

**TRAINING COURSE ON PRACTICAL TECHNIQUES FOR
REDUCING DOSES RECEIVED BY MEMBERS OF THE
PUBLIC AT LEGACY SITES ASSOCIATED WITH THE
MINING AND PROCESSING OF URANIUM ORE**

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CHAPTER 1. INTRODUCTION

Background

Significant legacy issues have arisen from past practices involving the mining and processing of uranium ore. In some cases, the sites associated with such practices were simply abandoned or their remediation and closure were not carried out in accordance with current IAEA safety standards. Such sites (hereinafter referred to as legacy sites) can give rise to various physical, chemical and radiological risks. As part of the overall approach to the remediation of legacy sites, as set out in the IAEA safety standards and supporting publications, Member States need to identify the sites concerned, assess the site specific risks to the local population, establish remediation priorities and match these to the financial and technical resources available for addressing them. Many legacy sites, both large and small, are located in countries in Eastern Europe, Central Asia and Africa where resources, regulatory capacity and experience in dealing with legacy sites may be limited. At present, such countries are generally not in a position to implement adequately funded and resourced long term remediation efforts; nevertheless, there may be a short term need to address the radiological risks to the public living nearby. This requires the development and implementation of practical, short term, site specific and low cost techniques for reducing doses received by members of the public.

In the past there have been some regional and national training courses that are somewhat relevant to remediation of legacy sites have been held. In almost all cases, the lectures have been prepared without the benefit of a structured syllabus and without training plans to describe the objective and scope for each lecture. Thus, a need for better standardization of lecture materials has been identified.

Objective

The objective of this training course is to provide information on short-term practical techniques for mitigating the radiological impacts of legacy sites, i.e. simple administrative, technical and practical measures to reduce doses received by members of the public. The training course is aimed primarily at Member States that do not yet have the necessary resources and/or experience to carrying out full scale long term remediation but need to begin implementation of short term dose reduction measures. The training course was developed as part of Project B.1. Practical Intervention Techniques to Reduce Public Doses at Uranium Mining and Milling Legacy Sites — this project is included under IAEA Project 3.4.1.3 on Decommissioning and Remediation Safety and is being conducted by the IAEA with supplementary funding from the European Union.

Scope

The training course is intended to address general background information on legacy sites and their remediation (including information from case studies) and to describe various practical techniques that can be used to obtain short-term reductions in public doses at legacy sites pending the implementation of long-term full-scale remediation.

The primary focus of the lectures is directed at legacies from the mining and processing of uranium ore, the principles and approaches outlined in the report can also be used to address legacies from the mining and processing of other radioactive minerals.

Structure

This Standard Syllabus is structured similarly to the syllabus for the *Postgraduate Educational Course in Radiation Protection and the Safety of Radiation Sources* (2002). The descriptions for the individual modules and specific training plans for each lecture and exercise were developed using the *Guidance for the elaboration of training material for the Post Graduate Educational Course and Practice Specific Specialized Courses in Radiation Protection and Safety of Radiation Sources* (IAEA unpublished working material, 2003). Using these guidelines, the syllabus is organized as follows: Chapter 2 includes an overview of the lectures in the module. Chapter 3 includes the lecture plans for the lectures in the module; Chapter 4 presents a suggested schedule for the training course.

CHAPTER 2. OVERVIEW

This chapter provides an overview of each lecture to be included in the training course.

Lecture 1. Workshop Introduction and Overview

Lecture 2. Introduction to Radiation and Radiation Protection

Uranium ores are radioactive materials that emit alpha, beta and gamma radiation. This lecture provides an overview of the basic characteristics of ionizing radiation from uranium ores, the potential risks and the basic principles and methods of radiation protection of workers and the public.

Lecture 3. Historical Overview of Legacy Sites

This lecture examines the historical exploitation of uranium ores, the uses of uranium, the origin of and types of legacy uranium sites. It also provides an overview of the variety of countries in which the exploration and exploitation of uranium ores has occurred.

Lecture 4. Risks to the Public Arising from Legacy Uranium Sites

This lecture provides an overview of the types of risks arising from legacy uranium mine sites, in particular radiological risks. It also examines the types of public interaction with legacy sites and how these interact with the radioactive source terms and exposure pathways.

Lecture 5. Existing Exposure Situations

Legacy uranium sites are historical operations that were abandoned without proper remediation. These types of sites are considered as existing exposure situations that may require intervention to reduce public radiation exposures. This lecture provides an overview of the IAEA Safety Standards guidance on existing exposure situations.

Lecture 6. Regulatory Aspects: Authorization and Inspection of Remediation

The regulator plays an important role in the process of identification, characterisation and remediation of legacy uranium sites. The regulatory process can be complicated in those cases where ownership of the legacy site cannot be assigned to a particular organisation. This lecture provides an overview of the regulatory aspects involved in the process of intervention and remediation of a legacy uranium site.

Lecture 7. Development of a National Inventory of Legacy Sites

The first step in a national remediation program is to identify the uranium legacy sites in a Member State in order to begin the process of site characterization and prioritization. This lecture provides an overview of the methods that can be used to develop a national inventory of uranium legacy sites.

Lecture 8. Issues to be considered in the Initial Site Visits

The initial site visits after the discovery of a uranium legacy site require a structured approach to gather sufficient information to commence the prioritization of sites and begin planning for the site characterization process. This lecture provides an overview of the aspects to consider in the initial site visits to a legacy uranium site by the regulator.

Lecture 9. Overview of the Site Characterization Process

The site characterisation process examines both the radiological and non-radiological characteristics of the uranium legacy site in more comprehensive detail. Site characterisation data is required in order to optimise and plan the intervention measures and remediation process. This lecture provides an overview of the aspects to consider in the site characterization process.

Lecture 10. Simple Radiological Surveys, Dose Assessments and Data Reduction

These surveys and assessments form part of the site characterization process. Member States may have limited financial, technical and equipment resources to conduct site surveys and dose assessments. This lecture provides an overview of simple survey and assessment methods that can be used at uranium legacy sites.

Lecture 11. Simple Sampling and Analysis Techniques

Sampling and analysis of materials such as soils, water and solid wastes are an important part of the site characterization process. This lecture provides an overview of simple sampling and analysis methods suitable for Member States with limited technical and financial resources.

Lecture 12. Prioritisation of Sites and Public Risks

Member States with limited human and financial resources may be confronted with a number of legacy uranium sites that require intervention. In order to make optimal use of the limited resources the legacy sites require to be prioritized in terms intervention and remedial actions. This lecture provides an overview of the site prioritization process and methods.

Lecture 13. Radiation Protection Programmes for Workers

Workers may be exposed to ionising radiation when the interim remediation measures are implemented. The level of exposure may require a radiation protection programme. This lecture provides an overview of the requirements of these programmes.

Lecture 14. Remediation Objectives and Criteria

Remediation criteria and objectives are applied to uranium legacy sites that are selected for intervention and remediation. In most cases the criteria and objectives are site specific and dependent on a wide variety of factors. This lecture provides an overview of the remediation criteria and objectives and how they can be applied to uranium legacy sites.

Lecture 15. An Overview of Simple Intervention Techniques to Reduce Public Doses Part 1: Non-Physical Aspects

This lecture comprises the first part of an overview of simple intervention techniques to reduce public doses from uranium legacy sites.

The objective of this lecture is to provide an overview of the simple non-physical intervention techniques that can be used to reduce public exposures to ionising radiation from uranium legacy sites. Non-physical intervention techniques include any strategy that does not include the movement and remediation of contaminated materials.

Non-physical techniques include strategies such as: stakeholder communication and education, regulatory aspects, preventing access to the site and posting warning signs.

Lecture 16. An Overview of Simple Intervention Techniques to Reduce Public Doses Part 2: Physical Aspects

The objective of this lecture is to provide an overview of simple physical intervention techniques that can be used to reduce public exposures to radiation from uranium legacy sites.

Topic areas include: simple remediation strategies for contaminated materials, covering and containment, methods of sealing open mine workings, and methods of moving solid materials.

Session 17: Prevention of Future Legacy Sites

The final session of the workshop is devoted to discussing how to prevent future uranium legacy sites. The discussion will be led by the experts and the participants will examine and discuss the following topics:

- What are the key issues?
- How can these be addressed?
- What resources are needed?

- What are the solutions?

Lecture 18. Case Study Presentation (South Africa and Mozambique)

This lecture examines three case studies of uranium legacy sites in South Africa (Rietkuil and Rystkuil) and Mozambique (Mavusi). The lecture provides an overview of the characteristics of these types of legacy sites and highlights various issues that are associated with them. None of these sites have ever been remediated.

Lecture 19. Case Study Presentation (Germany, Canada, USA)

Canada

The Canadian study looks at the history, identification, characterization, risk prioritization and remediation of numerous small legacy uranium mines or advanced exploration sites, without tailings.

Germany

Historical uranium mining activities in Germany involved major production centres and also many smaller uranium mining and milling sites. The German case study describes the recent remediation of one of the smaller sites.

USA

The subject of the study are the legacy sites that comprise a multitude of small, isolated operations which were abandoned 40-60 years ago. The case study describes the reclamation process and the simple remediation methods used since 1994 for these small uranium legacy sites.

Lecture 20. Case Study Presentation (Australia)

This case study deals with the remediation of a number of abandoned small-scale uranium mining and milling operations. Topic areas include: historical overview of exploration activities, operations and earlier remediation efforts; preparation of the rehabilitation plan; and remediation methods, activities and results.

Lecture 21 (optional). Case Study Presentation (China and Zambia)

These case studies describe the remediation of a radium processing plant in the People's Republic of China and two relatively small uranium tailings storage facilities in the Republic of Zambia.

Member State Reports by the Participants

The participants from each IAEA Member State would provide a short presentation to the workshop, as appropriate. The purpose of the presentations is to inform all participants and experts of the conditions and issues in each Member State related to uranium legacy sites.

Course Exercises

The course exercises comprise materials provided to the participants as a class or group on which they must provide a solution. Each group then presents their solution for discussion by all participants and the experts.

A sufficient amount of time is allocated for class exercises in the suggested training course schedule (Chapter 4). In most cases the exercises follow the material presented in relevant lectures and can be held at the end of each relevant presentation – depending on the availability of time. The list of exercises that are available and recommended is as follows:

1. Pre-course assignment,
2. Field sampling and monitoring equipment,
3. Non-radiological issues,
4. Planning initial site visit,
5. Simple gamma radiation dose calculation,
6. Sources of assistance and expertise,
7. Stakeholder engagement and communications.

The course experts will facilitate the exercises and discussions.

Discussion and Question and Answer Sessions

There is a brief period for class discussions and question and answer sessions after each presentation. At the end of each day there will be a longer period available for discussion of the presentations.

CHAPTER 3. DETAILED LECTURE PLANS

LECTURE 1. Workshop Introduction and Overview

Objectives

This lecture provides an introduction and overview of the one-week workshop on “Practical Intervention Techniques to Reduce Public Doses at Uranium Mining and Milling Legacy Sites”.

Lecture Topics

This lecture provides an overview of the following topics:

- Focus and purpose of the workshop,
- Provides an overview of the one week course agenda and structure,
- Provides a brief description of each lecture.

Scheduled duration

30 minutes

Guidance to Presenter

The final, long term remediation of even a small legacy site may require financial and other resources that are not available to many Member States. Until these countries are able to implement well-funded and resourced remediation efforts, there is a clear need to develop and apply short-term (i.e. interim) intervention techniques to reduce public doses.

The workshop and training materials were developed to:

- Assist regulators in Member States with legacy uranium sites,
- Assist Member States with insufficient technical and financial resources for the final remediation of uranium legacy sites,
- Assist regulators in Member States with limited regulatory capacity and experience of regulating uranium legacy sites,
- Provide regulators with an overview of a range of simple, practical, interim measures to mitigate impacts and protect populations exposed to legacy uranium sites.

The workshop is focused on the smaller uranium legacy sites and operations and is not intended to be applied to the remediation of full scale, commercial operations from the last 50-60 years.

LECTURE 2. Radiation and Radiation Protection

Objectives

This presentation provides an overview of basic concepts related with ionizing radiation and radiation protection, which serve as a basis for understanding the safety elements to be taken into account when deciding on, planning and carrying out a remediation project, in particular for the case of uranium mining and milling sites remediation.

At the end of the lecture, the participants should:

- (a) Understand the basic concepts related with ionizing radiation: radioactive decay, ionization, main types of ionizing radiation, activity, half-life;
- (b) Be aware of the harmful effects of ionizing radiation on humans and biota;
- (c) Be familiar with the magnitudes used for quantifying the effects of ionizing radiation on humans;

- (d) Explain the basic elements to be considered when protecting people and the environment from ionizing radiation.

Scheduled duration:

30 minutes

Guidance:

Lecture content and duration have been established on the assumption that the participants of the course have a basic to medium knowledge on the subjects of the lecture. The aim of this presentation is to provide an introductory overview and a refreshment of basic concepts needed for a better comprehension of the further presentations that conform the module.

Important note:

Depending on the level of audience understanding of radiation protection principles that would be available from the information collected prior to the course, this lecture can be:

- Used in full, with possible additional explanations, or
- Used in a very short time period, with a reminder to the participants that the additional information is available in the package that will be distributed, or
- Skipped in its entirety.

LECTURE 3. Historical Overview of Legacy Sites

Objectives

The objective of this lecture is to provide a historical overview of the origin of legacy uranium mine sites.

Lecture Topics

The lecture covers the following topic areas:

- Uses of uranium
- Uranium exploitation prior to 1940
- Historical uranium production activities
- The “ages” of uranium
- Legacy sites and remediation activities since 1980
- Smaller legacy sites and their characteristics

Scheduled duration

30 minutes

Guidance to Presenter

The lecture requires no prior knowledge of the subject and provides the background and context for the week’s course. The lecture provides an overview of the exploitation and uses of uranium and the origin of legacy uranium sites over the last 500 years to the present day.

LECTURE 4. Risks to the public arising from legacy uranium sites

Objectives:

This presentation provides information on the hazards for the public resulting from exposure to the radiological contaminants of legacy uranium sites as well as from exposure to other contaminants. It is expected that the information provided in the lecture will assist in the participants’ understanding of the objective of this project, i.e. to learn about Practical Intervention Techniques to Reduce Public Doses at Uranium Mining and Milling Legacy Sites.

Upon completion of this lecture, the participants will:

- Be able to describe the hazards from uranium legacy sites;
- Be able to describe the exposure pathways to the public from the radiological and other contaminants in the legacy sites;
- Have an understanding of the ways, and the need, to protect the public against the hazards;
- Be able to locate any required additional information in the references provided.

Scheduled duration:

30 minutes, including questions and answers.

General guidance:

Participants may not have sufficient knowledge of how the public is exposed to the contaminants in the legacy sites. It is, therefore, essential to allocate sufficient time for the details of the presentation, as well as for the questions and answers.

LECTURE 5. Existing Exposure Situations**Objectives:**

This presentation provides basic information on the likely situations leading to radiological exposures of the public at legacy uranium mining and milling sites. It is expected that the information provided in the lecture will assist in the participants' understanding of other lectures of the Module dealing with reducing public dose at legacy uranium mining and milling sites.

Upon completion of this lecture, the participants will:

1. Be able to describe potential sources and pathways for exposure at legacy sites,
2. Be able to describe the situations and activities leading to public exposure at legacy sites, and
3. Have an understanding of relative risks associated with these potential exposures.

Scheduled duration:

30 minutes, including questions and answers

General guidance:

Participants may not have any knowledge at all of radiological exposure scenarios or legacy site issues. It is, therefore, essential to allocate sufficient time for the details of the presentation, as well as for the questions and answers.

LECTURE 6. Regulatory Aspects: Authorization and Inspection of Remediation**Objectives:**

This presentation describes how the regulatory body will authorize the remediation activities, and then follow that up with their inspection and verification process. This lecture will connect with the roles and responsibilities of the regulators, and their regulatory requirements as defined by the state/country laws.

At the end of the lecture, the participants should understand:

- (a) How their regulatory requirements have been addressed in their authorization or approvals for the remediation activities; and
- (b) How their regulatory inspections will verify if the safety requirements and conditions for authorization have been met, and what their inspector roles would involve.

Scheduled duration:

30 minutes

Guidance:

Some of the participants at the course may only have a limited knowledge on regulatory oversight roles, authorizations and inspections, especially concerning remediation of legacy uranium mine and mill sites. Some limited knowledge of the subject should be assumed, and the lecture must be presented at a basic level, but be prepared for more detailed questions from some of the more experienced attendees.

LECTURE 7. Developing National Legacy Site Inventory**Objectives:**

This presentation provides basic information on how and why it is important to develop a National Inventory for Legacy Uranium Mining and Milling Sites. It is expected that the information provided in the lecture will assist in the participants' understanding of other lectures of the Module dealing with reducing public dose at legacy uranium mining and milling sites.

Upon completion of this lecture, the participants will:

- a) Be able to describe the reasons for developing and maintaining a Legacy Uranium mining and Milling Sites Inventory,
- b) Have an understanding of the normal components of an inventory of legacy sites
- c) Be able to identify typical sources of information to help develop the inventory of legacy sites

Scheduled duration:

30 minutes, including questions and answers

General guidance:

Participants may not have any knowledge at all of inventories, databases or historic data sources. It is, therefore, essential to allocate sufficient time for the details of the presentation, as well as for the questions and answers.

LECTURE 8. Initial Site Visits**Objectives:**

This presentation provides basic information on the fundamentals of the initial site visits to an identified legacy sites. It is expected that the information provided in the lecture will assist in the participants' understanding of other lectures of the Module dealing with reducing public dose at legacy uranium mining and milling sites.

Upon completion of this lecture, the participants will:

1. Be able to describe how to plan a site visit,
2. Be able to describe potential areas interest and aspects to observe,
3. Be able to identify the basic equipment necessary for an initial site visit, and
4. Understand the important conclusions to be drawn from an initial site visit.

Scheduled duration:

30 minutes, including questions and answers

General guidance:

Participants may not have any knowledge at all of how to conduct site visits or of legacy site issues. It is, therefore, essential to allocate sufficient time for the details of the presentation, as well as for the questions and answers.

LECTURE 9. Overview of site characterization (including non-radiological aspects)**Objectives:**

This presentation deals with the scope and objectives of site characterization. It contains information on how a site characterization assessment should be performed, taking into account radiological and non-radiological aspects, and covers also the contents of a site characterization report.

Upon completion of this lecture, the participants will:

- Understand the purpose of site characterization and its objectives;
- Identify sources of information that are used for the development of the site characterization document;
- Discuss reliability of information;
- Discuss conceptual models and their implication for seeking information in the site characterization process;
- Provide an example Site Characterization Report format.

Scheduled duration:

30 minutes, including questions and answers.

General guidance:

Participants should understand the purpose of site characterization as part of the decision making process for remediation of legacy sites. It is, therefore, essential to allocate sufficient time for the details of the presentation, as well as for the questions and answers.

LECTURE 10. Simple Radiological Survey, Dose Assessments and Data Reduction

Objectives:

The assessment of a legacy site requires that the regulator carries out a preliminary assessment of the site and then performs a planned formal radiation survey and takes representative samples of water, soils and contaminated wastes. This presentation provides an overview of some of the main elements to consider by the regulator when assessing a legacy site, in particular those related with the measurement techniques to be used, and survey strategies to be applied during the simple radiological survey of legacy sites.

At the end of the lecture, the participants should:

1. Describe the main features of the simple radiological survey;
2. Explain the basic characteristics required for measurement equipment;
3. Explain the measuring methods and strategies used in the simple radiological survey;
4. Explain the importance of making a realistic assessment of doses for optimizing available resources;
5. Explain the role of the survey strategy in the reduction of data needed for characterization.

Scheduled duration:

60 minutes

Guidance:

Lecture content and duration have been established on the assumption that the participants of the course have a basic knowledge on the subjects of the lecture. The aim of this presentation is to provide an introductory overview of surveys, dose assessments and data management that should serve as a basis for a better comprehension of the further presentations that follow in the module.

LECTURE 11. Simple Sampling and Analysis Techniques. Data management and evaluation of data

Objectives:

One important component in the process of radiological characterization of legacy sites is the determination in the laboratory of radioactive content of samples collected in the field. Laboratory determinations serve as a complement of field measurements and allow to obtain additional information useful in the decision making process. By this reason it is important to consider, in the initial stages of planning the logistics needed for assessing legacy site, to ensure the availability of technical and materials capabilities for carrying out a proper sampling program and performing the laboratory analysis needed in support of the assessment process. Basic information on sampling strategies and techniques, as well as on analysis techniques and processing of measurement results follow.

At the end of the lecture, the participants should:

- Explain the simple sampling techniques, equipment and strategies applicable to simple radiological surveys of legacy sites;
- Describe the analysis techniques and basic equipment needed for analysing samples collected as part of surveys programs;
- Describe the sequence in processing of data obtained from simple radiological surveys;
- Explain the main elements to be considered for evaluation of data obtained from environmental measurements.

Scheduled duration:

60 minutes

Guidance:

Lecture content and duration have been established on the assumption that the participants of the course have a basic knowledge on the subjects of the lecture. The aim of this presentation is to provide the basic elements to be considered when planning a sampling program followed by laboratory measurements with the purpose of characterizing legacy sites.

LECTURE 12. Prioritization of Sites and Public risks

Objectives:

This presentation deals with the role of prioritization in the decision making process for remediation. It includes information on how to prioritize legacy sites, as well as information of the public risks associated with remediation of legacy sites.

Upon completion of this lecture, the participants will:

- Understand the purpose of the prioritization of legacy sites and its objectives;
- Understand the role of screening and prioritization of legacy sites in the decision making process for remediation on the basis of dose and risk assessment;
- Identify the risks of remediation for the public living close to legacy sites.

Scheduled duration:

60 minutes, including questions and answers.

General guidance:

Participants should understand the purpose of site prioritization as part of the decision making process for remediation of legacy sites. It is, therefore, essential to allocate sufficient time for the details of the presentation, as well as for the questions and answers.

LECTURE 13. Radiation Protection Programmes for Workers

Objectives:

This presentation deals with the remediation related aspects of the radiation protection programme (RPP) for workers involved in the remediation of the legacy sites. It provides a description of the radiological risks to workers involved in remediating legacy sites, a description of a Radiation Protection Program, and information on monitoring of exposure.

Upon completion of this lecture, the participants will:

- Identify the sources of exposure of workers during remediation;
- Understand the need for radiation protection measures for workers during remediation of legacy sites;
- Describe the content of a Radiation Protection Program.

Scheduled duration:

60 minutes, including questions and answers.

General guidance:

Participants should understand the purpose of a RPP in remediation of legacy sites, in order to control and minimize occupational exposure. It is, therefore, essential to allocate sufficient time for the details of the presentation, as well as for the questions and answers.

LECTURE 14. Remediation Objectives and Criteria

Objectives:

This presentation is aimed at explaining the importance of setting in advance of a remediation project sound and achievable remediation objectives and criteria. Ideally these criteria will already exist within the country's regulatory and legal framework but there needs to be consideration of the next intended use of each particular site and the principles of sustainability and optimization. The objectives and criteria are therefore closely linked. Socio-political factors also require consideration as these may also impact upon and drive the remediation criteria that are eventually utilized.

At the end of the lecture, the participants should:

- (a) Understand that environmental remediation is aimed to protect human health and the environment;
- (b) Gain an initial understanding of the types of remediation objectives and criteria that need to be set and achieved in order to adequately protect human health and the environment;
- (c) Become familiar with the principles of practices and intervention, and
- (d) Gain an appreciation about how the approach to remediation can in some instances be optimized.

Scheduled duration:

60 Minutes

Guidance:

Some of the participants on the course may only have a very limited knowledge of the different kinds of mining and milling sites, even in their own country. The course may be undertaking work in the uranium mining arena for the first time. No prior knowledge of the subject should, therefore, be assumed and the lecture must be presented at a basic level.

LECTURE 15. An Overview of Simple Intervention Techniques to Reduce Public Doses (Part 1): Introduction and an Overview to Non-physical Intervention Techniques

Objectives

The objective of this lecture is to provide an overview of the simple non-physical intervention techniques that can be used to reduce public exposure to ionizing radiation from uranium legacy sites.

Lecture Topics

The lecture covers the following topic areas:

- Introduction to Uranium Legacy Sites
- Definition of Remediation and Mitigation
- Overview of Risks to the Public Arising from Legacy Uranium Sites
- Potential Public Exposure Pathways to Radiation from Legacy Sites
- Simple Non-Physical Actions to Reduce Public Doses

The lecture is illustrated with numerous photos taken from the case studies.

Scheduled duration

60 minutes

Guidance to Presenter

This lecture comprises the first part of an overview of simple intervention techniques to reduce public doses from uranium legacy sites. The lecture explores the options available to Member States with limited financial, technical and human resources for intervention at uranium legacy sites.

This lecture provides an introduction to the topic and an overview of non-physical intervention techniques. The second part of this topic which deals with physical intervention techniques is presented in Lecture 18.

The lecture is illustrated with examples from a wide variety of case studies, which are addressed in other lectures.

The lecture examines simple administrative, technical and practical intervention techniques can be used in the interim to reduce the risks to the public from legacy uranium sites.

LECTURE 16. An Overview of Simple Intervention Techniques to Reduce Public Doses (Part 2): Physical Intervention Techniques

Objectives

The objective of this lecture is to provide an overview of simple physical intervention techniques that can be used to reduce public exposures to radiation from uranium legacy sites.

Lecture Topics

The lecture covers the following topic areas:

- Remediation Strategies for Contaminated Materials
- Covering and Containment of Radioactive Materials
- Methods of Sealing Open Mine Workings
- Methods of Moving Solid Materials
- Removing Contaminated Materials from the Legacy Site

The lecture is illustrated with numerous photos taken from the case studies.

Scheduled duration

45-60 minutes

Guidance to Presenter

This lecture comprises the second part of an overview of simple intervention techniques to reduce public doses from uranium legacy sites. This lecture provides an introduction to the topic and an overview of physical intervention techniques.

The lecture is illustrated with examples from a wide variety of case studies, which are addressed in other lectures.

The simple remediation strategies for radioactive materials on a uranium legacy site discussed in this lecture are primarily intended as interim measures until the financial resources for the final remediation and disposal of the contaminated material are available. The lecture examines simple physical intervention techniques that can be used in the interim to reduce the risks to the public from legacy uranium sites.

LECTURE 17. Prevention of Future Legacy Sites

Objectives:

This presentation is aimed at highlighting the importance of preventing future legacy sites. Many legacy sites exist today and are often extremely difficult to manage and remediate because the tailings and rock piles were not adequately engineered or remediated in the past with a long term vision in mind. Nowadays these sites often have no owner, little funding and reside in countries which may not have a well-developed regulatory and statutory regime. The lecture highlights many of the approaches that can be taken throughout the mining lifecycle which should go some way to prevent a site eventually becoming a legacy site that future generations need to resolve.

At the end of the lecture, the participants should:

- (a) Understand why legacy sites exist and the importance of preventing future sites of this nature;
- (b) Learn that the main concern around legacy sites will revolve around contaminated groundwater, tailings and rock piles;
- (c) Learn about the concept of Lifecycle Management and why its implementation can help prevent future legacy situations, and
- (d) Gain an understanding of the different measures that can be taken during the mining lifecycle, which will help reduce the chances of future legacy sites being created.

Scheduled duration:

60 Minutes

Guidance:

Some of the participants on the course may only have a very limited knowledge of the different kinds of mining and milling sites, even in their own country. The course attendees may be undertaking work in the uranium mining arena for the first time. No prior knowledge of the subject should, therefore, be assumed and the lecture must be presented at a basic level.

LECTURE 18. Uranium Legacy Site Case Study: Republic of South Africa and Republic of Mozambique

LECTURE 19. Uranium Legacy Site Case Study: Germany, Canada, United States

LECTURE 20. Uranium Legacy Site Case Study: Australia

LECTURE 21. Uranium Legacy Site Case Study: China and Zambia

Objectives

Each lecture provides an overview of the characteristics of different types of legacy sites in different areas of the world, highlights various issues that are associated with them, and provides a description of remediation activities undertaken in each case.

Scheduled duration

60 minutes – each lecture

CHAPTER 4. EXAMPLE COURSE SCHEDULES

This final chapter presents suggested schedules for the one-week training workshop, in Table 1 on the following page.

The lecture and exercise durations have usually been set at certain number of minutes generally reflecting the number of slides and information to be presented but also having regard to the difficulty of the subject. It is expected that individual lectures will deviate from these preset durations so that some sessions may be shorter or longer than shown in the schedules, depending on the character of the course (National or Regional) and on the prior knowledge of subject matter by the participants. This, combined with the proposed discussion sessions and class exercises, should provide, over the course of a day, adequate time to cover all the material and to have fruitful discussions.

It is extremely important that the lecturers should aim to stimulate debate and discussion amongst the participants and the course includes exercises and question-and-answer sessions for this purpose.

DRAFT AGENDA FOR A ONE-WEEK TRAINING WORKSHOP

Project B.1. Practical Intervention Techniques to Reduce Public Doses at Uranium Mining and Milling Legacy Sites

	Monday	Tuesday	Wednesday	Thursday	Friday
08.30-9.30	Opening statements (IAEA & MS representatives) House Keeping	Development of a national inventory of legacy sites (L-7) (30 minutes)	Exercise 5: Simple gamma radiation dose calculation (60 minutes)	Case study presentation (L-18) (South Africa and Mozambique)	Exercise 6.- Presentation and discussion of the group exercise results by group (cross-cutting review of each groups results)
	Round table introduction (everyone)	Exercise 2: Possible Sources of Resources and Expertise			
9.30-10.30	Workshop overview and introduction (L-1) (30 minutes)	Exercise 3: Stakeholder Engagement and Communication	Exercise 6: Planning initial site visit (60 minutes)	Case study presentation (L-19) (Germany, Canada, USA) (60 minutes)	CONTINUATION
	Introduction to radiation and radiation protection (L-2) (30 minutes)				
10.30-10.45	Break				
10.45-11.45	Historical overview of legacy sites (L-3) (30 minutes)	Exercise 3: Stakeholder Engagement and Communication (continued)	Exercise 7: Field sampling and monitoring equipment (60 minutes)	Case study presentation (L-20) (Australia) (60 minutes)	Exam/test An overview of simple intervention techniques to reduce public doses, Part 1 – non-physical aspects (L-15)
	Risks to the public arising from legacy uranium sites (L-4) (30 minutes)	Initial site visits (L-8) (30 minutes)			
11.45-12.45	Existing exposure situations (L-5) (30 minutes)	Overview of the Site Characterization (L-9) (including non-radiological aspects) (30 minutes)	Prioritisation of sites and public risks (L-12) (60 minutes)	Exercise 4	Workshop wrap-up Workshop recommendations for improvements Closing remarks
	Regulatory aspects: authorization and inspection of remediation (L-6) (30 minutes)				
12.45-14.00	Lunch break				
14.00-15.00	Exercise 1 Pre-Course assignment Member State Reports (10 minutes presentation based on IAEA template) <i>Time slot adjustable to amount of presentations</i>	Simple Radiological Survey, Dose Assessments and Data Reduction (L-10) (60 minutes)	Remediation objectives and criteria (L-14) (60 minutes)	Exercise 5	An overview of simple intervention techniques to reduce public doses, Part 2 – physical aspects (L-16)
15.00-16.00		Simple Sampling and Analysis Techniques (L-11) (60 minutes)	Radiation protection programmes for workers (L-13) (60 minutes)		
16.00-16.15	Break				
16.15-17.15	Continuation of Pre-Course assignment	Exercise 4: Non-radiological issues (60 minutes)	Exercise 3	Exercise 5	Prevention of future legacy sites (L-17)

Additional comments:

- Presenters would preferably be experts with both regulatory and hands on field experience
- MS reports: IAEA would provide a template for the presentations
- Develop Excel spreadsheets for calculations and for pre- and post-course questionnaires
- Participants should bring laptops
- Exam course evaluation: A short multiple choice (20-30 questions) would be of use to focus the attention of the participants during the course.

1. Pre-course assignment,
2. Sources of assistance and expertise,

3. Stakeholder engagement and communications.
4. Non-radiological issues,
5. Simple gamma radiation dose calculation,
6. Planning initial site visit,
7. Field sampling and monitoring equipment,