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Ionizing Radiation

QUALIFICATION TRAINING PACKAGE

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STS Line Item 4.9.2.6: Identify radiological/nuclear hazards

TRAINER GUIDANCE

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed
Prerequisites:	None
Training References:	• AFIOH Report IOH-SD-BR-SR-2005-0004, *Bioenvironmental Engineer's Guide to Ionizing Radiation, October 2005* • AFI 48-148, *Ionizing Radiation Protection, 21 September 2011*
Additional Supporting References:	• N/A
CDC Ref*erence:*	4B051
Training Support Material:	• Labeled source of ionizing radiation such as Troxxler, or medical/industrial X-Ray source
Specific Techniques:	Conduct hands-on training and evaluation.
Criterion Objective:	Given a source of ionizing radiation and installation inventory, determine hazards presented to workers and general public successfully completing all checklist items with NO trainer assistance.

Notes:

Identifying sources of ionizing radiation typically fall on the installation radiation safety officer (IRSO), and requires a technician to do no more than consult the radioactive material inventory maintained by the IRSO. Under some circumstances a technician may be required to identify new hazards that will need to be reported to the IRSO. New sources may be reported from a shop supervisor or identified during routine or special surveillance.

The purpose of this objective is not to *measure* radiation levels, as that is performed elsewhere. Instead it is meant to determine if radiation is present, and how it is produced; either from radioactive material, such as Cs-137, or from another process, such is in an an x-ray tube head.

TASK STEPS

1. Determine if device/material *contains* radioactive material or *produces* radiation through other means.[1]
2. Identify device/material on RAM inventory.[2]
3. Record all pertinent information if necessary.[3]
4. Determine potential population at risk.[4]

LOCAL REQUIREMENTS:

NOTES:

1. Devices containing radioactive material should be labeled with radioactive sticker and isotope contained within. Serial number of source and equipment will be recorded to compare to the inventory.

2. X-Ray tubes should be labeled with a radiation sticker, if KvP and mA settings are not labeled on machine, other sources of intel should be used, such as an interview with the operator.

3. If device/material is not listed on the installation inventory, record all pertinent information to report to IRSO. This includes, but is not limited to:
   - Manufacturer
   - Model
   - Serial number of device
   - Source isotope, activity, and date activity was measured
   - Serial number of radiation source (if applicable)
   - Machine parameters (KvP, mA, duration of exposure) (if applicable)
   - Using organization
   - Location: Bldg #, Room # for both use and storage areas (if different)

4. Take in to consideration operators/users, adjacent rooms and areas, and if area is accessible by the general public. This is necessary when determining priority for special surveillance.

TRAINEE REVIEW QUESTIONS

STS Line Item 4.9.2.6: Identify radiological/nuclear hazards

1. Machines used in medicine produce varying amounts of radiation energy based on what parameters?
2. What information should be recorded when identifying a new radiation source?
3. Where would you find information about an x-ray emitter if the labels were missing?

PERFORMANCE CHECKLIST

STS Line Item 4.9.2.6: Identify radiological/nuclear hazards

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed

DID THE TRAINEE…		YES	NO
1. Determine if device/material contains radioactive material, or produces radiation through other means?			
2. Identify device/material on RAM inventory?			
3. Record all pertinent information if necessary?			
4. Determine potential population at risk?			

TRAINEE NAME (PRINT)

TRAINER NAME (PRINT)

ANSWERS

1. Machines used in medicine produce varying amounts of radiation energy based on what parameters?

   A: Kilovolt Peak, milliamperes (KvP, mA).

   (Source: 4B051 CDC)

2. +What information should be recorded when identifying a new radiation source?

   - Manufacturer
   - Model
   - Serial number of device
   - Source isotope, activity, and date activity was measured
   - Serial number of radiation source (if applicable)
   - Machine parameters (KvP, mA, duration of exposure) (if applicable)
   - Using organization
   - Location: Bldg #, Room # for both use and storage areas (if different)

   (Source: 4B051 CDC)

3. Where would you find information about an x-ray emitter if the labels were missing?

   A: Other sources of intel should be used, such as an interview with the operator.

   (Source: 4B051 CDC)

STS Line Item 4.9.2.9: Perform medical / diagnostic x-ray scatter surveys (ION Chamber Method)

TRAINER GUIDANCE

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed
Prerequisites:	Training Module 4.9.2.11.1 – Ion Chamber (i.e. Victoreen 451P) Training Module 4.9.2.11.3 – Geiger-Mueller (i.e. ADM 300)
Training References:	• AFIOH Report IOH-SD-BR-SR-2005-0004, *Bioenvironmental Engineer's Guide to Ionizing Radiation, 14 Feb 2013* • AFI 48-148, *Ionizing Radiation Protection, 21 September 2011*
Additional Supporting References:	• 29 CFR 1910.1096, *Occupational Safety and Health Standards - Ionizing Radiation* • 10 CFR 20, *NRC Regulations - Standards for the Protection Against Radiation* • 21 CFR 1020 • TM OEH 10-2(a)
CDC Refe*rence:*	4B051
Training Support Material:	• Radiation detection instruments 1. Victoreen 451P (ion chambers – preferred, set to "integrate mode") 2. ADM-300 (energy-compensated G-M tubes, set to "rate mode") • Paper and pencil • Personal radiation monitoring devices 1. Thermo-Luminescent Dosimeters (TLDs) 2. Electronic Personal Dosimeters (EPDs) • 1- gallon Cubitainer® (or equivalent plastic container) filled with water
Specific Techniques:	Conduct hands-on training and evaluation.
Criterion Objective:	Given survey meters and a radiation source, evaluate ionizing radiation controls and perform ionizing radiation surveys successfully completing all checklist items with NO trainer assistance.
Notes:	

TASK STEPS

Measure scatter radiation using instrument (ion chamber) survey meter method

1. Determine measurement points.[1]
2. Have technician set-up X-ray machine.[2]
3. Place dummy load 1-gallon Cubitainer® (or equivalent plastic container) filled with water as the target for the x-ray beam.
4. Select appropriate range on survey meter.
5. Position survey meter at 1st location.[3]
6. Have the technician take a table shot.[4]
7. Record measurement.
8. Allow the tube to cool between shots to prevent burnout of the X-ray tube
9. Repeat measurements as necessary to get all desired readings.
10. Have the technician take a chest x-ray shot.[4]
11. Record measurement.
12. Allow the tube to cool between shots to prevent burnout of the X-ray tube
13. Repeat measurements as necessary to get all desired readings 14. Repeat the process for all other locations.
15. Review measurements/readings and estimate annual exposure.
16. Calculate and check to see that no location exceeds standards.[5]
17. Complete survey results.[6]
18. Utilize OEHMIS (DOEHRS or equivalent), as applicable.

Dental X-ray scatter surveys

1. Have technician set-up X-ray machine.[7]
2. Place a wastebasket in the dental chair and a 1-gallon Cubitainer® (or equivalent plastic container) filled with water in the wastebasket to simulate the patient's head.
3. One exposure is made with the X-ray tube parallel to the floor and in contact with the Cubitainer® (simulating the shot to be made through the ear of the patient).
4. Record measurement and allow the tube to cool between shots to prevent burnout of the X-ray tube.
5. Repeat measurements as necessary to get all desired readings.
6. Second exposure is made on the opposite side, through the other 'ear.'
7. Record measurement and allow the tube to cool between shots to prevent burnout of the X-ray tube.
8. Repeat measurements as necessary to get all desired readings.9. Review measurements/readings and estimate annual exposure.
10. Calculate and check to see that no location exceeds standards. [5]
11. Complete survey results.[6]
12. Utilize OEHMIS (DOEHRS or equivalent), as applicable

LOCAL REQUIREMENTS:

NOTES:

1. Measurement points typically include:
   - At the operator's location inside the X-ray room
   - Outside the door to the X-ray room
   - Exposure room door
   - In adjacent waiting areas and/or offices
   - On the other side of the wall from the chest cassette holder
   - Along exterior of walls, focusing on the door area
   - Locations above and below the room, if occupied
   - Film pass through opening

2. Device Settings
   - Use a high kilovolt peak (kVp) setting that is appropriate for the exposure.
   - Use the highest milliamperes (mA) setting that is appropriate for the exposure

3. Take measurements at each location of interest:
   - Tube head oriented for a table shot (vertical position pointed downward toward the table)
   - Tube head oriented for a chest X-ray (horizontal position pointed at the wall, source to film distance of 72 inches)
   - 3 feet above floor
   - 30 cm (12 inches) from surface for radiation fields penetrating surfaces (like walls)

4. The technician should take the shot in the same manner they would for that type of x-ray

5. Calculate and check to see that no location exceeds standards:
   - Consider occupancy factors (length of time someone might stay at that location)
   - To find the yearly exposure, find the number of films exposed per week (see formula below)
   - Standard is 100mr/yr
   - Also need to consider radiation exposures in radiation worker areas.

6. Survey results shall include:
   - A description or drawing of each measurement location
   - Measured dose or contamination levels at each location
   - The type, model number, serial number and calibration date of the instrument
   - Name of individual performing the survey
   - Date and time of the survey and applicable comments

7. Use a high kilovolt peak (kVp) setting that is appropriate for the exposure.

Formula:

$$\text{mR/wk} = \frac{\text{scatter reading (mR/hr)} \times \text{number of films/wk} \times \text{sec/film}}{3600 \text{ sec/hr}}$$

$$X_{Annual} = T \times \left(\frac{50 \text{ wk}}{\text{yr}}\right) \times \left[\sum_{i=0}^{n} \frac{X_{i(survey)}}{mAs_{i(survey)}}\right] \times W_i$$

X_{Annual} = Total annual exposure in mR/yr for a single location (all configurations)
T = Occupancy Factor: fraction of time spent at surveyed locations (NCRP 147, etc.)
i = information specific to a particular machine configuration (i.e., chest film, etc.)
$X_{i(survey)}$ = Measured Integrated Exposure in mR for specific location/configuration
mAs_{Annual} = mAs setting for measured shot (from radiation technician)
W = Workload: Average Total mAs per week mAs/wk for specific configuration.

EPDs - Electronic Personal Dosimeters
TLD - Thermo-Luminescent Dosimeter

Note: See AFIOH Report IOH-SD-BR-SR-2005-0004 for occupancy factors.

TRAINEE REVIEW QUESTIONS

STS Line Item 4.9.2.9: Perform medical / diagnostic x-ray scatter surveys (ION Chamber Method)

4. Do you need to perform a new scatter survey if a medical x-ray unit is moved/repositioned in a room?
5. What is the gallon container of water used for?
3. What is the occupancy factor in the bathroom of a waiting area?

PERFORMANCE CHECKLIST

STS Line Item 4.9.2.9: Perform medical / diagnostic x-ray scatter surveys (ION Chamber Method)

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed

DID THE TRAINEE…		YES	NO
MEASURE SCATTER RADIATION USING INSTRUMENT (ION CHAMBER) SURVEY METER METHOD			
1. Determine measurement points?			
2. Have technician set-up X-ray machine?			
3. Place dummy load 1-gallon Cubitainer® (or equivalent plastic container) filled with water as the target for the x-ray beam?			
4. Select appropriate range on survey meter?			
5. Position survey meter at 1st location?			
6. Have the technician take a table shot?			
7. Record measurement?			
8. Allow the tube to cool between shots to prevent burnout of the X-ray tube?			
9. Repeat measurements as necessary to get all desired data			
10. Have the technician take a chest x-ray shot?			
11. Record measurement?			
12. Allow the tube to cool between shots to prevent burnout of the X-ray tube?			
13. Repeat (Take measurements at each location of interest twice)?			
14. Repeat the process for all other locations?			
15. Review measurements/readings and estimate annual exposure?			
16. Calculate and check to see that no location exceeds standards?			

17. Complete survey results?			
18. Utilize OEHMIS (DOEHRS or equivalent), as applicable?			
DENTAL X-RAY SCATTER SURVEYS			
1. Have technician set-up X-ray machine?			
2. Place a wastebasket in the dental chair and a 1-gallon Cubitainer® (or equivalent plastic container) filled with water in the wastebasket to simulate the patient's head?			
3. One exposure is made with the X-ray tube parallel to the floor and in contact with the Cubitainer® (simulating the shot to be made through the ear of the patient)?			
4. Record measurement and allow the tube to cool between shots to prevent burnout of the X-ray tube?			
5. Repeat measurements as necessary to gather all desired data?			
6. Second exposure is made on the opposite side, through the other 'ear'?			
7. Record measurement and allow the tube to cool between shots to prevent burnout of the X-ray tube?			
8. Repeat measurements as necessary to gather all desired data?			
9. Review measurements/readings and estimate annual exposure?			
10. Calculate and check to see that no location exceeds standards?			
11. Complete survey results?			
12. Utilize OEHMIS (DOEHRS or equivalent), as applicable?			
Did the trainee successfully complete the task?			

TRAINEE NAME (PRINT) TRAINER NAME (PRINT)

ANSWERS

1. Do you need to perform a new scatter survey if a medical x-ray unit is moved/repositioned in a room?

   A: Yes, surveys are required when there are changes in the operation.

   (Source: 4B051 CDC)

2. What is the gallon container of water used for?

   A: To create a scatter medium and act as a human body would during medical x-rays

   (Source: 4B051 CDC)

3. What is the occupancy factor in the bathroom of a waiting area?

   A: 0.05

   (Source: 4B051 CDC)