or chest counts	TP-RWT-64
a. Chest counter for transuranics, whole body for all others	3.6.4.2.2.d
b. If contamination detected on nasal/oral swabs	
c. Baseline required before first entry to regulated area	
(1) If have worked at other facilities where internal contamination possible	
(2) To differentiate between SR and previous exposure	
d. Periodic routine	
(1) Frequency based on work assignment	
(2) To detect long term accumulation of very small quantities	
3. Urine/feces/blood samples	
a. Analyzed in laboratory	3.6.4.2.2.c
b. Collection	
(1) Urine/feces by individual -- instructions provided	TP-RWT-65
(2) Blood collected by medical	3.6.4.2.2.b
c. Urine sample used to measure isotopes not readily measured by chest or whole body counter	3.6.4.2.2.a
(1) Baseline required if have worked at other facilities	
(2) Periodic routine required for all who enter regulated areas	
(3) Routinely performed for those working where tritium present	
(4) Only dosimetry available for low energy beta from tritium	
M. Actions for internal contamination	Ask students what will happen if they get contamination inside their body.
1. Nasal passages decontaminated by irrigation with saline	3.6.5.1.d
a. By individual after instruction	
b. By medical personnel	

Content:

Instructor's Notes:

2. Venous tourniquets — TP-RWT-66
   a. Used to reduce absorption of transuranics through wounds
   b. Applied with moderate pressure
      (1) Between wound and heart
      (2) Doesn't stop arterial flow
      (3) Stops venous flow
         (a) Prevents contaminant from spreading through blood stream
         (b) Local blood pressure increase promotes bleeding, flushes wound
3. Natural elimination according to chemical form — TP-RWT-67
   a. Ingested insoluble material passed through G-I tract
   b. Inhaled insoluble material cleared by mucous, coughing
   c. Soluble materials eliminated in urine
4. Medicines to enhance natural elimination
   a. Laxatives to speed up elimination through G-I tract
   b. Expectorants to promote lung clearance -- spit, don't swallow
   c. Chelating agents
      (1) Form soluble complex with metals
      (2) Eliminated with urine
5. Frequent bioassay
   a. Evaluate effectiveness of treatment
   b. Calculate exposure
6. If deliberately administered by doctor for medical treatment or diagnosis
   a. Medical exposure not part of occupational exposure
   b. Inform supervisor upon returning to work
      (1) Presence in body may interfere with contamination detection, control
      (2) Temporary reassignment possible

Content:	Instructor's Notes:
N. Avoiding spread of contamination and generation of radioactive waste	Ask students how avoiding the spread of contamination and generation of radioactive waste reduces radiation exposure 3.6.8
1. Minimize amount of material taken into contaminated areas	
a. Minimizes total volume that can become contaminated	
b. Reduced waste volume reduces exposure to those who process	
2. Control direction of flow of things entering contaminated areas	3.6.3.3.e
a. From lowest to highest contamination levels	
b. Controls to prevent contamination from leaving area at exit point	
c. Prevents spreading high levels of contamination to areas of lower contamination	
d. Applied to both design and administrative practices	
e. Separate personnel entry, exit points	
(1) Enter at area of lowest contamination	
(2) At exit	
(a) Containers for used protective clothing, trash	TP-RWT-68
(b) Instrument to monitor self for contamination	
(c) May have step off pad on clean side	
(d) All tools, equipment, etc. must by monitored by HP before being removed from area	
- Green tag for unconditional release	TP-RWT-69
- White tag for conditional release -- can leave area but not SRP site	
f. Most ventilation systems designed around same concept	
(1) Flow from cleanest to most contaminated areas	
(2) Special filters on exhaust	
(3) Some rooms have airlocks -- open one door at a time	
P. Precautions for specific work/tasks	
1. All work in regulated areas requires procedures	3.6.5.3.b
2. DPSOP-40 provides general guidance	
3. Procedures and posted instructions provide precautions for routine work	TP-RWT-70 TP-RWT-71
4. Job plans for non routine work	
5. Verbally by HP	3.6.3.4.c

Content:	Instructor's Notes:
4. Combinations/variations of techniques already covered based on	
a. Experience	
b. Knowledge	
(1) Conditions in area	
(2) Activities that could change conditions in area	
V. CHANGES IN RADIOLOGICAL CONDITIONS	Ask students what might cause exposure rates or contamination levels to suddenly increase.
A. Identification, alerting of workers	
1. Conditions periodically monitored by HP	
a. Frequency based on	
(1) Likelihood of change	
(2) Relative magnitude of potential hazards	
b. Will inform all in area if significant change for worse	
2. Continuous monitors in areas with high probability for rapid changes	3.6.5.2.c
a. Air monitors	TP-RWT-72
(1) Permanently installed or portable	
(2) Several models in use	
(a) Health Monitor (HM)	
(b) VAMP	
(c) GA-6	
(3) Alarm if preset levels exceeded	3.6.5.2.g
(a) Local visual and audible	AT-RWT-73 Play CAM alarm.
(b) May have remote at HP office or control room	TP-RWT-74
b. Area radiation monitors	TP-RWT-75
(1) Permanently installed or portable	
(2) Alarm if preset levels exceeded	AT-RWT-73 Play HM alarm.
(a) May have local visual and audible	
(b) Remote at HP office or control room	
(c) PA used to alert workers if no local alarm	
c. Nuclear Incident Monitors	TP-RWT-76
(1) Permanently installed	
(2) Alarm if criticality detected	
(a) Local visual and audible -- audible is bell with distinctive sound	AT-RWT-73 Play NIM alarm.
(b) Always have remote at continuously manned located with PA access	

Content:	Instructor's Notes:
3. Individual observation of malfunction, failure of process equipment	
a. Leaks and spills	
b. Air reversals	
B. Individual response	
1. Obey all stop work orders from HP	
2. CAM or area monitor alarm	TP-RWT-77
a. Place work in safe condition	3.6.5.2.h
b. Exit promptly using normal precautions/procedures	
c. Report to HP for instructions	
3. NIM alarm	TP-RWT-78
a. Exit immediately	
(1) Follow evacuation route signs	
(2) Assemble at designated area	
b. Do not delay to	
(1) Place work in safe condition	
(2) Remove protective clothing or monitor for contamination	
c. Contamination monitoring will be done at assembly area if needed	
4. If you observe unusual conditions	3.6.5.2.k, 3.6.5.2.j
a. Leave immediate area	
b. Notify operations supervision, HP	
5. Personal injury in contaminated area	3.6.9
a. Medical/first aid treatment has priority over contamination control unless injury is minor	
(1) Serious injuries sent to 719-A for both medical treatment and decon	
(2) Minor injuries treated in area, individual deconned before leaving regulated area	
b. Contamination controlled to extent it won't jeopardize health of injured	

Content:	Instructor's Notes:
6. Fire	AT-RWT-73 Play fire alarm.
a. Could damage lead or poly shielding	
b. Could damage containments	
c. Specific response procedures	
(1) Developed by area supervision	
(2) Have special considerations for possible radiological hazards	
(3) Each individual responsible for knowing relevant content	
7. Area and site emergency plans and procedures	3.6.5.2.a, b, d, e, f
a. Cover wide range of incidents	
(1) Some that are not radiological in origin have radiological consequences	
(2) Some possible accidents so severe that other site areas can be affected	
b. Respond as directed over PA or by supervision	
c. Additional training provided if you have specific response duties	
VI. DEMONSTRATIONS	During each of the demonstrations explain what you are doing and why. Discuss the different sizes available. Show how to check each item for damage.
A. Putting on protective clothing	
1. Inner shoe covers	3.6.3.3.h.1
2. Dosimetry	3.6.4.2.1.a
a. TLD	
b. SRD -- record initial reading	Use TP-RWT-79
3. Coveralls	
4. Cap or hood	
5. Outer shoe covers	
6. Inner gloves	
7. Outer gloves	
B. Entering contaminated area	
C. Reading SRD in contaminated area	3.6.4.2.1.b

Content:	Instructor's Notes:
D. Exiting contaminated area	3.6.3.3.j
1. Monitoring with count rate meter	3.6.2.5.b, 3.6.3.3.p
a. Check hands	
b. Source check instrument	3.6.4.1.b
c. Monitor body	
d. Monitor personal items	
d. Replace probe so others can monitor hands	
2. Remove protective clothing	Demonstrate the techniques used when a CRM is not available to monitor the clothing before removal.
a. Outer shoe covers	
b. Outer gloves	
c. Cap or hood	3.6.3.3.h.2
d. Coveralls	
e. Inner shoe covers	
f. Inner gloves	
3. Segregation of trash and protective clothing	
4. Proper use of step off pad	3.6.3.3.1
E. Recording SRD reading	Use TP-RWT-79 3.6.4.2.1.c Explain to students that they will be required to individually demonstrate their ability to perform the tasks that you have just shown them before they are permitted unescorted access to Regulated Areas.
VII. RADIATION EXPOSURE HISTORY RECORDS	Provide each student with a blank form OSR 5-145. Use TP-RWT-80 to show the proper entry for each blank on the form. Instruct the students to bring the completed form with them to OSB Radiation Safety so that a permanent TLD can be assigned.
A. Employee	
1. Certifies whether or not has previous radiation exposure	
2. Lists previous facilities where exposed if applicable	
B. DOE uses to	3.6.6
1. Ensure that employee exposure history records complete	Explain that DOE will contact each of the previous employers listed to obtain copies of radiation exposure records.
2. Ensure that exposure at SR combined with previous exposure will not exceed limits	

DOE-SR RADIATION WORKER TRAINING

LIST OF TRANSPARENCIES

TP-RWT-1	DOE Whole Body Radiation Exposure Limits
TP-RWT-2	Radiation Sickness -- Blood Forming Organ Syndrome
TP-RWT-3	Radiation Sickness -- Gastro Intestinal Tract Syndrome
TP-RWT-4	Radiation Sickness -- Central Nervous System Syndrome
TP-RWT-5	Other Possible Biological Effects from Short Term Radiation Exposure
TP-RWT-6	Relative Radiosensitivity of Human Cells
TP-RWT-7	Possible Biological Effects from Long Term Radiation Exposure
TP-RWT-8	Risk Comparison -- Long Term Radiation Exposure vs. Other Common Risk Factors
TP-RWT-9	Risk Comparison -- Work Involving Long Term Radiation Exposure vs. Common Occupations
TP-RWT-10	The ALARA Concept
TP-RWT-11	Savannah River Radiation Exposure Guidelines
TP-RWT-12	Risks to the Unborn from Prenatal Exposure to Hazards
TP-RWT-13	DOE Radiation Exposure Limits for Individual Organs
TP-RWT-14	New DOE Radiation Exposure Limits
TP-RWT-15	Sources of Radiation
TP-RWT-16	Types of Radiation
TP-RWT-17	Alpha Radiation
TP-RWT-18	Beta Radiation
TP-RWT-19	Gamma and X-ray Radiation
TP-RWT-20	Neutron Radiation
TP-RWT-21	Map of Savannah River Site
TP-RWT-22	Radiological Hazards in Fuel and Target Fabrication Areas
TP-RWT-23	Production Reactor Process Description
TP-RWT-24	Common Fission Products
TP-RWT-25	Common Neutron Activation Products
TP-RWT-26	Estimating Radiation Exposure from Exposure Rate and Time
TP-RWT-27	Picture of Regulated Area Sign
TP-RWT-28	Picture of Radiation Zone Sign
TP-RWT-29	Exposure and Exposure Rate Units of Measurement
TP-RWT-30	Picture of Radiation Warning Tags/Labels
TP-RWT-31	New Signs for Posting Areas Where Radiation is Present
TP-RWT-32	Status Board Showing Exposure Rates
TP-RWT-33	Picture Showing an SRP TLD Badge Properly Worn
TP-RWT-34	Picture of B-Line TLD Badge
TP-RWT-35	Picture of Typical TLD Storage Rack in Security Building
TP-RWT-36	Picture of Ring Mounted TLD
TP-RWT-37	Picture of Person Wearing Multiple TLD's
TP-RWT-38	Picture of SRD
TP-RWT-39	Picture of TLND
TP-RWT-40	Picture of CND
TP-RWT-41	Employee Radiation Dose Record Card with Example Entries
TP-RWT-42	Summary of Radiation Exposure Limits and Guidelines
TP-RWT-43	Basic Radiation Exposure Reduction Techniques
TP-RWT-44	Basic Radiation Exposure Reduction Techniques -- Time
TP-RWT-45	Basic Radiation Exposure Reduction Techniques -- Distance

TP-RWT-46	Basic Radiation Exposure Reduction Techniques -- Shielding
TP-RWT-47	Summary of Posting Requirements for Regulated Areas
TP-RWT-48	Summary of Posting Requirements for Radiation Zones
TP-RWT-49	New Signs for Posting Areas Where Contamination is Present
TP-RWT-50	Contamination Units of Measurement
TP-RWT-51	Status Board Showing both Exposure Rates and Contamination Levels
TP-RWT-52	Picture of Typical Glove Box
TP-RWT-53	Picture of Person Selecting or Inspecting Typical Protective Clothing (should show typical clothing storage containers)
TP-RWT-54	Picture of Person Properly Wearing Typical Protective Clothing (Photo should show tape around wrists and ankles)
TP-RWT-55	Picture of Regulated Use Vacuum Cleaner (tagged or painted orange)
TP-RWT-56	Picture of Regulated Use Hand Tools (painted orange)
TP-RWT-57	Picture of Person Monitoring for Contamination with Count Rate Meter at Exit from Contaminated Area while Wearing Protective Clothing
TP-RWT-58	Picture of Count Rate Meter with Detector
TP-RWT-59	Picture of Person Properly Removing Protective Clothing (rolling clothing inside out)
TP-RWT-60	Picture of Person Using Portal Monitor
TP-RWT-61	Picture of Person Using Hand and Foot Monitor
TP-RWT-62	Procedure for Self Decontamination if Wet with Moderator
TP-RWT-63	Decontamination Facilities and Methods
TP-RWT-64	Picture of Person Being Counted in Whole Body Counter
TP-RWT-65	Picture of Urine Containers at a Typical Bioassay Station
TP-RWT-66	Picture of Venous Tourniquet Being Used
TP-RWT-67	Treatments for Assimilation of Radioactive Material
TP-RWT-68	Picture of the Exit Area from a Contaminated Area (should show barricades, signs, receptacles for trash and used protective clothing, a step off pad and a count rate meter)
TP-RWT-69	Picture of Green and White Release Tags
TP-RWT-70	Typical Radiological Precautions in a Procedure
TP-RWT-71	Picture of Person Reading Posted Radiological Instructions
TP-RWT-72	Picture of Typical Continuous Air Monitor
TP-RWT-74	Picture of Typical Alarm Panel in an HP Office
TP-RWT-75	Picture of Typical Health Monitor
TP-RWT-76	Picture of Nuclear Incident Monitor
TP-RWT-77	Response to Continuous Air Monitor or Health Monitor Alarms
TP-RWT-78	Response to Nuclear Incident Monitor Alarms
TP-RWT-79	Employee Radiation Dose Record Card (black on white)
TP-RWT-80	Employee Radiation Exposure History Form (OSR 5-145, back) (black on white)