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Characterization Survey Techniques and Some Practical Feedback

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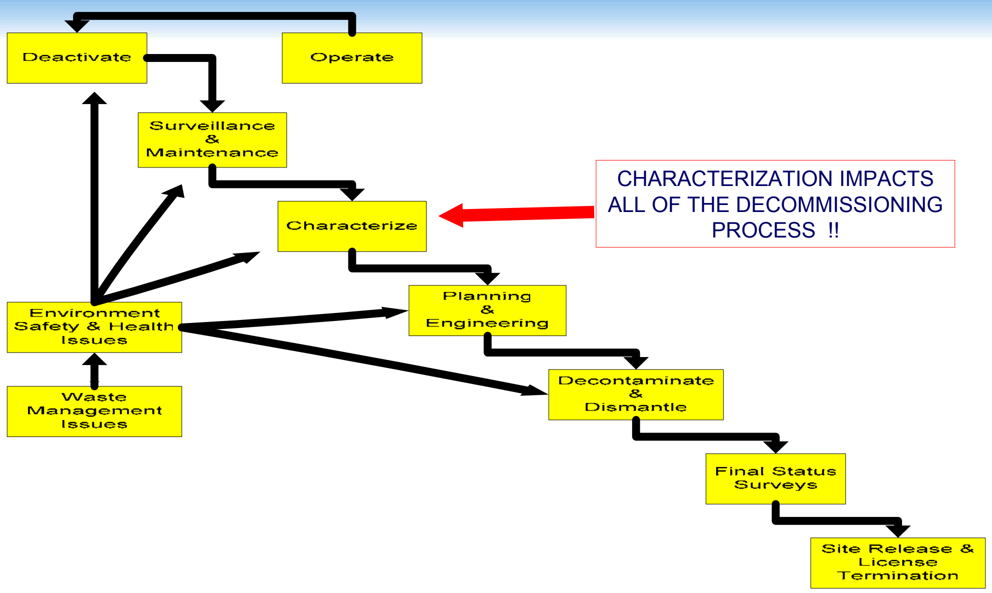
Characterization Objectives

- Remember overall characterization process objectives –
  - Document the initial working conditions/environment for the decommissioning activities
  - Identify potential hazards present and which may require controls or mitigation to protect the workers, environment and the public
  - Initial documentation from characterization activities provides details for future planning and basis for detailed characterization surveys
  - Field measurements and sample collection and laboratory analyses are the 'heart' of the characterization process



Points to Remember

- **The Steps in a simple scheme are to:**
  - **Review the existing data**
  - **Develop a plan to fill the data gaps**
  - **Execute the plan and document the results**
  - **Support field work & finalize details as the decommissioning progresses**

- **The trick of this process is knowing when ‘enough is just enough’ and exactly when you reach the point of diminishing returns from further dedicated and intensive characterization; this optimizes the schedule and use of funds – some degree of risk and assumptions of homogeneity of conditions are required to be made**

- **Characterization never really is ‘completed’ at a decommissioning project site and you need to know where you want to end up at before you ever start**

Points to Remember (ctd)

- Many of the same problems encountered from poor characterization can be traced back to the same standard list of problems encountered to date in performing decommissioning -
  - Poor records management
  - Lack of funding
  - Lack of equipment
  - Poor understanding of the entire process
  - Lack of management support
  - etc etc
- Don’t forget to look where you can’t see and verify what you might feel you already know

Introduction

- In 2005, a workshop was held in Manila which addressed "Characterization for Decommissioning"
- The remainder of this lecture is a summary of that lecture material addressing:
  - Survey Techniques
  - Materials Sampling
  - Laboratory Analysis
- The complete detailed presentations can be accessed from the IAEA WSS server

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FIELD MEASUREMENTS

SIMPLE MONITORING INSTRUMENTS

Application	Detector	Characteristics	Remarks
Alpha emitters	proportional – various windows sizes	0.4 to 3 Bq/100 cm^2 sensitivity for scanning	Sensitivity depending on type of surface
	scintillation	3 Bq/100 cm^2 sensitivity for scanning	Sensitivity depending on type of surface
Beta emitters	proportional – various windows sizes	3 Bq/100 cm^2 sensitivity for scanning	Sensitivity depending on type of surface
	Geiger-Muller	3 Bq/100 cm^2 sensitivity for scanning	Sensitivity depending on type of surface
Gamma emitters	Geiger-Muller	Measurement at 50% above background	Better sensitivity with time integration
	proportional	Measurement at 50% above background	Better sensitivity with time integration
	scintillation	Measurement at 50% above background	Better sensitivity with time integration
Note: These instruments can be used for scanning or in a time integration mode for increased precision during direct measurements			

RADIATION DETECTORS FOR DOSE RATE MEASUREMENTS

Application	Detector	Characteristics	Remarks
Active	pressurised ionisation chamber	<100 nSv/h sensitivity	high precision
	Geiger-Muller	100 nSv/h sensitivity	Energy compensation needed
	proportional	100 nSv/h sensitivity	Energy compensation needed
	scintillator	<100 nSv/h sensitivity	Dual phosphor or tissue for flat energy response (used in current mode)
Passive	Thermoluminescence dosemeter	<50 nSv/h in 1 month	Good for wide area deployment
	Film badge	100 µSv/month	Sensitivity not sufficient for background measurements
	Electret ionisation chamber		Measures radon as well
Active/passive	Electronic dosemeter		Good for personal monitoring

FIELD RADIATION DETECTORS FOR NUCLIDE-SPECIFIC MEASUREMENTS			
Application	**Detector**	**Characteristics**	**Remarks**
Alpha emitters	Sealed –large area proportional counter	Minimum deectable activity (MDA) of 0.3 Bq/g or 2 Bq/100 cm^2	Used as X ray spectrometer
	FIDLER (Field Instrument for Determination of Low Energy Radiation)	MDA of 70 Bq/100 cm^2 for Pu mix	Can be used for scanning, detects X rays
	Array of Si or Ge crystals	MDA of 0.03 Bq/g for Pu mix in 1 hour	Detects X rays or 60 keV line of ^{241}Am
Beta emitters	Scintillating fibres	MDA of 0.2 Bq/g for ^{90}Sr in 1 minute	Provides some nuclide / energy discrimination
Gamma emitters	NaI gamma spectrometer	10×10 cm crystall measures background nuclide concentrations in minutes	Low energy resolution
	Ge gamma spectrometer	Larger types can measure 0.004 Bq/g in 10 minutes	High energy resolution

Monitoring Instruments

Portable gamma spectroscopy

MilliSv meters

Special Use Instruments

Fidler

Floor Monitor

Portable alpha- beta swipe counter

Remote Monitor

Radiological survey methods

- **Scanning - Moving a detector across or through an area to detect the presence of radiation**
- **Measurement - Determining the quantity (and quality) of radiation or radioactive material at a location, based on direct response of a detection system**
- **Sampling - Selecting a portion of the medium being evaluated for analysis**

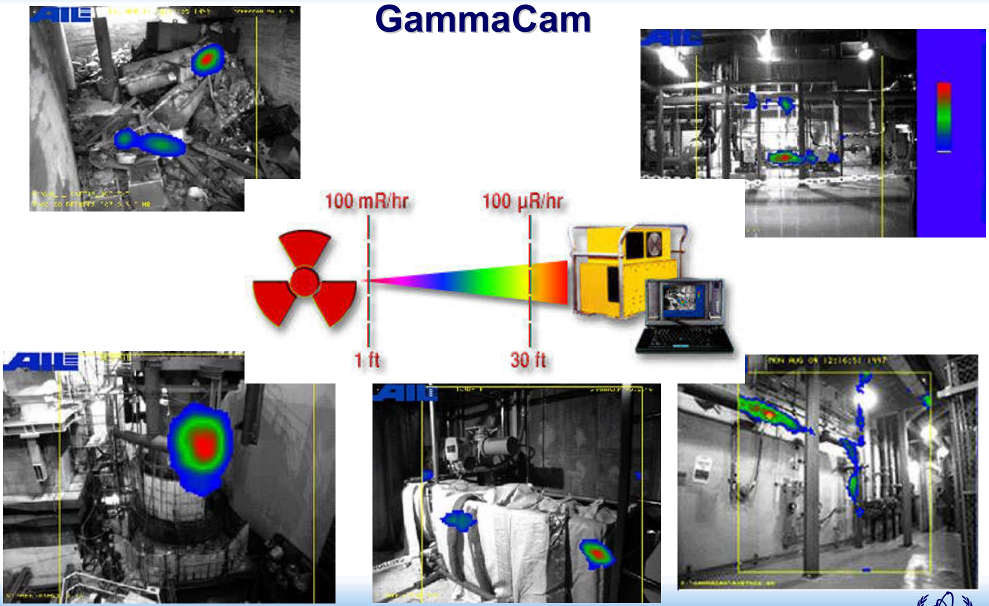
Data Recording

- Obtain drawing or sketch for area
- Obtain survey sheet and complete as much as possible before entering area
- Record readings as measurements are taken
- When departing, bag survey sheet in plastic Ziplock bag or fax the results to a machine outside the contaminated area

New Technologies

- New technologies have recently been entering the marketplace to support characterization and monitoring in general
- Focus of new technologies is on reducing:
  - Effort required to conduct the measurements
  - Effort required to get the samples results from the analytical laboratory
  - More automated systems – less 'hands on' or manned entries into areas
  - Less opportunities for incidents to occur with workers involved

GammaCam



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MATERIAL SAMPLING

Sampling Techniques and Field Procedures for Preparing Samples for Analysis

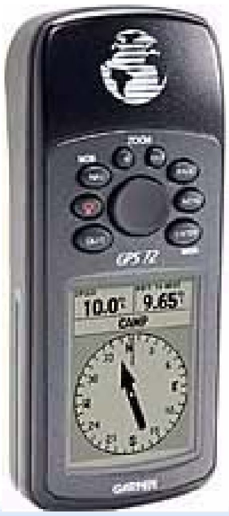
- Concrete
- Steel, equipment and components
- Paint
- Floor and ceiling tile
- Drains, pipes and ducts
- Surface and subsurface soil
- Biota
- Foodstuffs
- Water and sediments
- Airborne contamination

Sampling Methodology

- Biased sampling
  - Use systematic approach
    - Grid for reference
  - Finding or defining contamination
  - Used where contamination is likely
- Unbiased sampling
  - Areas where little contamination is expected
  - Areas are expected to be homogeneous
  - Sampling areas compared to reference areas

Sample Locations

- The exact location must be recorded properly each time a sample is taken
- Use of traditional map-spotting techniques are slow and require trained personnel
- Modern positioning techniques: global positioning system (GPS) and microwaves, ultrasound and laser ranging systems are preferable



Tracking system for samples

- Code samples for easy identification
- Samples codes should be simple but able to distinguish between samples and between the associated analytical data;
- Samples codes must be explicitly documented in a special procedure
- Personnel must be trained in the procedure
- Special care is required when labelling samples.

Post-Sample Considerations

- Split samples
- Packaging
  - Labeling
- Sample preservation
- Shipping and transportation
- Chain of custody
- Archiving and storage
  - Holdup times

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LABORATORY REQUIREMENTS

IAEA Characterization Course

Laboratory Requirements

- Must hold a license from the regulatory authority to analyze samples
- Must have counting instruments that can meet detection requirements
- Staff training and capable of meeting required turnaround time
- Data of known and documented quality
- Provide analytical services for sites prior to, during, and post remediation
- Radiological and non-radiological capabilities may be required and useful
- QA is a must to ensure data of proper quality

  - Optimization of the use of laboratory analyses from a cost-benefit perspective is critical – can become prohibitively expensive otherwise

Common Laboratory Analyses

- Gross measurements (alpha and beta)
- Gamma spectroscopy
- Alpha spectroscopy
- Beta spectroscopy (liquid scintillation)
- Radiochemical analysis
- Autoradiography
- Activation analysis
- Other measurement techniques

Lessons Learned

- 'As Built' does not translate to 'As Found'
- Review available records and photos
- Interview former or current workers
- Don't overlook groundwater and soil contaminants
- Be aware of non-radiological hazards
- Understand the expectations of the regulator and other authorities – example - waste management authority
- Use techniques and instruments capable of measuring down to the release criteria values
- Account for naturally occurring radioactivity
- Activation analysis codes are only one tool; couple with some verification by sampling
- Identify operational issues before decommissioning to handle during operations if possible
- Surface coatings of materials being surveyed and weather conditions can impact instrumentation response
- Laboratory personnel should understand your expectations of them

Summary

- Good characterization requires:
  - Field measurements
  - Sample collection and analysis
  - Laboratory analyses
- Experiences are available to draw lessons from and should be used as applicable to optimize the process
- New technologies are available and entering the field as tools for use in performing characterization