Contamination Control Lesson Plan

ACADs (08-006) Covered

1.1.8.4.1	1.1.8.4.2	1.1.8.4.3	1.1.8.4.4	3.2.3.13	3.2.3.23.5	3.2.3.23.6
3.2.3.23.12	3.2.3.28.2	3.3.8.7	3.3.8.9	3.3.9.5	3.3.9.8.1	3.3.9.8.5
3.3.9.16	3.3.9.17	3.3.9.18	3.3.9.21	3.3.10.13	3.3.13.3	3.3.13.6
3.3.15.1	3.3.15.2	4.16.1	4.16.2	4.17.1	4.17.2	

Keywords

Beta/gamma contamination, alpha contamination, loose, airborne, fixed, wipe, smear, noble gases, particulate, vapors, hot particles, contamination limits, personnel monitors, loose survey, direct survey, RCA release survey, contamination control, inhalation, ingestion, absorption, personnel contamination protection, personnel contamination detection, plant area decontamination.

Description

This lesson plan provides guidance for an entire lesson with references to the ACADs addressed, texts and resources and Powerpoint presentation, along with instructor slide notes and scenario problems for students to answer as assessment of learning.

Supporting Material

Contamination Control Powerpoint presentation

Office of Environmental, Safety and Health: Radiological Control Technician Training Site Academic Training Study Guide Phase I, Project Number TRNG-0003

Gollnick, D. (2006). Basic Radiation Protection Technology, 5th Ed. Pacific Radiation Corporation, Altadena, CA.

Spectrum Spectroscopy Techniques Lab Manual (Instructors and Student Versions)

Supplemental Lab Manual (instructors and Student Versions)

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Module 6: Perform Environmental Sample Counting Using Proportional Counters

Table of Contents:

Resources Key

This refers to:	This reference:
ACAD	National Academy for Nuclear Training, Uniform Curriculum Guide for Nuclear Power Plant Technician, Maintenance, and Nonlicensed Operations Personnel Associate Degree Programs, ACAD 08-006.
DOE-SG	Office of Environmental, Safety and Health: Radiological Control Technician Training Site Academic Training Study Guide Phase I, Project Number TRNG-0003 Available at: http://nsedu.rnet.missouri.edu/docshare/. File is located under the Docs/General Curriculum/DOE materials folder.
G.	Gollnick, D. (2006). Basic Radiation Protection Technology, 5th Ed. Pacific Radiation Corporation, Altadena, CA.
Spectrum	Spectrum Spectroscopy Techniques Lab Manual (Instructors and Student Versions)
Supl. Lab	Supplemental Lab Manual (instructors and Student Versions)

Module Readings and Homework

Primary Scenario "Determine Gross Alpha/Beta Activity in Air Exhaust"

Core Concept: Alpha/Beta Gross Counting Using Proportional Counter		
	Homework (end of chapter)	
Readings	Calculation Items	Non-calculation Items
G., Chap. 7, 254-260 DOE SG 1.13-14 through 1.13-17 DOE SG 2.19-7 though 2.19-8	N/A	DOE SG 2.19.01
Core Concept: Alpha/Beta Particle Discrimination Using Proportional Counter		
	Homework (end of chapter)	
Readings	Calculation Items	Non-calculation Items
G., Chap. 7, 254-260 DOE SG 1.13-14 through 1.13-17 DOE SG 2.19-7 though 2.19-8	N/A	G., Chap. 7, #12 DOE SG 2.19.01
Core Concept: Air Particulate Monitoring		
	Homework (end of chapter)	
Readings	Calculation Items	Non-calculation Items
G., Chap. 10, 416-427 DOE SG 2.06-6 through 2.06-20	DOE SG 2.06.09	DOE SG 2.06.03 through 2.06.08

Core Concept: Calculation of Air Concentrations		
	Homework (end of chapter)	
Readings	Calculation Items	Non-calculation Items
G., Chap. 10, 423 DOE SG 2.06-6 through 2.06-20	DOE SG 2.06.09	N/A

Transfer Scenario "Determine Gross Alpha/Beta Activity in Environmental Samples"

Refer to readings and homework for primary scenario above.

Module Assessment Items

Note: If instructors wish to increase the difficulty of any item, then we suggest you use it as the basis for an in-class discussion, and / or require students to write an explanation for why a particular choice is correct.

Primary Scenario "Determine Gross Alpha/Beta Activity in Air Exhaust"

Assessment Items

You are a Radiation Protection Technician at the Nuclear Maintenance Facility (NMF). This facility specializes in the maintenance of contaminated nuclear power plant equipment. The work spaces at the NMF are ventilated with fresh air which is discharged to the environment after passing through HEPA particulate filters. The effluent air flow is continuously sampled with an isokinetic sample probe providing a representative volume of air drawn through an effluent sample filter to collect particulate material. Every week the radioactivity collected on the sample filter is collected and analyzed approximately 72 hours later to determine the amount of radioactive particulate NMF discharges to the environment. One of your routine job tasks is to collect the effluent sample filters for analysis.

1. (Inference) While you are performing the sampling evolution, you accidentally drop the filter paper when removing it from the sample holder. It lands on the floor with the sample side down. You carefully pick it up and place it in the protective envelope for analysis. What is the most important consequence of this occurrence?
    - A.) The radioactive contamination on the floor is most important due to the radioactive particles on the filter being a significant source of contamination.
    - B.) The larger amount of radioactive particulate discharged to the environment is most important due to some of the radioactive material on the sample filter being lost to the floor.
    - C.) The smaller amount of radioactive particulate discharged to the environment is most important due to some of the radioactive material on the sample filter being lost to the floor.
    - D.) The accuracy of the amount of radioactive particulate discharged to the environment is most important due to the sample results being inaccurate.(Correct)

2. (Prediction) In a gas-filled detector operating in the Proportional Region, how would a change in the detector voltage affect the number of electrons produced in the detector?
    - A.) As voltage decreases, the number of electrons increase
    - B.) As voltage increases, the number of electrons increase (Correct)
    - C.) As voltage decreases, there is little or no change in the number of electrons.
    - D.) As voltage increases, there is little or no change in the number of electrons.

3. (Explanation) Which of the answers below best explains how alpha and beta radiation each impact the circuitry of a gas-filled proportional detector?

A.) Alpha radiation produces smaller pulses of current in the detector circuitry than beta radiation because if its lower penetrating ability.
B.) Beta radiation produces larger pulses of current in the detector circuitry than alpha radiation because of its higher penetrating ability.
C.) Alpha radiation produces larger pulses of current in the detector circuitry than beta radiation because of its higher ionization potential. (Correct)
D.) Beta radiation produces larger pulses of current in the detector circuitry than alpha radiation because of its lower ionization potential.

4.) (Inference) Given the conditions in the scenario described above, which type of detector system provides the most accurate measure of effluent air radioactivity?
A.) A gas-filled G-M detector system is best because it is portable and permits quick and immediate results.
B.) A gas-flow proportional detector system is best because it measures current instead of pulses.
C.) A gas-filled G-M detector system is best because it responds indiscriminately to most types of radiation.
D.) A gas-flow proportional detector system is best because it discriminates between different isotopes. (Correct)

5.) (Explanation) Explain why this sampling method (Isokinetic with 72-hour decay)does not measure the actual amount of radioactive material discharged from the facility in the effluent air flow?
A.) Isokinetic sampling is not representative of the effluent air flow.
B.) The upstream HEPA filters remove the radioactive isotopes before they are discharged.
C.) The sample only contains long-lived isotopes when it is analyzed (Correct)
D.) The sample analysis is masked by short-lived isotopes before they decay away.

6.) (Prediction) How would the number of calculated DACs in the effluent air change if an error in sample counting date resulted in the sample being counted one day early?
A.) The number of DACs would not change because only long-lived isotopes are being counted.
B.) The number of DACs would increase because there would be more activity due to short-lived isotopes.(Correct)
C.) The number of DACs would decrease because there would be less activity due to short-lived isotopes.
D.) The number of DACs would not change because only short-lived isotopes are being counted.

Suggested Labs

Supl. Lab #16: Alpha-Beta Discrimination in Proportional Counters, page 13

Supl. Lab #17: Measurement of alpha energy spectrum, page 20.

ACAD References

ACAD
3.2.3 RADIOLOGICAL SURVEY AND ANALYSIS INSTRUMENTS
• Identify the instruments available for performing contamination surveys such as the following – Proportional counters
• Explain the operating characteristics and use of the following radiological survey and analysis instruments: – Gross alpha counter – Gross alpha/beta counter
3.3.15 ENVIRONMENTAL MONITORING
• Explain the purpose of the plant environmental monitoring program.
• Describe the methods used to conduct environmental monitoring, such as: – Air sampling – Vegetation sampling – Aquatic life sampling – Water sampling – Soil sampling – Milk sampling

Lesson Plan

I. PROGRAM: Radiological Protection Technician

II. COURSE: Fundamentals Training

III. LESSON TITLE: Contamination Control

IV. LENGTH OF LESSON/COURSE:

V. TRAINING OBJECTIVES:

A. Terminal Objective:

Upon completion of this course, the participants will demonstrate their knowledge and understanding of the information presented during RADCON Technician training by obtaining a score of greater than or equal to 80% on a written examination. The information presented in this lesson plan may be part of an overall exam or be the only information for which the student is examined.

B. Enabling Objectives:

Standards and conditions apply to all enabling objectives. They include under the examination ground rules, without the use of training materials or outside assistance, and utilizing information presented in this lesson plan. Upon completion of this lesson each participant will be able to:

1. Define contamination and list its sources, types and forms.
2. List and describe the two types of survey techniques, media, and instrumentation used for loose contamination.
3. Describe the proper technique and instrumentation used for fixed contamination surveys.
4. Discuss "Hot Particles" and the proper survey techniques.
5. Discuss the mechanism utilized to determine alpha limits and survey requirements.
6. State the limits for smear, wipe, and direct surveys.
7. Describe the identification and control requirements for an item/object exceeding the limits.

8. Describe the identification and control requirements for a plant area exceeding the limits.

9. Explain the proper control requirement and survey for items exiting a "Contamination Area".

10. State the limit for personnel contamination and describe proper utilization of personnel monitoring devices.

11. Describe the monitoring and release requirements for personnel and items leaving the "Radiologically Controlled Area".

12. Discuss contamination control to include determining source of contamination, stopping the release of contamination, limiting the spread of contamination, and protection/monitoring of personnel.

13. Identify the types of personnel contamination protection utilizing protective clothing and devices to include the deposition of these items and contamination limits for reuse.

14. Discuss plant area decontamination techniques.

15. Discuss item/equipment decontamination techniques.

16. Discuss personnel decontamination techniques, documentation, and pathway surveys

VI. TRAINING AIDS:

A. Computer and projection system with power point capabilities.

VII. TRAINING MATERIALS:

A. Attachment A: HPT001.015 Power point presentation, P:\Training\Technical Programs and Services\Radcon\Initial Program\Lesson Plan Library\Library\HPT001.015 Contamination Control
B. Appendix 1: Just-in Time Operating Experience

VIII. REFERENCES:

A. **10 CFR 20**, January 2001.
B. TVAN Standard Programs and Processes, SPP-5.1, Radiological Controls, revision 5.
C. TVAN Standard Department Procedure, RCDP-1, Conduct of Radiological Controls, revision 2.

D. TVAN Standard Department Procedure, RCDP-10, Conduct of Radiological Controls, revision 3.

E. Martin, Alan and Harbison, Samuel A., **An Introduction to Radiation Protection, 3rd Edition**, Chapman and Hall, 1986.

F. Moe, H. L., **Operational Health Physics Training**, Argonne National Laboratory, 1988.

G. Shapiro, Jacob, **Radiation Protection – A Guide for Scientist and Physicians-Third Edition**, Harvard University Press, 1990.

Notes for Powerpoint Presentation

IX. INTRODUCTION:

In a nuclear power plant, radioactive material is present in the primary piping systems as a result of the fission process. Fission and activation products produced provide a source of contamination if the radioactive material escapes the piping in which it is contained. This lesson will explain the types of contamination and their sources, contamination survey techniques, contamination limits and identifications, contamination control, personnel contamination protection and detection, and decontamination. In addition, the hazards associated with contamination and necessary actions to limit personnel exposure to these hazards will be explained. Your knowledge of these hazards will allow you as a Radcon technician to make the appropriate decisions and provide the necessary guidance to other nuclear plant workers.

A. Contamination Definition and Survey Techniques — Objective 1

1. Contamination is radioactive material in an unwanted place. — Slide 2, 3

2. The sources of contamination are fission products, activation products, and activated corrosion products produced in the reactor core and reactor coolant of the nuclear power plant.

    a. Reactor coolant, coolant gases, fission products and activation products which circulate through the primary system and its support systems will become contamination when they escape the system piping or components.

    b. Contamination escapes a system through

        1) System breaches for maintenance or testing

        2) Reactor coolant spills

        3) Reactor coolant leaks from:

            a) Valves

b) Flanged connections such as manways, closures, pipe-caps

c) Defective pump gaskets

d) Defective welds

e) Boric acid corrosion through piping

3. Contamination is defined in two types based upon the decay process of the isotopic mixture. — Slide 3

   a. Alpha contamination – the isotopic makeup of the contamination releases alpha during the decay process

   b. Beta/gamma contamination – the isotopic makeup of the contamination releases beta and/or gamma during the decay process

4. Contamination exists in 3 forms — Slide 4

   a. Loose

   b. Fixed

   c. Airborne

5. Loose contamination is removable, smearable, transferable.

   a. Loose surface contamination is detected by indirect surveys through transference of the contamination to smears or wipes when swiped across the surface.

   b. The smears or wipes are monitored for the contamination present as a representation of the amount present on the item surveyed.

Instructor notes: Defn – Survey - the process of monitoring for ionizing radiation, analyzing the results in regard to establishing protection standards, and defining or evaluating any radiological hazard which may exist. Objective 2

Show smear, wipe and frisker.

c. Wipes are utilized when contamination is not expected for verification of non-contamination.	Slide 5 Note – Due to the oil present in wipes alpha contamination cannot be detected – wipes are not used for alpha contamination surveys.
1) Wipes are chemically treated cloths, attached to a mop handle and lightly pushed across the floor.	
2) Wipes are taken over a 100 ft^2 (10 x 10 ft) area to indicate the presence of beta/gamma loose surface contamination.	*Demonstrate wipe survey technique to include frisker checks and use.*
3) Wipes will be folded when removed from the mop to contain any potential contamination present while in route to survey instrument.	Human performance - STAR
4) Wipes are monitored by direct survey to determine the presence of the beta/gamma contamination.	Note - Wipes are directly surveyed with a GM pancake type instrument –referred to as a 'frisker'.
5) The unit of measurement used for a direct survey is cpm.	cpm – counts per minute
d. Smears are utilized to <u>quantify</u> the amount of contamination present on the area surveyed.	Slide 6
1) Smear surveys shall ensure a representation of the total area is surveyed.	Human Performance – QV&V, 2 minute rule
2) A smear is taken over a 100 cm^2 (~4 x 4 inch) area to represent the amount of loose surface contamination present on the area surveyed.	*Demonstrate "s" technique.*
3) Identification of each smear for the corresponding area surveyed is necessary.	
4) Smears shall be handled in a manner to ensure potential contamination is contained and no cross-contamination occurs with use of small envelopes, folding holders or Petri dishes.	Defn - Cross-contamination – the physical transfer of contamination from one object/place to another

5) Smears are counted with laboratory counters or the use of direct survey instrumentation.

   Human Performance – STAR, 2 minute rule, QV&V

   a) Caution is needed during the counting of smears to prevent contamination of the laboratory counters and surrounding area.

   b) Each smear shall be surveyed with a direct survey instrument prior to utilizing the laboratory counter.

   c) Each site has limits for smears placed into laboratory counters

6) The unit of measurement used for a quantified smear survey is dpm/100 cm^2.

   dpm – disintegrations per minute

   a) Counting instruments utilize cpm as the unit of measurements.

   b) Calculation of activity into dpm is obtained by dividing the cpm obtained by the instrument efficiency.

   c) When utilizing a direct survey meter for counting smears for beta/gamma the counter efficiency is 10%.

   d) When utilizing a direct survey instrument for counting smears for alpha the efficiency for each separate instrument is listed on the side of the instrument.

   Note – Examples of direct survey instruments for alpha contamination are PACS-4S & Model 3-99

   e) Each laboratory counter is calibrated to determine its specific efficiency.

7) Smears with activities exceeding the upper limit of a direct survey instrument will be counted with an ion chamber (open window) and the unit of measurement utilized is mrem/hr/100cm^2.

   Demonstrate ion chamber technique to count smear.

6. Fixed contamination is embedded in the object and cannot be removed, smeared, or transferred with normal handling.

   Objective 3

   Slide 7

   a. The presence of fixed contamination is determined through direct surveys.

   b. Direct surveys are usually accomplished with a thin probe GM instrument that is equipped with an audible response.

      Demonstrate frisker technique for a direct survey to include audible count rate, meter reading, and alarm.

      Human performance STAR

      1) The probe is moved slowly ensuring the total area is surveyed.

      2) The presence of contamination is indicated through the increase in audible count rate, increase in meter reading, or sounding of alarm.

      3) If contamination is indicated, traverse the area with the probe and define the boundaries of the contamination and the measured amount.

      4) Caution should be utilized to ensure the total area is surveyed and the appropriate speed is used to ensure adequate response times.

   c. Large floor areas can be surveyed with a multiple probe device and multiple probe conveyor belt apparatus can be used to continually survey items.

   d. The unit of measurement used for a direct survey for fixed contamination is cpm.

   e. Fixed contamination can become loose and/or airborne with degradation of material such as welding, grinding, cutting, or any other abrasive type work.

      Human Perfomance -STAR

7. Airborne contamination is suspended in the air in the form of noble gases, vapors (iodines), or particulates.

   Instructor Notes: Slide 8

   a. The presence of airborne radioactivity (contamination) is determine through the use of a sampler to draw air into or across a collection media (ie filter, charcoal filter, marinelli container) and counting the media to quantify the amount of radioactivity present.

   b. The unit of measurement used to quantify radioactivity present is air µCi/cc.

   c. Airborne radioactivity will become loose contamination with plate-out and fixed contamination if embedded into an object.

   d. Airborne radioactivity Control will be discussed further in another lesson plan.

8. A special type of loose contamination is discrete particles.

   Instructor Notes: Objective 4

   Slide 9

   Human Performance – STAR, QV&V

   a. A ‘Hot Particle’ is a discrete object (particle) generally difficult to see (usually <100 microns) with the naked eye, and at least 0.1 microcuries of radioactivity.

   b. A discrete particle is either an activated/corrosion wear product (normally stellite) or fuel fragment (fuel flea) with high specific activity.

   c. Discrete particles are beta emitters and thus negatively charged.

      1) This negative charge creates an attraction field causing the discrete particle to mobilize relatively easily.

      Instructor Notes: Discuss the high potential of finding particles outside zoned areas due to their mobility.

LESSON BODY	INSTRUCTOR NOTES
2) Due to the high specific activity of the discrete particle and their beta decay mode, they can create a high localized skin exposure when transferred to personnel.	
d. Personnel surveys indicating the presence of contamination should be performed in a manner to determine if discrete particles are present.	Slide 10 Human Performance – STAR, QV&V
1) The use of a shielded 1 cm probe or other shielding mechanisms can be utilized to distinguish discrete particles from area contamination.	Note – Show 1 cm probe and discuss other shielding techniques (i.e. credit card use)
2) Removal of a discrete particle from personnel should be performed with tape to allow gamma isotopic analysis if needed.	*Demonstrate discrete particle survey and removal technique (include 1 cm probe).*
3) Any discrete particle surveyed with a standard frisker probe and found to have levels of greater than or equal to 20,000 cpm, shall be considered a 'Hot Particle'.	Note – If levels exceed the upper limit of a frisker then count with an ion chamber (open window)
e. Area surveys for discrete particles are normally performed with a sticky media such as a "tacky roller" to ensure their retrieval and limit their mobilization.	Note – Show media for Particle surveys (ie tacky roller)
1) The sticky media will be directly surveyed to determine the presence and activity levels of discrete particles.	*Demonstrate tacky roller survey technique.*
2) Extra precautions are necessary when known discrete particle areas exist to limit their spread from the area and the potential for transference to personnel.	Human Performance – STAR, QV&V
9. Surveys are performed on a routine and an unscheduled basis.	Slide 11
a. Personnel shall adhere to requirements for the area entered for surveys.	Human Performance – STAR, QV&V, 2 minute rule

b. Caution shall be taken by the surveyor to minimize his/her radiation exposure and eliminate personal contamination potential.

c. All instruments used for the survey will be checked for proper operation, calibration, source checks and will be assigned to the surveyor.

d. Surveys are documented in a computerized survey system - VSDS and/or HIS-20.

e. The utilization of these systems will be discussed further in another lesson plan.

10. Cross contamination may occur when contamination is spread from one surface to another which is not contaminated. This can result in uncontrolled spread of contamination.

B. Contamination Limits and Identifications. — *Objective 5*

1. Contamination limits for the plant are based upon the isotopic mixture of the reactor coolant and subsequent systems. — *Slide 12*

a. The potential presence of alpha emitting nuclides is reviewed through beta-gamma isotopic analysis and correlation of the presence of specific beta-gamma isotopes for potential presence of alpha emitting nuclides.

1) Alpha emitting nuclides, normally contained within the fuel elements, may contaminate various areas of a nuclear power plant when fuel failures occur during operating cycles.

2) Alpha emitting nuclides have high internal dose conversion factors and are difficult to measure directly, thus it is important to quantify their presence and assess their impact. — *This is the reason alpha contamination limits are lower than the limits for beta/gamma contamination.*

3) Gross alpha counting techniques are utilized by the plant to determine actual presence and levels.

4) The limits for the presence of alpha emitting nuclides are derived by considering the potential for internal deposition and are based upon the inhalation stochastic Annual Limit of Intakes (ALI's) in 10CFR20.

5) Alpha contamination levels are correlated to beta/gamma contamination levels by applying the ratios of the inhalation stochastic ALIs for the beta/gamma emitting nuclides to the alpha emitting radionuclides.

6) Areas with beta/gamma to alpha ratios of 50:1 or lower require alpha monitoring of personnel and equipment.

7) Beta/gamma to alpha ratios >50:1 are utilized to :

   a) alleviate the requirements for routine plant alpha surveys and routine release alpha surveys.

   b) set the requirements for alpha contamination surveys in work areas based upon the beta/gamma contamination levels present.

   c) determine the alpha contamination limit of 20 dpm/100 cm^2 smearable and 30 cpm direct based upon the beta/gamma limit of 1000 dpm/100cm^2 smearable and 100 cpm direct. — Objective 6

b. Quantification of loose contamination is determined through a smear survey.

1) Beta/gamma loose contamination survey results greater than or equal to 1000 dpm/100cm^2 indicates the object surveyed is contaminated and controls will be utilized.

2) Alpha loose contamination survey results greater than or equal to 20 dpm/100cm^2 indicates the object surveyed is contaminated and controls will be utilized.

Note – If alpha survey required.

c. Verification of non-contamination can be performed with a wipe survey and results <100 cpm.

d. Quantification of fixed contamination is determined through a direct survey.

1) Beta/gamma direct contamination survey results greater than or equal to 100 cpm indicates the object surveyed has is contaminated and controls will be utilized.

2) Alpha direct contamination survey results greater than or equal to 30 cpm indicates the object surveyed is contaminated and controls will be utilized.

Note – If alpha survey required.

2. Contamination identification of an object, a plant area, or personnel is required based upon smear and/or direct surveys exceeding the contamination limits.

Objective 7

Slide 13

Human performance – STAR, QV&V

a. An object with smear survey results exceeding the beta/gamma limit of 1000 dpm/100cm^2 and/or the alpha limit of 30 dpm/100cm^2 indicates loose contamination.

Note – If alpha survey required.

1) Control of loose contamination by placing the object in a bag or wrapping.

Note – Show radioactive material bags and wrapping.

LESSON BODY	INSTRUCTOR NOTES
2) A Radioactive Material Tag will be placed on the outside of the bag or wrapping to denote:	Note – Show Radioactive Material Tag
a) Content	
b) Contamination levels	
c) Radiation levels	
d) Name of person performing survey	
3) Radioactive material must be stored in a location designated for the storage of radioactive material.	
b. A plant area with smear survey results exceeding the beta/gamma limit of 1000 dpm/100cm^2 and/or the alpha limit of 30 dpm/100cm^2 indicates loose contamination.	Objective 8 Slide 14
1) Yellow & magenta rope, ribbon, or chain is placed around the contaminated area.	Note – Show rad rope, ribbon, chain, stantions. Discuss correct tie-off.
2) Sign postings are installed stating "Caution, Contamination Area"	Note – Show rad sign
3) Install a Step-off-pad (SOP).	Note – Show SOP
a) A step-off-pad is placed at the designated entry/exit point to the contamination area creating a line of demarcation between the Contamination Area and RCA.	Note – Some areas may not provide space for SOP installation. Human Performance – STAR
b) Proper procedures for crossing the SOP must be observed to prevent the spread of contamination out of the Contamination Area.	
c) All items/personnel entering or exiting the contamination area will be via the SOP.	
d) The SOP is part of the barrier and is part of the non-contaminated RCA.	

e) Contamination Areas with high levels of loose contamination and/or 'Hot Particles' may require multiple SOP's, with only the outer SOP being considered non-contaminated.

Note – Show multiple SOP examples and discuss use.

4) All items/personnel exiting a Contamination Area will be considered contaminated until survey is performed to determine otherwise.

Objective 9

Slide 15

a) Items exiting a Contamination Area will be either surveyed to determine contamination levels <1000 dpm/100cm^2 beta/gamma and <20 dpm/100cm^2 alpha prior to removal from the Contamination Area or will be placed in a bag at the SOP, sealed and transported to the designated Radcon survey area.

Human Performance – STAR

Note – Reiterate the use of the bag as a containment of the loose contamination.

b) Results greater than or equal to 1000 dpm/100cm^2 beta/gamma and/or greater than or equal to 20 dpm/100cm^2 alpha requires the item to remain inside the Contamination Area or placed in a bag, tagged as radioactive material, and stored in a designated storage location.

c. Personnel surveys are performed through the use of automated personnel monitors or hand-held friskers.

Objective 10

Slide 16

1) Automated personnel monitors survey hands, shoes, clothes, and personnel through the use of multiple detectors and a preset limit which activates an alarm when reached.

Note – Automated personnel monitors preferred when available.

Note – Contamination monitoring devices are located throughout the plant as needed to provide for monitoring requirements.

a) The automated personnel monitor utilized inside the RCA is the PCM 1B.

b) The automated personnel monitors utilized at RCA exits are the PCM 1B and/or PCM 2A.

c) The PCM 1B and PCM 2A are beta detecting proportional monitors which will indicate the area of contamination normally consistent with the detector which alarms.

d) 'Hot Particles' and/or high contamination activity can instigate an alarm beyond the area of contamination.

Human Performance – STAR, QV&V, 2 minute rule

e) Automated portal monitors are "door frame" type gamma detecting scintillation personnel monitors.

(1) Automated portal monitors are installed at the RCA exits and site gatehouse exits as a final check.

(2) Contamination levels exceeding a preset limit will activate an alarm for the detector monitoring the contamination.

2) Hand-held monitoring devices (friskers) are utilized when automated monitors are not available or as a precursor to the automated personnel monitor.

Slide 17

a) Operational checks are required prior to utilization of the frisker.

Demonstrate checks and frisker personnel survey techniques.

(1) Verify plugged to AC if AC adapter is available. Check battery if DC supply only.

Human Performance – STAR, QV&V

(2) Verify volume is turned to high.

(3) Verify scale is on X1.

(4) Verify switch is on slow response.

(5) Verify background is <300 cpm.

b) Proper technique is required to ensure contamination is detected.

(1) The probe will be held ½” from the surface.
(2) Movement will be slow (~1-2”/sec).
(3) The technique shall ensure all areas are surveyed.

c) Contamination will be indicated.

(1) The frisker has an audible count rate which will increase with the detection of contamination.
(2) An alarm will sound when a preset limit is reached.
(3) The meter display will increase with the detection of contamination and results 100 cpm above background indicates personnel contamination.

d) Personnel are determined to be non-contaminated when the results are <100 cpm beta/gamma.

e) When required, results for alpha personnel surveys are <30 cpm for determination of non-contamination.

Demonstrate alpha direct survey meter checks and personnel survey techniques.

Slide 18

d. Objects also require a direct survey for determination of non-contamination.

1) Direct survey results for non-contamination are <100 cpm beta/gamma and <30 cpm alpha.

2) Items >100 cpm direct beta/gamma and/or >30 cpm alpha are required to be marked and remain in a radiologically controlled area.

Note – Purple/magenta tape or paint used to designate RCA use.

3) All items exceeding the limits set forth in 10CFR20.1904 will be labeled/tagged as radioactive materials unless exempt per 10CFR20.1905.

4) All radioactive material will be stored in designated storage areas for radioactive material.

e. All personnel who enter the Radiologically Controlled Area and all items utilized in the RCA requiring release for non-restricted use to the "clean" area will be surveyed for verification of non-contamination.

Instructor notes: Objective 11

Slide 19

In addition, personnel will be monitored when they leave the plant utilizing passive whole body contamination methods (portal monitors).

1) Personnel will process through automated counters with preset alarm set-points to ensure non-contamination.

2) Items which have been utilized in the Radiologically Controlled Area but have not been used in a Contamination Area are allowed to be surveyed by a Small Article Monitor with preset limits.

Instructor notes: Note – Show automated tool monitor.

3) Items which have been utilized in a Contamination Area are required to be surveyed by Radcon prior to release.

Instructor notes: Prior to removal from contaminated areas, items must be bagged, wrapped or surveyed by RP.

4) An item surveyed with results:
<1000 dpm/100cm^2 (smearable) &
<100 cpm (direct) - beta/gamma
and
<20 dpm/100cm^2 (smearable) &
<30 cpm (direct) - alpha;
is determined to be non-contaminated or "clean" and is not required to be radiologically controlled.

Instructor notes: Note – Alpha limits if alpha survey required.

Tools and equipment that are not considered "clean" shall be stored in the "hot tool room" for continued used in radiologically controlled areas.

5) Bulk items and liquids require an isotopic analysis in addition to the direct and smearable surveys for verification of non-contamination prior to release for non-restricted use.

Instructor notes: Note – Examples of bulk items – wood, sand, concrete.

Human Performance – QV&V

6) Tools and equipment released from the radiologically controlled area do not require any additional monitoring prior to release from the plant.

C. Contamination Control — Objective 12

1. Contamination is radioactive material in an unwanted place. — Slide 20

2. The origin of contamination is fission and activation products from the core or from the coolant.

3. Release of fission and/or activation products from the system provides contamination.

4. Once contamination occurs, it becomes imperative to determine the contamination source, stop any on-going release, limit the spread of the contamination, and protect and monitor personnel from the hazard. — Slide 21

   Human Performance –2 minute rule, STAR, QV&V,

   a. Pinpoint the contamination source:

      1) Survey and inspect the area if possible

      2) Review the history of the area to help determine higher probability areas

      3) Review the work and operational activities in the area to help determine areas which would have changed

      4) Sending smear for gamma spectroscopy may help to determine the source of the contamination.

      5) The given cause may never be found if the contamination source release has stopped.

   b. If the release is on-going, implementation of site procedures are needed to stop the release source.

c. If an on-going release cannot be terminated, implementation of site procedures to install containment devices is necessary to limit the spread and control the output.

   1) To limit the spread of contamination requires: Slide 22

      a) Ceasing a release

      b) Containing a release if termination is unattainable through the use of catch containment devices or glove bags with drain bottles, drain hoses, absorbents, and/or ventilation filter, etc.

      c) Confining a release to as small an area as possible.

         (1) Confinement

            (a) reduces the exposure potential of the incident
            (b) eases the task of controlling the extent of the spill
            (c) enhances the clean-up of the area

         (2) Confinement can be accomplished by:

            (a) setting-up zones or areas to isolate the more hazardous processes
            (b) controlling access
            (c) directing traffic patterns
            (d) setting-up monitoring stations at zone interfaces
            (e) using protective clothing in the zone and leaving protective clothing in area at exits
            (f) surveying anything leaving area
            (g) clean-up

d) Cleaning-up a release

e) Conducting surveys to identify an unknown release.

(1) Frequent surveys are performed so contamination incidents are picked up quickly to aid in reducing the size of area involved in contamination release.
(2) Regular surveys in controlled areas and in the adjacent uncontrolled areas ensure that contamination is not spreading beyond the barriers.

d. Protect and monitor personnel from a release by: — Slide 23

1) Placing a barrier between workers and contamination.

2) Proposing necessary requirements and guidance for personnel protection in a Contamination Area.

3) Providing surveys and monitoring devices for area and personnel to detect and quantify contamination present.

5. With strict adherence to the control procedures, the extent of any contamination can be limited to the contaminated area. — Slide 24

6. When cooperation breaks down and exceptions to the control procedures begin to increase in frequency then the probability of losing control is greatly increased. — Human Performance –2 minute rule, STAR, QV&V

7. Plant areas which require work to be performed resulting in the breaching of a radioactive system and subsequent release of contamination to that area requires contamination control measures to be implemented.

a. The area can be covered with material to be disposed of upon completion of work. — Slide 25

b. Caution should be utilized to ensure contamination does not enter cracks, crevices or other small open areas.

c. Containment control devices can be installed to contain the contamination to that area.

d. Upon completion of the work to be performed the covering and/or containment devices will be removed.

e. Contamination in the plant area will be removed though a cleaning process called decontamination.

f. Work site can be prepared in advance for performance of highly contaminated work using the following methods.

(1) covering the work area with disposable plastic (Herculite, oil cloth, etc.)

(2) covered with launderable, reusable sheeting.

(3) covered with strippable paint.

(4) concrete or other surfaces painted for ease of decontamination.

D. Personnel Contamination Protection and Detection

Objective 13

1. The primary personnel hazard from entering a Contamination Area is the possible inhalation, ingestion, or absorption of radioactive material into the body, thus we must utilize measures of contamination protection for personnel.

Slide 26
Entries in contamination areas require: radiation work permits, protective clothing, use of tools from the hot tool room, a step-off-pad, and notification of RADCON.

a. Contamination of the skin or clothing of an individual has the potential for subsequent internal deposition thus efforts are utilized to limit personnel contamination and/or internal deposition.

b. Extra care should be exercised to prevent contamination of skin areas where there is a break in the skin.

Human Performance – STAR, QV&V,

c. Excess skin or clothing contamination has the potential for significant radiation exposure especially to the skin.

d. Entry by personnel into a Contamination Area requires personnel protective clothing to reduce the potential of transference of contamination to the person.

1) Entries will be controlled through the use of Radiation Work Permits which will provide the necessary requirements for protective clothing and devices.

Slide 27

2) Protective clothing and devices required will be determined by Radcon based upon:

Human Performance –2 minute rule, STAR, QV&V,

a) Radiological hazards in the area

b) Work to be performed

c) Form of contamination present (ie, wet, dry, dust, hot particle, etc)

d) Work environment

3) Suitable gloves must be worn whenever hand contamination is likely.

4) Other protective clothing such as lab-coats, coveralls, shoe covers, etc should be worn whenever contamination of clothing is possible.

a) For low levels of surface contamination an ordinary lab coat with booties, overshoes, inserts and gloves may be sufficient.

b) Normally a 'full dress-out' is required for entry. A 'full dress-out' consists of:

(1) 1 pair of reusable c-zone coveralls
(2) 1 pair of reusable c-zone booties
(3) 1 pair of reusable c-zone shoe covers
(4) 1 pair of disposable cotton inserts
(5) 1 pair of reusable c-zone rubber gloves
(6) 1 reusable hood
(7) 1 pair reusable wrist cuff retainers
(8) 1 pair reusable ankle cuff retainers

Slide 28

c) Work performed in areas with higher levels of contamination and/or "hot particles" normally requires the use of a second set of protective clothing ('double dressout'). The outer coveralls are usually paper coveralls and are disposable.

Slide 29

Note – Face shields, "ski masks" or other specially designed hoods may be used to prevent facial contamination.

d) When the contamination is in liquid form it is often necessary to wear an outer rain-suit.

e) Dust cups and/or face-shields may be required if there exist a higher potential for facial contamination.

f) When substantial levels of airborne contamination exists, it may be necessary to have a respiratory device; possibly a fully-enclosed suit and a filter mask or a mask fitted with an air supply.

e. Proper steps should be utilized to ensure protective clothing is donned and doffed correctly to limit the potential for contamination transference.

Note – Show protective clothing donning and doffing tape.

Human Performance – STAR

f. All protective clothing/equipment will be inspected prior to use to ensure no degradation has occurred which would deteriorate its efficiency.

g. Protective clothing should not be removed from the Contamination Area used and should be placed in appropriate hampers for either reusable or disposable items.

Slide 30

Human Performance –2 minute rule, STAR, QV&V,

1) Reusable protective c-zone clothing is placed in magenta colored bags and sent to be laundered.

2) Upon completion of laundering the reusable protective clothing will be directly surveyed to ensure levels <4500 cpm beta/gamma and <30 cpm alpha prior to reuse.

3) Respiratory devices are cleaned and surveyed along with the canister to ensure levels for smearable contamination are <1000 dpm/100cm^2 beta/gamma and <20 dpm/100cm^2 alpha and for direct surveys <500 cpm beta/gamma and <30 cpm alpha prior to reuse.

4) Disposable protective clothing is placed in yellow bags and processed as Radioactive waste.

h. Proper utilization of a step-off-pad(SOP) for entry and especially exit is necessary to ensure limited potential for the spread of contamination.

1) The SOP area will be used to remove protective clothing ensuring all clothing is removed prior to stepping on the pad.

2) The step-off-pad(SOP) area will be utilized to transfer items from contamination area.

3) Items will either be surveyed to ensure non-contamination prior to crossing SOP or will be placed in a bag at the SOP to limit the potential for the spread of contamination.

2. Verification of non-contamination of personnel or early detection and removal(decontamination) are essential to personnel protection.

   Slide 30

   a. Upon exit of a Contamination Area personnel will proceed directly to the nearest monitoring device to ensure non-transference of contamination.

   b. When available an automated personnel contamination monitor will be utilized to verify contamination is below preset alarms set-points <100 cpm.

   c. If an automated personnel contamination monitor is not available, a hand-held direct survey meter will be utilized.

      1) Proper technique will be utilized to ensure a complete and accurate survey is performed with results <100 cpm for non-contamination.

      2) If survey for alpha is required a hand-held direct survey meter will be utilized to ensure results <30 cpm.

      3) Survey results greater than or equal to 100 cpm beta/gamma and/or greater than or equal to 30 cpm alpha indicate personnel contamination and appropriate decontamination and documentation is required.

      Human Performance – STAR

E. Decontamination — Objective 14

1. Contamination in the plant area will be removed though a cleaning process called decontamination. — Slide 32

   a. Decontamination is accomplished through the use of cleaning solutions, water, rags, and mops.

   b. Review of work area configuration, radiological conditions and desired outcome will determine the mechanism utilized to accomplish the decontamination. — Human Performance –2 minute rule, STAR, QV&V

   c. Mechanisms for decontamination are:

      1) Working from boundaries inward reducing the Contamination Area size as decontamination is performed

      2) Decon from lowest levels of contamination to highest

      3) Fold rags and frequently turn rag to clean fold and change rags when all folds are used

      4) Rinse mop and change water frequently to ensure contamination is removed, not spread

      5) Detailed attention is given to equipment, cracks, crevices, and other difficult places

      6) Ensure all equipment and walls in the area are deconned.

   d. Items utilized in the decontamination process are considered contaminated until surveyed by Radcon.

   e. Discarded wet items will be placed separately in Radioactive Waste containers ensuring all excess water is removed.

f. Determination of non-contamination for the area can be performed utilizing wipes, but quantification of non-contamination levels <1000 dpm/100cm^2 for the removal of the Contamination Area must be performed with smears. Surveys should be inclusive of floors, walls, and equipment with attention to cracks, crevices, etc.

2. Equipment decontamination is normally achieved in a designated equipment decon facility through the use of cleaning solutions, water, and rags.

   Objective 15

   Slide 33

   a. Notification to Radcon is necessary prior to decontamination and special requirements met based upon survey results.

      Human Performance –2 minute rule, STAR, QV&V, 3 way communication

   b. Equipment decon is required when beta/gamma smearable contamination is >1000 dpm/100cm^2 and/or alpha smearable is >20 dpm/100cm^2 and the item is desired to be non-contaminated.

   c. Caution must be used to ensure the decon method does not damage the equipment.

   d. All parts of the equipment require decon and surveys.

   e. Authorization is required on designated items prior to any part and/or cover removal and restrictions on disassembly of certain equipment exist.

      Human Performance –2 minute rule, STAR, QV&V, 3 way communication

   f. All areas of equipment must be surveyed after decontamination to ensure beta/gamma smearable levels are <1000 dpm/100cm^2 and beta/gamma direct levels are <100 cpm prior to release as non-contaminated.

3. Personnel and clothing contaminations are defined as contamination on a person or clothing (excluding natural products or noble gas) that is greater than or equal to 100 cpm above background when surveyed with a frisker type instrument using a 15.5 cm^2 probe and requires the use of the decontamination process for removal of the contamination.	Objective 16 Slide 34
a. Clothing contamination requires the cautious removal of the clothing to ensure skin contamination does not occur.	
1) Surveys will be performed on both the outside and inside of the clothing for dose calculation.	Human Performance – STAR, QV&V
2) If possible, capture contamination or a sample of contamination for isotopic analysis (especially 'Hot Particle').	Note – Discuss the use of tape to capture contamination (hot particles).
3) Decontamination techniques can include use of tape, cleaning solution and water, and brushes.	
4) If decontamination is ineffective and personnel clothing is confiscated, completion of a form for the confiscation of personnel effects is necessary for reimbursement.	
5) Complete the personnel contamination report and survey documentation of the contamination and ensure the Radcon shift supervisor is notified.	*Review RCDP-10.*
b. Personnel skin contamination requires decontamination as soon as possible to decrease personnel exposure.	Slide35 Human Performance – STAR, QV&V,
1) If possible, capture contamination or a sample of contamination for isotopic analysis (especially 'Hot Particle'). Capturing of contamination shall not impede the decontamination process.	

2) Obtain direction from the Medical Staff prior to any decontamination process to remove contamination from the ear canal, eye, or a break in the skin.

3) Contamination of skin adjacent to an open wound or break in skin requires the open area to be covered prior to the decontamination process to ensure cross-contamination into the wound does not occur.

4) Surveys and/or decontamination processes for injured personnel are secondary to medical treatment based upon the seriousness of the injury.

   a) Minor injuries, occurring within the RCA, requiring on-site medical attention should be surveyed. Ensure medical staff notified of non-contamination prior to the arrival of the injured person at the medical station.

   b) Injuries requiring off-site medical assistance will be covered in another lesson plan.

   Note – MERT class and EPIP.

5) A bioassay (Whole Body Count) shall be performed if:

   Human Performance – STAR, QV&V,

   a) Contamination on the face indicates that an uptake may have occurred

   b) Nasal contamination is detected through nasal smears or other detection.

   c) Ingestion or suspected ingestion of radioactive material has occurred.

   d) An open wound is contaminated.

6) Personnel decontamination is normally conducted through the use of soap and water.

Note – Water temperature should be controlled to a tepid temperature, near body temperature.

7) Tape can be utilized as a decontamination process to remove and/or capture the contamination but caution is to used especially in hair covered areas.

8) If normal soap and water decontamination efforts are ineffective, other solutions can be utilized.

9) Caution shall be used to ensure skin is not broken.

10) The sweating technique can be utilized if other efforts are ineffective. This is accomplished covering the affected area with absorbent material and wrapping with rubber or plastic to introduce heat to the localized area.

11) Showers can be utilized for large area personnel contamination.

Slide 36

   a) Caution should be used to ensure contamination does not enter the body through openings (i.e. wounds, mouth, nose, etc).

Human Performance –STAR

   b) Decontamination processes should start at the head and progress downward to the feet.

12) Hair can be decontaminated by washing with shampoo and water.

   a) Caution should be used to ensure contamination does not enter the body through openings (i.e. wounds, mouth, nose, etc).

   b) Ineffective decontamination processes may require the hair to be cut after notification of Radcon Supervision.

13) Notification of the Radcon Shift Supervisor is necessary for difficult decontaminations.

Human Performance – QV&V

14) Transversal of a contaminated person through the RCA to the decon facilities requires the use of some type containment clothing such as paper coveralls and/or booties, and a pathway survey is needed to ensure no cross-contamination occurs.

Human Performance –2 minute rule, STAR, QV&V

a) A pathway survey from the incident area to the monitoring area is needed to ensure no cross-contamination has occurred.

b) An incident area survey may also be required to determine cause of contamination.

15) Complete the personnel contamination report and survey documentation of the contamination and ensure the Radcon shift supervisor is notified.

16) Natural product and noble gas contaminations fall under the normal release criteria and should be documented as a release survey. Therefore, natural products or noble gas contaminations are not considered a Personnel Contamination.

Review Att 1 – Just-in Time
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XI. SUMMARY:

Contamination is radioactive material in an unwanted place created from the release of fission and/or activation products from the system. Correct survey technique determine the quantity, type, and form of contamination. This information is used to determine the appropriate mechanisms to provide proper control of the contamination and protection for the workers. Accurate posting and labeling for areas and/or items exceeding the contamination limits are required. Proper decontamination techniques are utilized when removal of contamination is desired. Utilization of adequate personnel protective measures and detection devices is mandatory for personnel protection. Personnel contamination requires the use of designated decontamination techniques and documentation. As a Radcon technician you will ensure the knowledge you have gained will be utilized to perform your job correctly thus providing guidance to ensure limited personnel exposure to the hazard.

Appendix 1

Just-In-Time Operating Experience

Hot Particle Work Area

Radiological controls of work areas have not prevented the spread of hot particles to unwanted areas increasing the risk of personnel radiation exposure.

Events

Plant: Prairie Island Unit 1

Potential Overexposure Because of Inadequate Radiation Work Oversight -- Reference: OE 12059

On January 31, 2001, while performing maintenance on a safety injection cold leg check valve during a refueling outage, a hot particle (600 rem per hour gamma on contact) was found to have dislodged from the shielded area of the valve internals. The particle was found adjacent to the scaffold platform exposing two maintenance workers to an uncontrolled radiation field.

Important Point:

- **Radiation protection work planning and work practice were inadequate.**

Contributors:

- **A radiation protection supervisor determined that the requirements of the hot particle program were not applicable because the definition of a hot particle area was not met, even though it was known that a hot particle existed within the valve for several years.**
- **The assigned radiation protection supervisor did not immediately stop work or urge the workers to leave the area when indication of general radiation levels increased from 15 mrem per hour to 250 mrem per hour.**

Plant: Susquehanna Unit 1

Highly Radioactive Particles Associated With Fuel Pool Work -- Reference: OE 11779, SER 3-01

On October 12, 2000, an advanced crusher and shearer (ACS) unit used to crush control rod blades was removed from the fuel pool and stored on the refueling floor. Following ACS removal and transfer, three discrete radioactive particles (DRPs) with contact dose rates of up to 800 rem per hour were discovered on the refueling floor. These high activity particles did not come in contact with personnel. During subsequent cask packaging and shipping evolutions, three additional particles were identified with measured dose rates of up to 220 rem per hour. One particle with a dose rate of 1 rem/hr was found adhered to a worker’s protective shoe cover.

Important Points:

- **Managers were aware of the potential for DRPs to be present; however, the magnitude of the dose rates that were encountered was not anticipated.**
- **There was previous plant experience with DRPs in excess of 100 rem per hour when this evolution was performed in 1991, but this information was not widely known, nor was it incorporated into planning for this evolution.**

Appendix 1

Contributors:

- **Contingency plans or actions to be taken if DRPs were encountered in other than controlled areas were not developed.**
- **Turnover to the evening shift occurred while work continued, potentially distracting individuals from receiving needed information.**
- **Clear expectations regarding DRP controls for the travel path during the transfer of the ACS were not established.**
- **Although workers believed DRPs might be present, a DRP check of the unit was not required by the work package nor was one completed before the transfer of the ACS began.**
- **Because of the ACS design, and the inability to hydrolaze in an upward direction, portions of the unit could not be effectively cleaned.**
- **The ACS was not rinsed with demineralized water as it was raised from the fuel pool as had been the practice in the past to help remove potential DRPs.**

Plant: Surry Unit 2
Radioactive Particles Detected at Protected Area Exit -- Reference: **OE 10083**
Between April 20 and May 21, 1999, during the refueling outage, there were seven cobalt-60 hot particle personnel contamination events (PCE). The hot particles escaped detection at the radiological controlled area (RCA) monitors but were detected by the protected area exit monitors as the workers were leaving the station. During separate instances, seven individuals exiting the protected area were identified by monitors as having levels of 3,000-dpm to 300,000-dpm of hot particle activity.

Important Point:

- **The increase in hot particle contamination was attributed to the reduced scope of containment and scaffold decontamination.**

Contributor:

- **The personnel contamination monitors at the RCA exit were relatively insensitive to the higher energy cobalt-60 gamma radiation and may not detect beta radiation if shielded by clothing or in a location of poor geometry relative to the monitor.**

Plant: Prairie Island Unit 1
Radioactive Hot Particles from Incore Instrumentation Work -- Reference: **OE 9329**
On June 12, 1998, the radiation protection specialist group noticed an increased number of individual contamination cases from work in containment. These cases followed the forced shutdown to repair several leaking incore instrumentation thimble tube seals. Thirteen separate radiation occurrences were recorded involving 11 individuals.

Appendix 1

Important Point:

- **Relevant information about hot particles had been omitted from previous post-work ALARA reviews therefore, this information was not incorporated into the incore instrumentation work.**

Contributors:

- **Sticky pads were not used as prescribed by procedure.**
- **Less than adequate radiological work practices were identified.**
- **Lack of proper labeling existed at the job site.**
- **Less than adequate planning regarding communication methods when wearing certain protective equipment.**
- **Less than adequate training for identifying the location of special tags and equipment used for hot particles.**

Important Considerations for Hot Particle Work Areas (Lessons Learned)

- What contamination controls should be used when a contaminated piece of equipment is moved? What is the most effective way to communicate these controls to personnel involved with the task?
- What course of action should be taken if hot particles are anticipated? What course of action should be taken if hot particles are identified?
- What controls should be considered prior to retrieving a hot particle? How do we consider dose, particle movement, and difficulty of removal?
- How do we capture radiological lessons learned at the completion of our task?
- What are the hazards associated with hot particles? How do we communicate the potential hazards to those involved?
- How do we ensure prejob briefs are sufficiently in-depth and inform workers of the radiological risks associated with the task to be performed?
- Under what conditions do we expect radiological technicians to stop work in the field?
- When should a hot particle control zone be established? When should a check of hot particles be made?
- What monitors should be used considering the type of contamination anticipated?

- What training is required to support the task if hot particles are anticipated?