Radiation Surveys

Professional Training Programs

ORAU

Objectives

- To discuss the different types of radiation surveys
- To discuss the components of a radiation survey
- To discuss the techniques necessary to complete a survey
- To discuss the components of a survey record

Radiation Survey Types

- **Exposure Rate**
- Contamination
- Air
- Water
- Bioassay

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Radiation Survey Types

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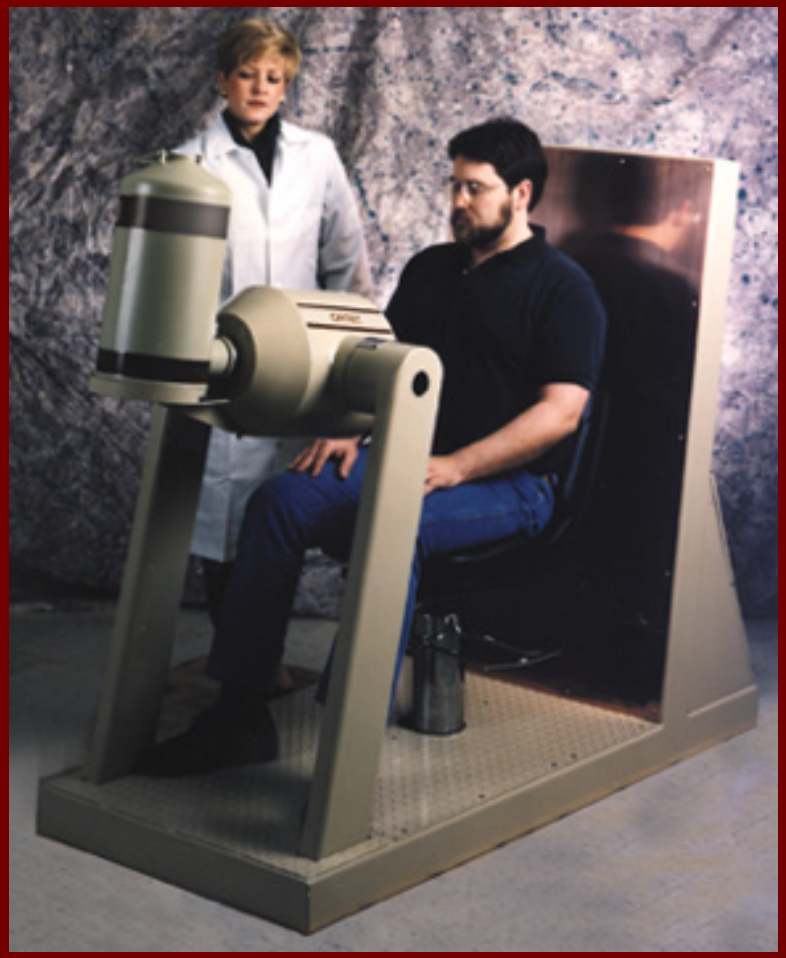
Radiation Survey Types

- Exposure Rate
- Contamination
- Air
- Water
- **Bioassay**
  - Direct measurement (in-vivo)
  - Indirect measurement



Pre-Survey

- Training
- Instrument Choice
- Instrument Calibration
- Instrument Check Out
- Site Preparation
- Guideline or Action Level Establishment

Training

- RSO (designee) determines adequate training and experience
- Academic training
  - Lecture
  - Videotape
  - Self-study

Training

Academic subject areas:

- Principles and practices of radiation protection
- Radioactivity measurements, monitoring techniques, and using instruments
- Mathematics and calculations basic in using and measuring radioactivity
- Biological effects of radiation

Training

On-the-job training:

- Observing authorized personnel
- Use of survey, sampling and analyzing equipment under direct supervision of authorized individual

Instrument Choice

- Type and energy of radiation
- Type of measurement
- Survey conditions
- Objects or samples
- Portable or stationary

Portable Instruments Used for Contamination and Ambient Radiation Surveys – NUREG 1556, Vol. 9			
Detectors	**Radiation**	**Energy Range**	**Efficiency**
Exposure Rate Meters	Gamma, X-ray	µR - R	N/A
Count Rate Meters			
GM	Alpha	All energies (dependent on window thickness)	Moderate
	Beta	All energies (dependent on window thickness)	Moderate
	Gamma	All energies	<1%
NaI Scintillator	Gamma	All energies (dependent on window thickness)	Moderate
Plastic Scintillator	Beta	C-14 or higher (dependent on window thickness)	Moderate

Stationary Instruments Used to Measure Wipe, Bioassay, and Effluent Samples – NUREG 1556, Vol. 9			
Detectors	**Radiation**	**Energy Range**	**Efficiency**
Liquid Scintillation Counter*	Alpha	All Energies	High
	Beta	All energies	High
	Gamma		Moderate
Gamma Counter (NaI)*	Gamma	All energies	High
Gas Proportional	Alpha	All energies	High
	Beta	All energies	Moderate
	Gamma	All energies	<1%

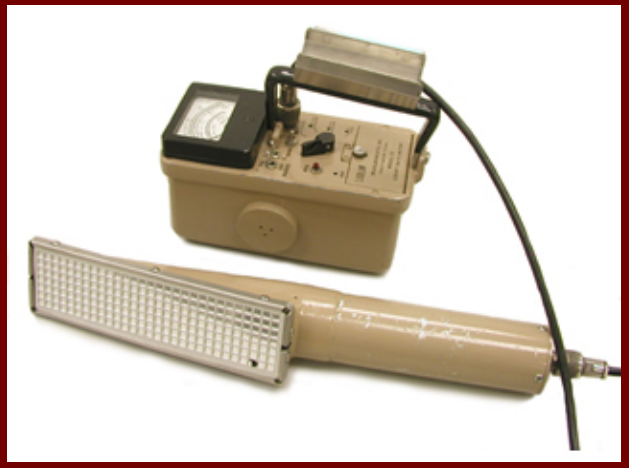
*not extracted from source handbook: "The Health Physics and Radiological Handbook, " Revised Edition, 1992

Instrument Choice

- Survey Instruments
- Surface Contamination Measurement Instruments
- Liquid Scintillation, Gamma, and Gas Flow Proportional Counters

Survey Instruments

Surface Contamination Measurement Instruments



Liquid Scintillation, Gamma, and Gas Flow Proportional Counters

Instrument Calibration

- Required for most instruments:
  - Annually
  - When damage is apparent or suspected
  - Instrument fails check-out
- The calibration must be documented

Calibration – Survey Instruments

- Sealed source should approximate a point source
- Approximate the same energy and type of radiation of survey conditions
- Dose and exposure rate instruments should be calibrated with a source >30 mR/hr at 100cm

Calibration – Surface Contamination Measurement Instruments

- Efficiencies must be determined using sources with similar energies and types of radiation to be measured
- Geometry/area factors must be considered

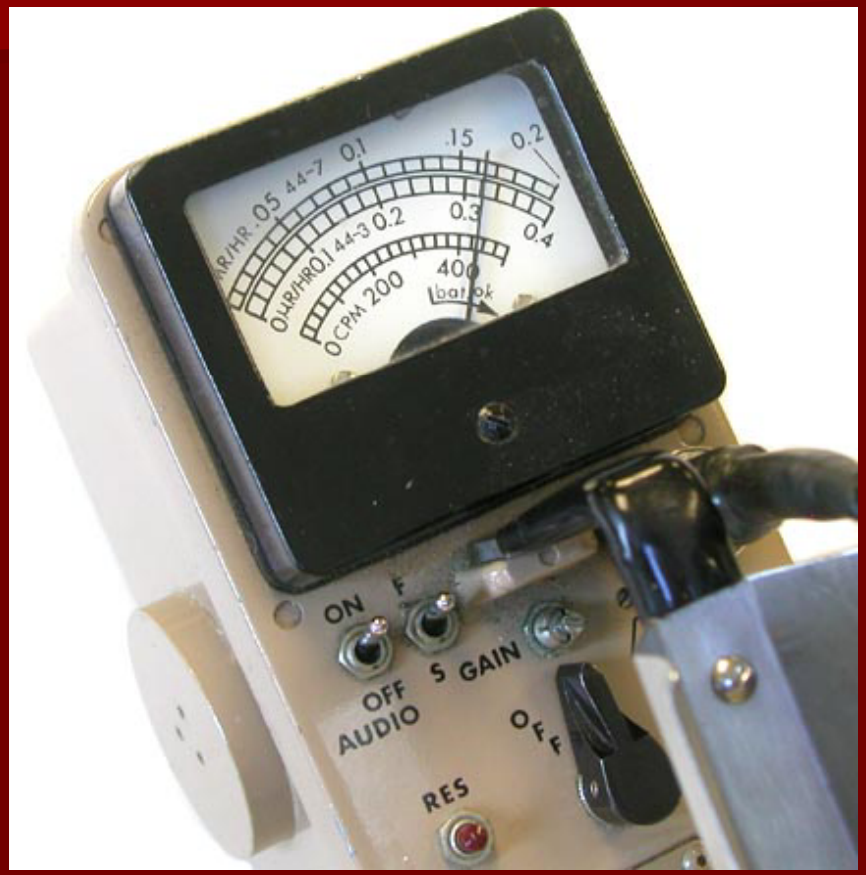
Calibration – LSC, Gamma, and Gas Flow Proportional Counters

- Source should approximate the geometry of the samples
- Approximate the same energy and type of radiation as samples to be measured

Instrument Check-Out

- Attach detector to instrument when applicable
- Battery
- Threshold and high voltage settings
- Background count
- Source count
- Audible output when applicable

Battery Check

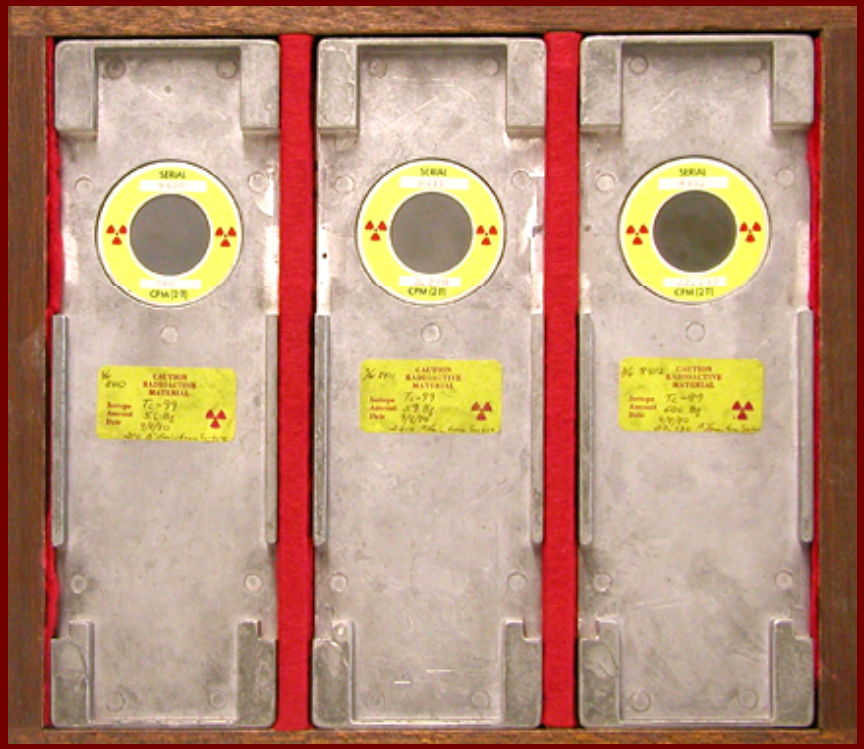


Threshold and High Voltage Check

Background Check

- Ion chamber – 0 mR/hr
- µR-Meter – 10 to 20 µR/hr
- GM detector – 30 to 50 cpm
- NaI detector – 2000 cpm
- Gas Flow Proportional – 400 cpm
- ZnS – 0 to 1 cpm

Source Check



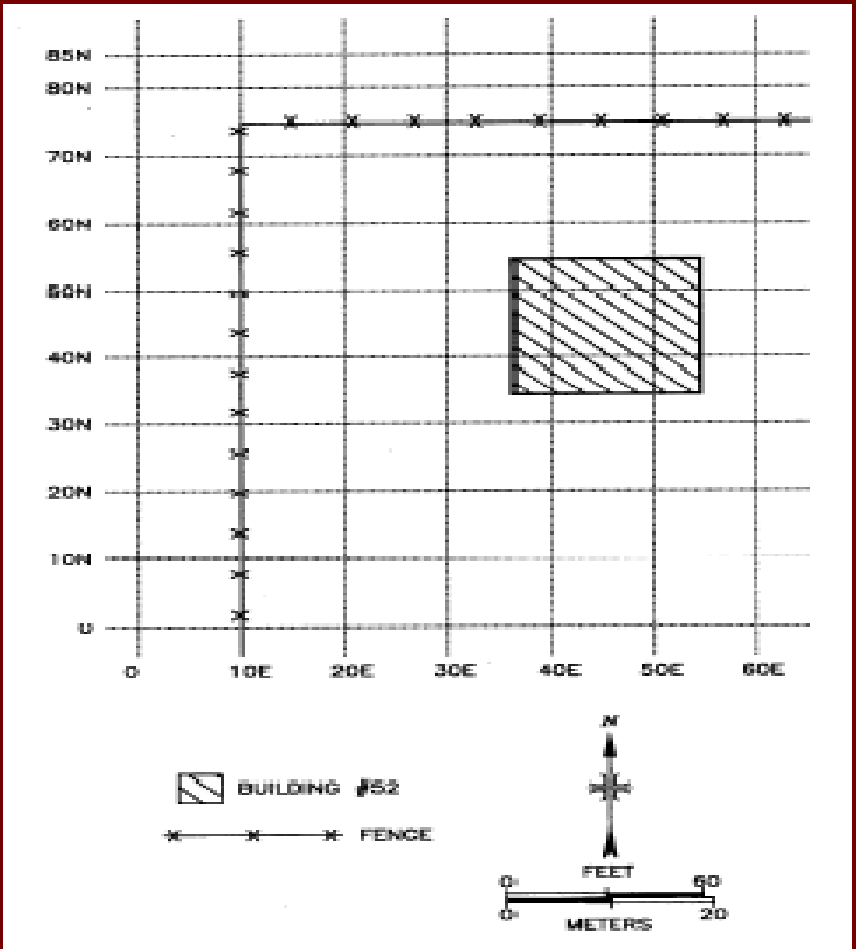
Audible Output

Site Preparation

- Clearing to provide access
- Reference grid system – outdoor and indoor

Site Preparation

Coordinate system referenced to a 0,0 point using alpha-numeric identifiers



Guideline or Action Level Establishment

- General Rule - > three times background = further investigation
- Licensing limits
- Calculated based on survey plan

Survey

- Surface scanning techniques
- Measurement techniques

Surface Scanning Techniques

- Instrument set on FAST response if available
- Wear head-set when possible to focus surveyor

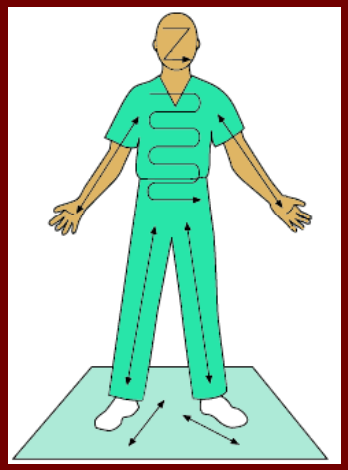
Surface Scanning Techniques

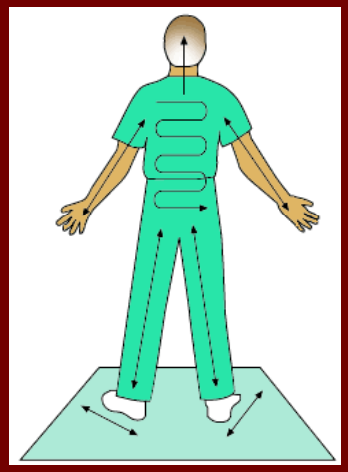
- Pass detector slowly over the surface to be scanned
- Scan speed depends on radionuclide of concern
- Typical scan speed is 1/3 to 1 probe widths per second

Surface Scanning Techniques

- Scan as close to the surface as conditions allow (1-4 cm)
- Keep eyes on detector not the meter to avoid contamination of detector

Surface Scanning Techniques





- Work systematically to ensure coverage of area to desired amount
- Remember to scan all surfaces of objects

Surface Scanning Techniques

- Floor monitors used to survey large areas

Surface Scanning Techniques

Large area gamma scanning performed by swinging the detector in front of the body in a pendulum manner while moving forward slowly

Surface Scanning Techniques

Mark areas that meet or exceed established guidelines or action levels

Surface Scanning Techniques

- A wipe tests may be necessary to detect low energy beta emitters
- Wipe tests are necessary to test for removable contamination
- Use a Z or S shaped pattern
- Wipe tests must be analyzed using the appropriate detector

Measurement Techniques – Portable Instruments

- Select an appropriate counting time (1 minute is appropriate for most radionuclides)
- Place detector face on contact or as close to the surface to be measured as possible

Measurement Techniques – Portable Instruments

- Collect measurement
- Record location, surface type and condition
- Calculate the activity (dpm/100 cm^2)

Measurement Techniques – Wipe Test

- Area of 100 cm^2
- Use a Z or S shaped pattern
- Area corrections can be made for objects smaller than 100 cm^2
- Use appropriate detector for analysis

Contamination Limits

- Established by the regulatory authority
- Usually based on NRC Reg Guide 1.86

Survey Record

- A diagram of the area
- List of items and equipment surveyed
- Specific locations where wipe test was taken
- Ambient radiation levels with appropriate units

Survey Record

- Contamination levels with appropriate units
- Make, model and calibration date of instruments used
- Background levels
- Name of surveyor and date

Summary

- Types of radiation surveys
- Components of a radiation survey
- Techniques used during radiation surveys
- Record requirements of radiation surveys