DMaLSE

Decommissioning Management and Leadership for Safety Education

International Scientific Workshop report

19.-21 June 2024, Université Côte d´Azur

Co-funded by the European Union

UNIVERSITÉ CÔTE D'AZUR

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KIT Karlsruher Institut für Technologie

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Content

DMaLSE Project Presentation

Context

A Major Issue

The DMaLSE project is taking place in a context of a sharp increase in the numbers of nuclear decommissioning projects. Many installations around the world are now reaching the end of their life cycle. The number of D&D projects in nuclear power plants (NPPs) and nuclear research reactors (NRRs) will increase from 50 today to over 400 by 2040. In the coming decade, many emerging countries will begin the process of decommissioning their existing facilities, such as research reactors.

The Complex Nature of D&D Projects

D&D projects for nuclear facilities are particularly complex to manage because of the need to coordinate activities of many stakeholders over very long periods. Regardless of the facility size and nature, these projects must consider the risks associated with nuclear safety and radiation protection, in addition to the conventional risks associated with any deconstruction site.

Management of D&D projects, regardless the nature of the site, poses major challenges in terms of safety, costs, deadlines, quality and social acceptability.

The proliferation of future D&D projects implies a growing need for competent specialists. Experienced project managers will no longer be sufficient to meet this need. The development of D&D competencies of many young project managers will largely be done through training.

Blind Spots in the Existing Training Programs

Most challenges encountered during the D&D projects find their sources in the interaction between technical and organizational aspects of these projects. In recent years, many efforts have been made to help project managers face these challenges. For instance, international standards, directives and good practice guidelines – provided by the IAEA or EURATOM among others – have been developed to enhance safety.

However, the existing training programs mainly address the technical aspects of D&D projects. Also, the various standards and guidelines developed are not sufficient to help the different actors develop the necessary competencies to regulate and manage complex D&D projects.

Objectives

DMaLSE aims to fill the described gap in existing training programs and develop a Master-level (M2) training based on research and experience related to the organisational and managerial aspects of D&D projects of nuclear facilities.

DMaLSE was launched on 01 January 2023 and will be carried out for a period of 48 months. It has two main objectives :

→ Further developing a science-based training on "management and leadership for safety" for future decommissioning project managers and experts.

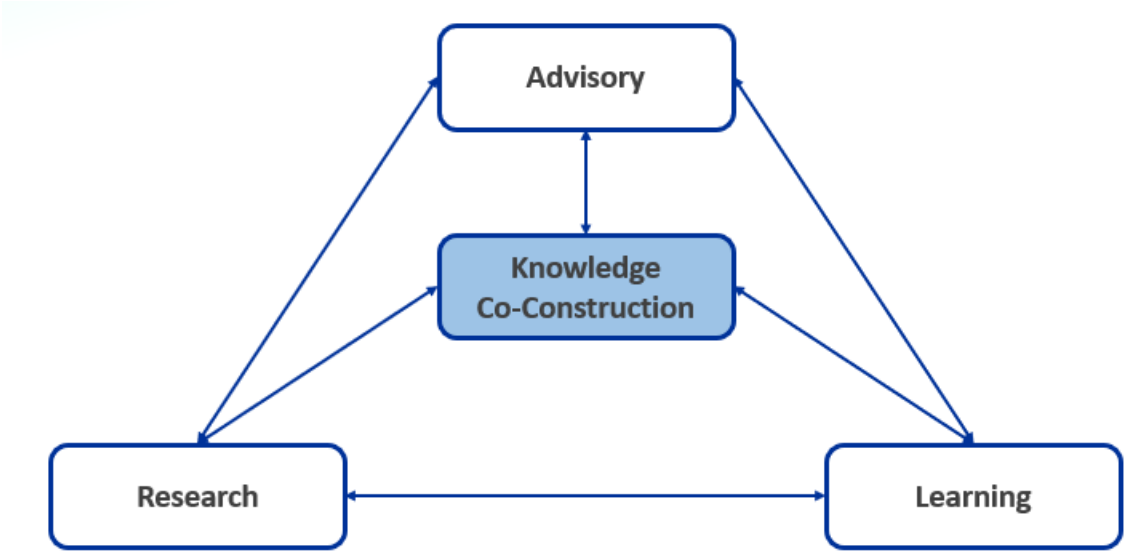
The DMaLSE training will provide nuclear sector actors and regulating institutions with a certified Master's-level university diploma in the field of management and leadership for safety applied to decommissioning projects.

→ Extending knowledge and training to reach wider target groups :

- Through a Bachelor's-level on-site training for operators involved in nuclear decommissioning projects;
- Through the creation of a 30-hour syllabus on management and leadership for safety in NDP to be integrated within a university Master's degree program at a European university.

Methodology

DMaLSE training is based on the CoReAL approach:



→ Knowledge **Co**-creation: Co-create new knowledge through combining empirical and academic knowledge and adopting a pluridisciplinary approach;

- **R**esearch: Favours the co-creation process through scientific methods and validate this new knowledge through participation in academic conferences and scientific publication;
- **A**dvisory: Enrich the co-creation process and diffuse the new knowledge through the participation in professional events and professional publications;
- **L**earning: disseminate the generated new knowledge in the implementation of varied training programmes: Master level programmes, a master module to be integrated in Master University programmes, specific modules for operators, etc.

Consortium

DMaLSE is implemented by 3 high-level academic partners: Université Côte d'Azur, SKEMA Business School, and Karlsruhe Institute for Technologies. The project also benefits from the expertise of Jacques Repussard, president of Institut de Maîtrise des Risques (IMdR), consultant, former director general of Institut de Radioprotection et de Sûreté Nucléaire (IRSN).

The daily management of the project, including its project team, is placed under the responsibility of UniCA.

A Steering Committee – chaired by Jacques Repussard – has been formed to act as Scientific Advisory Board in order to review the quality and relevance of the training programmes and assess the diploma management. It is a consulting and advisory body and is composed of around ten representatives of various stakeholders of the nuclear industry: operators, regulatory bodies, and technical safety organizations.

Co-funded by the European Union's Instrument for International Nuclear Safety Cooperation (INSC) under Grant Contract number INSC/2022/ 432-533, DMaLSE is a continuation of the ELSE (European Leadership for Safety Education) project led by the Université Côte d'Azur. ELSE delivered the first Master-level (M2) university-accredited training based on research in the field of leadership for safety.

Workshop Presentation

Objectives

The workshop aims to establish the syllabus of the DMaLSE training by exploring the state of the art in the field of complex project management, leadership for safety, knowledge management, and ethics & stakeholder engagement and discussing the implications for decommissioning projects. More specifically it aims to:

- → help identify the existing knowledge, challenges and stakeholder expectations related to Management and Leadership in decommissioning projects, to discuss the implications in terms of safety and to help design a training programme for managers and students
- → Forster research collaborations between scientists in different disciplines and nuclear decommissioning experts to guarantee a continual development of knowledge on management and leadership for safety in the context of nuclear decommissioning.

Methodology

The workshop was based on the co-ReAL approach as is the DMaLSE training and was organised around three elements:

1. Roundtable on stakeholder expectations

The workshop started with a roundtable on stakeholder expectations related to training on Management and Leadership for safety in decommissioning projects.

The round table was composed of:

- Xavier Vitart, former Director of the General and Nuclear Inspectorate at CEA;
- Maria Moracho Ramirez, Senior Nuclear Safety Officer, International Atomic Energy Agency (IAEA);
- Tetiana Kilochytska, Decommissioning Specialist, International Atomic Energy Agency (IAEA);
- Jorge Borque Linan, Head of Administration and General Services CN José Cabrera at Enresa (Spanish Radioactive Waste Company).

The participants were asked to give a three-minute answer to the following questions:

1. What are, in your opinion, the most important challenges related to Management and Leadership for safety in decommissioning projects?

2. What are the implications of these challenges in terms of safety?

3. How training can help overcome these challenges?

2. Two-hour group-work sessions on four specific themes + One-hour debriefing session for each

The workshop group work sessions were focussing on the following four themes:

- → Complex Project Management
- → Ethics and Stakeholder Management

→ Knowledge Management

→ Related Challenges to Decommissioning projects: Human Resources, Digital Technologies, Waste Management

The figure below summarizes the different themes and their articulation:

Each group-session was organized as follows:

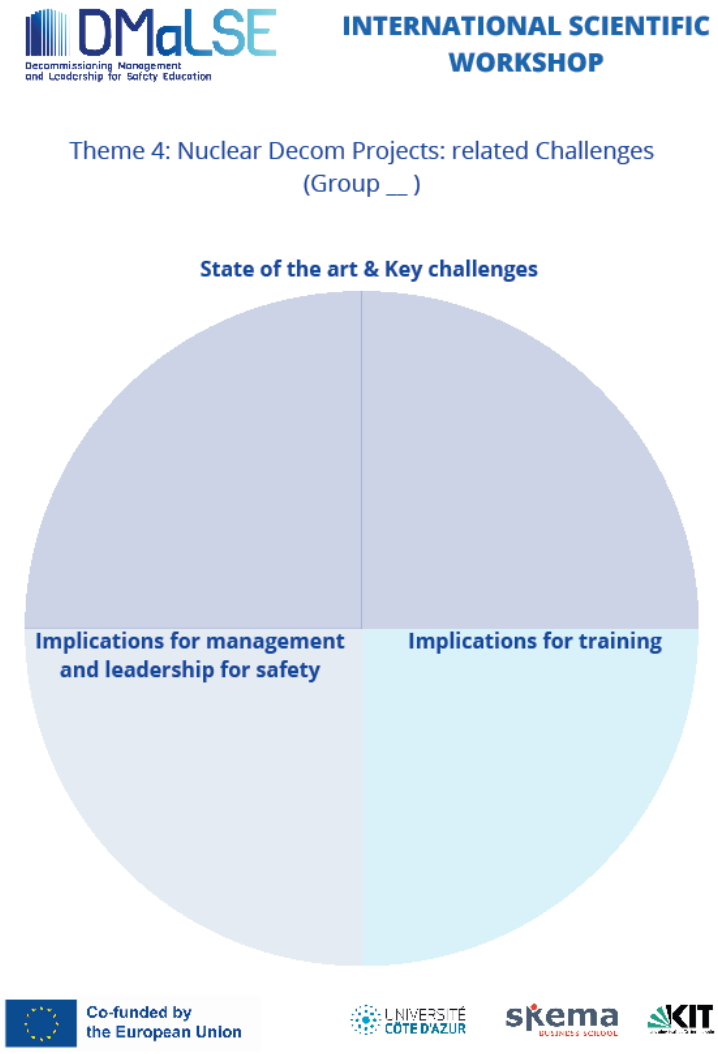
→ A keynote presentation (20 min) on state-of-the-art key challenges relative to a specific theme

→ Group discussion on: state of the art & key challenges (40 min), implications for management and leadership for safety (30 min) & implications for DMaLSE training (30 min)

→ Group discussion synthesis in a poster, which will serve a as basis for the discussion in the 1-hour plenary debriefing session with all 3 groups

Each group-session was moderated by a DMaLSE team member, and a volunteer reported the results of the discussion during the plenary sessions afterwards.

The synthesis of each session was formalized in a poster represented in the following figure:



3. One-hour Plenary session on "Complex Project Management and Resilience"

Andreas Nachbagauer, Deputy Head of Project Management Study Programmes from UAS BFI Vienna held a one-hour plenary session on Complex Project Management and Resilience.

Participants

Invited Guests

Experts (11)

Georg Bacmeister, *Founder of Nabac consulting agency on nuclear waste management issues, Germany*

Franz Borrmann, *Managing Director, Institut für Umwelttechnologie und Strahlenschutz (ius), Germany*

Jörg Feinhals, *CEO of Fachverband für Strahlenschutz, Germany*

Anne-Cécile Jouve, *Deputy Director of Safety Expertise at IRSN, France*

Tetiana Kilochytska, *Decommissioning Specialist, International Atomic Energy Agency (IAEA), Austria*

Jorge Borque Linan, *Head of Administration and General Services CN José Cabrera at Enresa (Spanish Radioactive Waste Company), Spain*

Maria Moracho Ramirez, *Senior Nuclear Safety Officer, International Atomic Energy Agency (IAEA), Austria*

Carla Eibl-Schwäger, *Head of International Relations, Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH, Germany*

Xavier Vitart, *former Director of the General and Nuclear Inspectorate at CEA, France*

Franck Wastin, *Senior Expert, European Commission-Joint Research Centre, Nuclear Decommissioning and Waste Management, JRC Petten, The Netherlands*

Ulrika Wretås, *Project Management Engineer, Uniper Sverige, Sweden*

Academics (9)

François Diaz-Maurin, *Associate editor for nuclear affairs at the Bulletin of the Atomic Scientists*

Martin J. Eppler, *Professor at University of St. Gallen, Switzerland*

Natalia Krasnopevtseva, *Assistant Professor at Université Bretagne Occidentale, France*

Darren A. McCauley, *Professor at Newcastle University, United Kingdom*

Benito Mignacca, *Lecturer, University of Cassino and Southern Lazio, Italy*

Andreas Nachbagauer, *Deputy Head of Project Management Study Programmes, UAS BFI Vienna, Austria (hybrid)*

Lucas Stephane, *Senior Scientist XR, Institute for Energy Technologie (IFE), Halden, Norway*

Kaupo Viitanen, *Senior Scientist, VTT Technical Research Centre of Finland, Finland*

Graham Winch, Professor at *University of Manchester, United Kingdom*

EC Representative

Xavier Pinsolle, *EC Project Manager – Nuclear Safety and Safeguards, DG International Partnerships, Belgium*

DMaLSE Project members

Karima Abidat, *Head for Grant Office & Partnerships at SKEMA Business School, France*

Jenna Barske, *DMaLSE Project Manager, Université Côte d´Azur, France*

Joseph Ridao Cabrerizo, *Research Associate, Karlsruhe Institute of Technology, Germany*

Savéria Cecchi, *Postdoctoral Fellow, Université Côte d'Azur, France*

Pierre Daniel, *Associate Professor, SKEMA Business School, France*

Yoann Guntzburger, *Assistant Professor, SKEMA Business School, France*

Renata Kaminska, *SKEMA Business School, France*

Carla-Olivia Krauß, *Research Associate, Karlsruhe Institute of Technology, Germany*

Jacques Repussard, *former Director General of IRSN, France*

Evelyne Rouby, *Associate Professor, Université Côte d´Azur, France*

Sefana Roulon, *Project Manager, SKEMA Business School, France*

Xhensila Tafaj, *ELSE Project Manager, Université Côte d´Azur, France*

Catherine Thomas, *DMaLSE Project leader, Professor at Université Côte d´Azur, France*

Please refer to Annex A for the attendance List.

Programme

Day 1 – Wednesday 19. June 2024

09h00 – 10h00	Participant registration/Welcome (Welcome Coffee)	MSHS hall
10h00 – 10h15	**Welcome speech** by DMaLSE Project team	MSHS, plenary meeting room
10h15 – 10h30	**Introduction** **Xavier Pinsolle**, *EC Project Manager – Nuclear Safety and Safeguards, DG International Partnerships*	MSHS, plenary meeting room
10h30 – 10h45	**Experience feedback** in leadership for safety/safety leadership training **Maria Moracho Ramirez**, *Senior Nuclear Safety Officer, International Atomic Energy Agency (IAEA)*	MSHS, plenary meeting room
10h45 – 12h00	**Presentation** of **ELSE-DMaLSE-SENSSEtt Projects** **Dr. Yoann Guntzburger**, *DMaLSE project team member, SKEMA Business School*	MSHS, plenary meeting room
12h00 – 12h30	**Workshop Presentation**: Objectives, Methodology, Themes **Prof. Renata Kaminska**, *DMaLSE project team member, SKEMA Business School*	MSHS, plenary meeting room
12h30 – 14h00	Lunch break	MSHS hall
14h00 – 15h30	**Roundtable** "Stakeholder expectations related to Management and Leadership for safety in decommissioning projects"	MSHS, plenary meeting room

	Xavier Vitart, *former Director of the General and Nuclear Inspectorate at CEA* **Maria Moracho Ramirez**, *Senior Nuclear Safety Officer, International Atomic Energy Agency (IAEA)* **Tetiana Kilochytska**, *Decommissioning Specialist, International Atomic Energy Agency (IAEA)* **Jorge Borque Linan**, *Head of Administration and General Services CN José Cabrera at Enresa (Spanish Radioactive Waste Company)*	
15h30 – 17h30	**Group work session** Theme 1 **"Complex Project Management"**	MSHS, working rooms
	Group A. Key-note speaker: **Prof. Graham Winch**, *University of Manchester*	Room 005
	Group B. Key-note speaker: **Dr. Pierre Daniel**, *Associate Professor SKEMA Business School*	Room 128
	Group C. Key-note speaker: **Dr. Benito Mignacca**, *Lecturer, University of Cassino and Southern Lazio (Italy)*	Room 131
17h30 – 17h45	Coffee break	MSHS hall
17h45 – 18h45	**Debriefing session** Theme 1 **"Complex Project Management"**	MSHS, plenary meeting room
19h00 – 21h00	Cocktail	MSHS hall

Day 2 – Thursday 20. June 2024

09h00 – 10h00	**Plenary session "Complex Project Management and Resilience"** **Andreas Nachbagauer**, *Deputy Head of Project Management Study Programmes, UAS BFI Vienna*	MSHS, plenary meeting room hybrid
10h00 – 10h30	Coffee break	MSHS hall
10h30 – 12h30	**Group work session** Theme 2 **"Ethics and Stakeholder Engagement"**	MSHS, working rooms
	Group A. Key-note speaker: **Prof. Darren A. McCauley**, *Newcastle University*	Room 005
	Group B. Key-note speaker: **François Diaz-Maurin**, *Associate editor for nuclear affairs at the Bulletin of the Atomic Scientists*	Room 009
	Group C. Key-note speaker: **Tetiana Kilochytska**, *Decommissioning Specialist, International Atomic Energy Agency (IAEA)*	Room 128
12h30 – 14h30	Lunch	MSHS hall
14h00 – 15h00	**Debriefing session** Theme 2 **"Ethics and Stakeholder Engagement"**	MSHS, plenary meeting room
15h00 – 17h00	**Group work session** Theme 3 **"Knowledge Management"**	MSHS, working rooms
	Group A. Key-note speaker: **Prof. Martin J. Eppler**, *University of St. Gallen*	Room 005
	Group B. Key-note speaker: **Franz Borrmann**, *Managing Director, Institut für Umwelttechnologie und Strahlenschutz (ius)*	Room 009

	Group C. Key-note speaker: **Dr. Franck Wastin**, *Senior Expert, European Commission-Joint Research Centre, Nuclear Decommissioning and Waste Management, JRC Petten, The Netherlands*	Room 128
17h00 – 17h30	Coffee break	MSHS hall
17h30 – 18h30	**Debriefing session** Theme 3 **"Knowledge Management"**	MSHS, plenary meeting room
19h30 – 22h00	Dinner	Restaurant Safari 1 Cr Saleya, 06300 Nice

Day 3 – Friday 21. June 2024

09h00 – 11h00	**Group work session** Theme 4 **"Nuclear Decom Projects: related Challenges"**	MSHS, working rooms
	Group A. Digital technology Key-note speaker: **Dr. Lucas Stephane**, *Senior Scientist XR, Institute for Energy Technologie (IFE), Halden (Norway)*	Room 005
	Group B. Waste management Key-note speaker: **Dr. Jörg Feinhals**, *CEO of Fachverband für Strahlenschutz, Germany*	Room 009
	Group C. Human resources management Key-note speakers: **Jorge Borque Linan**, *Head of Administration and General Services CN José Cabrera at Enresa*	Room 128
11h00 – 11h30	Coffee break	MSHS hall
11h30 – 12h30	**Debriefing session** Theme 4 **"Nuclear Decom Projects: related Challenges"**	MSHS, plenary meeting room
12h30 – 13h00	DMaLSE workshop key takeaways, next steps and concluding remarks	MSHS, plenary meeting room
13h00 – 14h30	Lunch	MSHS hall
	End of the workshop	

Working Groups

Group A	
Darren A. McCauley	*Professor at Newcastle University, United Kingdom*
Graham Winch	*Professor at University of Manchester, United Kingdom*
Martin J. Eppler	*Professor at University of St. Gallen, Switzerland*
Lucas Stephane	*Senior Scientist XR, Institute for Energy Technologies (IFE), Halden, Norway*
Carla-Olivia Krauß	*Research Associate at Karlsruhe Institute of Technology, Germany*

Anne-Cecile Jouve	*Deputy Director of Safety Expertise at IRSN, France*
Xavier Vitart	*former Director of the General and Nuclear Inspectorate at CEA, France*
Group B	
Pierre Daniel	*Associate Professor at SKEMA Business School, France*
François Diaz-Maurin	*Associate editor for nuclear affairs at the Bulletin of the Atomic Scientists*
Franz Borrmann	*Managing Director, Institut für Umwelttechnologie und Strahlenschutz (ius), Germany*
Joerg Feinhals	*CEO of Fachverband für Strahlenschutz, Germany*
Natalia Krasnopevtseva	*Assistant Professor at Université Bretagne Occidentale, France*
Carla Eibl-Schwäger	*Head of International Relations at Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH (ETSON), Germany*
Kaupo Viitanen	*Senior Scientist at VTT Technical Research Centre of Finland, Finland*
Group C	
Ulrika Wretås	*Project Management Engineer, Uniper Sverige, Sweden*
Benito Mignacca	*Lecturer at University of Cassino and Southern Lazio, Italy*
Tetiana Kilochytska	*Decommissioning Specialist at International Atomic Energy Agency (IAEA), Austria*
Franck Wastin	*Senior Expert, European Commission-Joint Research Centre, Nuclear Decommissioning and Waste Management, JRC Petten, The Netherlands*
Jorge Borque Linan	*Head of Administration and General Services CN José Cabrera at Enresa, Spain*
Karima Abidat	*Head for Grant Office & Partnerships at SKEMA Business School, France*
Maria Moracho Ramirez	*Senior Nuclear Safety Officer at International Atomic Energy Agency (IAEA), Austria*
Georg Bacmeister	*Founder of Nabac consulting agency on nuclear waste management issues, Germany*

Results

This section provides a detailed account of the discussions, presentations and group-work held during the workshop. During the event, key sessions included a roundtable on stakeholder expectations, group work sessions on specific themes, and a plenary session on complex project management and resilience. The various discussions that took place during the workshop highlighted essential issues regarding management and leadership for safety. The results of these discussions are summarised in the following sections, presenting the key points and insights from each session. By providing a clear understanding of the challenges and best practices identified, this part of the report aims to lay a solid foundation for the development of the training program designed to enhance management and leadership for safety skills in nuclear decommissioning projects.

Roundtable "Stakeholder Expectations Related to Management and Leadership for Safety in Decommissioning Projects"

Four nuclear decommissioning experts participated in a round table discussion moderated by Pierre Daniel. The discussion centered on stakeholder expectations regarding management and leadership for safety in decommissioning projects. The experts were Xavier Vitart, Maria Moracho Ramirez, Tetiana Kilochytska, and Jorge Borque Linan. The round table addressed three main topics: the challenges of decommissioning projects in nuclear facilities, their implications for safety, and the role of training in overcoming these challenges.

(1) Key Challenges in Nuclear Decommissioning

The roundtable participants identified three primary challenges facing the nuclear decommissioning industry:

→ **Lack of leadership and management skills specific to decommissioning**

- There's a recognised gap between the skillsets of nuclear engineers in operating facilities and the specialised leadership and management skills required for decommissioning.
- Decommissioning demands a project-oriented approach, necessitating a shift in mindset from steady-state operation, which emphasizes stability and routine, to a complex, multi-faceted project involving dynamic adaptability.
- Training programs are essential to bridge this gap and develop leaders who possess both technical expertise and the ability to manage complex decommissioning projects.

→ **Complexity of decommissioning projects**

- Decommissioning projects are inherently complex, involving a wide range of stakeholders with varying priorities, technical challenges, and long-term implications.
- These projects are dynamic and experience deviations over the time, creating a need for adaptable leadership.
- Participants emphasized the need for effective stakeholder management, ensuring alignment and communication across organizations, including the plant operator, contractors, regulatory bodies, and potentially local communities.
- Waste management strategies require careful consideration, ensuring the safe long-term storage and disposal of radioactive materials, as well as addressing environmental compliance concerns.
- Long-term projects, like nuclear decommissioning, involve a significant degree of uncertainty.
- Furthermore, the context in which decommissioning occurs is constantly evolving, encompassing technological, geopolitical, and societal factors. Even safety practices are constantly evolving. These must be considered when developing strategies and addressing challenges.

→ **Time and resource constraints**

- Decommissioning projects are typically very long-term endeavors, requiring substantial financial resources and a consistent supply of specialized labor.
- The pressure to meet deadlines and manage budgets can lead to safety compromises, creating potential shortcuts and risks with long-term consequences.
- A lack of skilled professionals can be a challenge, necessitating the development of methodologies to capture and preserve operational knowledge, as well as attracting and training qualified personnel.
- From a psychological perspective, demotivation and misperceptions about the decommissioning process can be significant challenges.

(2) Implications for Safety

→ A lack of expertise and resources can lead to errors in dismantling, waste management, and environmental protection, increasing the potential for accidents, radioactive releases, and environmental contamination. When failures are reported to the public, the stakeholders' expectations are down. Decommissioning projects are closely scrutinized by the public, and any safety compromises can damage public trust in the nuclear industry.

→ Safety is always evolving; it is in continuous process. The context is very important: technological, geopolitical, social, etc. It is needed to adapt safety to a specific context

and tackle with complexity between stakeholders. There are potential resistances, as acceptance is difficult when there are too many stakeholders.

→ When a country wants to embark on a nuclear program, lots of challenges and their impact on safety need to be studied: social, economic, exposition to radiation, protection of people, etc.

→ Safety in decommissioning is different from operations. In decommissioning transition, there is no nuclear criticality anymore. Some hazards may increase, and we talk about long term safety. Regarding the geological repository, people must think about what the site will look like in hundreds or thousands of years. Transitions of conceptualization of safety must be managed.

(3) Training Solutions

→ Training programs should be tailored specifically for decommissioning, focusing on both technical and managerial aspects of the process.

→ Training should emphasize leadership skills, such as communication, negotiation, risk assessment, and project management, encouraging effective coordination and collaboration among stakeholders.

→ Training programs need to be flexible and adaptable to the evolving needs of the nuclear decommissioning industry, integrating new technologies, regulations, and best practices.

→ Change of mind-set from operations to decommissioning is a great challenge: operation is more routine and stability, whereas decommissioning is modification of routine.

→ Knowledge is needed to develop new skills and training. The knowledge can be found in documents, but how to apply it is more difficult because it means practice. Analysis must be stochastic, systemic. And Experience has to be capitalized.

(4) Additional Key Discussion Points:

→ Participants emphasized the need to view decommissioning projects through a systemic lens, considering the interconnectedness of various aspects, such as waste management, financial resources, stakeholder expectations, and societal context.

→ The roundtable discussed the need to shift perceptions of safety in decommissioning. It is a continuous process requiring constant adaptation and attention to detail throughout the project's lifecycle.

- → Participants acknowledged the need for increased public engagement and stakeholder involvement throughout the decommissioning process to build trust, transparency, and a shared understanding of the challenges involved.
- → Decommissioning projects require comprehensive long-term planning, including financial projections, waste management strategies, and the development of a skilled workforce.

The roundtable concluded that training plays a crucial role in addressing the challenges of decommissioning. By equipping professionals with the necessary technical and management skills, training programs can help ensure safer, more efficient, and more sustainable decommissioning projects.

Group work sessions

The workshop members were divided into three different groups to work on relevant themes related to decommissioning projects. In each group, a key-note speaker gave a presentation related to the theme, which formed the basis for discussion among the group members. The aim of the discussion was to (1) highlight the main elements of the state of the art presented and the main challenges arising from it, (2) identify their implications for management and leadership for safety (3) identify their implications for the training program. Group members were asked to summarize the results of their discussions on a poster as described in the introduction.

These working sessions were followed by a session of collective debriefing with all workshop participants. In the plenary session, each group presented the conclusions of its collective work with the help of the above poster.

Please find here an overview of the discussions that took place in the different working groups and during the final debriefing session.

Complex Project Management (Group-work session 1)

Group A. Key-note speaker: Prof. Graham Winch

(1) Prof. Graham Winch's Presentation

Prof. Graham Winch delivered a presentation focusing on the complexities of managing nuclear decommissioning projects. He introduced the Three Domain Model (3D Model) and the Project Leadership Model (PML) as frameworks for understanding and leading complex projects.

The 3D model includes:

- *Owner domain*: projects are not the core business, but extend the core business and source of capital. Owners do not have project management capabilities; they ensure work is done rather than doing it themselves.
- *Supplier domain*: the realm of contractors, specialist advisors, and technology suppliers, where projects are the core business.
- *Delivery domain*: encompasses infrastructure, new project development, and organisational transformation, often temporary depending on the contract.

Prof. Winch discussed the governance and commercial strategies needed to connect these domains, highlighting leadership theories that include the leader as a warrior, politician, teacher, and problem-solver. He focused on a functional leadership approach, emphasizing what leaders do over who they are (contrary to what is generally done in the project management literature).

The project leadership model (PML) comprises:

- *Enabling dimension*: sensemaking (understanding uncertainty and complexity) and relating (building stakeholder relationships).
- *Action dimension*: projecting (creating a compelling future narrative) and creating (innovating and designing).
- *Synthesis and integration*: judging (using intuition, experience, and values to make decisions).

(2) Working Group Discussion: Key Insights

Challenges:

→ The group identified that complexity in decommissioning projects arises from various factors, including technological, organizational, and human elements. They highlighted the need for a thorough complexity analysis to understand these factors, alongside the uncertainties and dynamic changes that occur over the long timelines typical of such projects.

→ What complexity means and where complexity is observed must be taken into account, as this will influence the identification of the challenges for example, projecting may be difficult because of high level of uncertainties at the beginning of the projects.

→ A significant challenge discussed was the identification of where leadership is needed and how it shifts over time, impacting both safety and the leadership for safety. Reporting dynamics is important.

→ Additionally, cultural differences, particularly the Anglo-American dominance in leadership styles, were noted as important factors to consider.

- → Finally, decommissioning projects are challenging for safety permanently. Introducing the safety dimension into complex project management is therefore crucial and challenging (regarding its three pillars: in-depth defense, questioning attitude, and prudent attitude).

Implications for Management and Leadership for Safety:

- → The discussions underscored the importance of recognizing the shifts in leadership dimensions over time and their impacts on safety and leadership for safety.
- → It was emphasized that at the end of decommissioning projects, leaders should share their experiences and best practices to help shape future project narratives. This sharing is crucial for continuous improvement and learning within the industry.
- → Different important topics to investigate are identified: flexibility/adaptation, understanding the why, trust building, ethics and soft skills.

Implications for the Training Program:

- → The training program should address the two primary models of decommissioning: one where the operator becomes the decommissioner, and another where a different entity takes over the decommissioning process.
- → It should also address the types of stakeholders as well as the types of uncertainties.
- → Managing the paradox between stability and flexibility in leadership was highlighted as a key training focus.
- → The program should also incorporate cultural competence, addressing different safety cultures, regulations, and processes to prepare leaders for working in diverse international contexts.
- → It should also incorporate integrated system management.

Group B. Key-note speaker: Prof. Pierre Daniel

(1) Prof. Pierre Daniel's Presentation

In his presentation on *Complex Project Management: Key Challenges*, Prof. Daniel began by defining a project and explaining the rationale behind Project Management (PM), including the project life cycle: feasibility, planning, implementation, handover, and results. He then explored the concept of complexity, differentiating between structural complexity and dynamic complexity.

Returning to the definition of a project, Prof. Daniel introduced concepts such as modular structure, sub-projects, programs, and the project life cycle. The presentation then addressed

key challenges, including program integration, governance, interface management, and performance.

(2) Working Group Discussion: Key Insights

The discussion group focused on key challenges, their implications for management and leadership in safety, and the subsequent impact on the training program. The following output summarises the key points.

Challenges:

- The group discussed project integration, often referred to in the literature as a significant challenge. One approach to managing this complexity is to break it down into smaller, well-defined subprojects, each with a clear start and end. In many cases, it is more effective to invest in smaller projects, as they tend to be less complicated, better defined, and easier to manage, leading to more successful outcomes. When programs are interconnected, they become part of the same overall project, making it essential to carefully model the program structure.
- The working group agreed that one of the biggest challenges is managing tensions and complex relationships. A key issue is how to reach consensus and establish a balance between interdependencies, which makes finding solutions significantly more difficult. An example of this challenge is maintaining the two distinct cultures of operators and "decommissioners" simultaneously.
- There are many uncertainties, emerging processes, and changing situations that cannot be predicted. Very few NDPs are completed on time and within budget. Therefore, we cannot expect that the end point of an NDP, as envisioned today, will remain the same in the coming years.

Implications for Management and Leadership for Safety:

- An effective leader must be able to navigate complexity and make informed decisions in response to it. The leader needs to understand the "why" behind the situation, present a clear rationale, and propose various courses of action, even while acknowledging that not everything will go as planned. Transparency and confidence should be conveyed, and trust must be built through ethics and strong interpersonal skills.
- Management and leadership for safety are relatively new in decommissioning projects, which are characterized by numerous uncertainties and new challenges. It is important to distinguish between projects with low levels of complexity and decommissioning projects, which involve much higher levels of complexity.

Implications for the Training Program:

- → Students are often educated in the context of contracts, leading them to believe that the way to achieve goals is by simply signing a contract with set requirements. However, they need to be trained to effectively manage changes in those requirements as projects evolve.
- → There is a need to train nuclear engineers in an epistemological framework that includes case studies, descriptions, and other practical examples. The engineers' mindset must evolve, as changes in the context may affect the types and roles of stakeholders, the nature of uncertainties, and other factors.
- → Further implications for training may include integrated management, context-specific considerations, and an emphasis on interdisciplinarity.

Group C. Key-note speaker: Dr. Benito Mignacca

(1) Dr. Benito Mignacca's Presentation

Dr. Benito Mignacca, a researcher specializing in management engineering, presented his work on modularization, modularity, and the modular circular economy. He emphasized that these concepts are often used interchangeably, but they hold distinct meanings, particularly in an academic context.

He began by defining a *module* as a pre-assembled unit that is fabricated off-site and then transported and installed on-site for its final use. He then moved on to *modularization*, which he defined as the process of converting a monolithic facility into smaller, modular units. The key aspect of modularization is the shift in construction activities from the site to the factory.

Dr. Mignacca highlighted the *Yamal liquefied natural gas project* as a successful example of modularization, showcasing its benefits in overcoming challenging site conditions.

Next, he transitioned to *modularity*, emphasizing that it involves not only off-site fabrication but also a reduction in the overall size of the facility. Modules designed according to modularity principles can be readily disassembled and reassembled, making them adaptable and potentially reusable.

Finally, Dr. Mignacca introduced the *modular circular economy*. This concept incorporates the principles of modularity into a circular economy framework, focusing on reusing and recycling components to minimize waste and optimize resource utilization.

(2) Working Group Discussion: Key Insights

Challenges:

- The working group acknowledged the need for robust standardization across various levels, including program, portfolio, and project management. This includes standardizing processes, interfaces, and modules for efficient integration.
- The group highlighted the challenge of transferring knowledge across borders and companies, including the need to overcome barriers posed by differing regulations and industry practices.
- The group recognized that modularity holds significant potential for decommissioning, particularly in the context of small modular reactors (SMRs), which should be designed not only for construction but also for efficient decommissioning.
- The group discussed the challenges of implementing a circular economy approach in decommissioning, including the need to address economic viability, public acceptance, legal frameworks, and maintaining demand for recycled materials.

Implications for Management and Leadership for Safety:

- The group emphasized the need for a flexible and agile management approach in nuclear decommissioning, recognizing that plans may need to be adapted to unexpected challenges.
- The group highlighted the importance of developing problem-solving skills among professionals. As not all scenarios can be anticipated, the ability to adapt and find solutions to unforeseen challenges is crucial.
- The group discussed the importance of fostering a strong safety culture while adhering to strict safety standards. It was acknowledged that the emphasis should be on the overall safety culture rather than merely complying with regulations.

Implications for the Training Program

- The training should integrate elements of project management, leadership, and safety, recognizing that these areas are interconnected and essential for success.
- The training curriculum should incorporate strategies for managing complex problems, fostering a problem-solving mindset among professionals.
- The training program should encourage a multidisciplinary approach, emphasizing the importance of communication and collaboration between diverse teams.
- The training should address the need for standardized procedures and processes, while also recognizing that some aspects may require bespoke solutions.

- → The training should incorporate elements of change management to prepare professionals for adapting to evolving technologies and approaches within the decommissioning context.
- → The training should provide a deep understanding of the complexity of nuclear decommissioning projects, including safety, risk, and project management. It should emphasize the importance of a sensemaking approach, enabling professionals to navigate and manage complex scenarios.
- → The training program should be structured with a graded approach, moving from foundational nuclear principles to specific decommissioning operations.

The working group concluded that the concepts of modularization, modularity, and the modular circular economy showed potential interesting aspects for nuclear decommissioning projects. However, addressing the challenges associated with their implementation is critical for successful and efficient application and will therefore not be at the heart of the training.

Debriefing of the group work session

The debriefing session served to consolidate the main results obtained by the working groups. Here are the main points that emerged:

- → ***Complexity***: all three groups acknowledged the inherent complexity of nuclear decommissioning projects, necessitating a nuanced understanding of various technical, managerial, and regulatory aspects.
- → ***Modularity***: the groups recognized the potential of modularization and modularity as efficient tools for managing decommissioning projects. This includes a shift towards "decommissioning by design" in the case of SMRs, and the application of circular economy principles to promote reuse and minimize waste.
- → ***Standardisation and flexibility***: the groups stressed the importance of standardizing processes and procedures, both for technical aspects and project management. They also acknowledged the need for flexibility to accommodate unique site-specific requirements.
- → ***Leadership for safety***: the groups emphasized the crucial role of leadership in fostering a strong safety culture and managing risk. They recognized the importance of communication, collaboration, and a proactive approach to problem-solving.
- → ***Training needs***: the groups identified a range of training needs for nuclear decommissioning professionals, including:
    - Interdisciplinary knowledge: professionals should have a strong understanding of project management, leadership, and safety principles.

- Problem management: training should equip professionals with the skills to identify, analyze, and manage complex problems.
- Adaptability and flexibility: professionals should be trained to adapt to changing circumstances and readily address unexpected challenges.
- Understanding complexity: the training should emphasize the importance of a "sensemaking" approach, enabling professionals to navigate and manage complex projects and situations effectively.

The debriefing session highlighted the need for a comprehensive and flexible training program that adequately addresses the complex challenges of nuclear decommissioning. The program should focus on the practical aspects of project management, leadership, and safety, incorporating insights from the circular economy and promoting interdisciplinary collaboration. By fostering a strong understanding of complexity, change management, and knowledge sharing, the training program can equip professionals with the necessary skills to successfully manage decommissioning projects and contribute to a safe and sustainable future for the nuclear industry.

Plenary session "Complex Project Management and Resilience"

(1) Prof. Andreas Nachbagauer's presentation

Prof. Andreas Nachbagauer's presentation focused on three key areas:

→ **Complexity of decommissioning projects**

The presentation emphasized that decommissioning projects are not simply scaled-down operations but present unique challenges due to their long-term nature, multiple stakeholders, and dynamic environments. Prof. Andreas Nachbagauer argued for a mindset shift from operational thinking to a more comprehensive, project-oriented approach. He also highlighted the critical distinction between structural complexity and dynamic complexity, both of which introduce unexpected and unpredictable changes. These complexities are characterized by two dimensions: the temporal and the content-related. As a result, managing surprises and unpredictable events in such turbulent fields requires both an understanding of complexity and the ability to draw on past experiences. This leads to two key questions: "Can we plan for complexity and resilience?" and "Can we prepare for complexity and resilience?"

→ **Importance of experience over expertise**

While technical expertise is important, the researcher emphasized that experience plays a crucial role in navigating the complexities of decommissioning projects. The presenter highlighted the need for professionals who can adapt to changing situations and use

experience-based learning to make informed decisions, rather than relying solely on pre-determined plans. Consequently, fostering learning is essential, particularly abstract learning (i.e., learning how to implement flexible rules to manage unexpected situations). Additionally, it is important to promote learning that focuses on the various elements that shape the mindset, such as patterns of action.

→ **The challenge of uncertainty**

Decommissioning projects are characterized by inherent uncertainties, with risks and unforeseen events likely to arise over the extended duration of the project. Prof. Andreas Nachbagauer emphasized the importance of:

- **Adaptability:** The ability to adjust plans and strategies to unforeseen situations. While planning is necessary, the planning process itself is more important than the final plan. The plan serves to establish a shared vision of the project, fostering a collective understanding and helping to focus attention on key aspects.
- **Resilience:** The organization and its personnel must be resilient, capable of responding effectively to challenges while maintaining safety standards. Resilience should be cultivated at various levels: organizational, team, and individual, as well as at the intersections of these levels.
- **Communication:** Clear and effective communication among stakeholders is crucial for managing uncertainties and addressing unexpected situations.

(2) Insights and Key Take Aways from the Discussion

The discussion following Prof. Andreas Nachbagauer's presentation provided valuable insights into the challenges and opportunities of managing these complex projects. Below is a compilation of the key takeaways:

Key Themes from the Discussion

→ **Systemic Approach:** Participants emphasized the need for a systemic approach to decommissioning, recognizing the interconnectedness of waste management, financial resources, stakeholder expectations, and the evolving social context.

→ **Collaborative Culture:** A collaborative culture, characterized by open communication, trust, and the valuing of diverse perspectives, was identified as essential for successful decommissioning.

→ **Experience-based Learning:** Participants highlighted the importance of experience-based learning, particularly in responding to unexpected events. This includes fostering

a culture of continuous learning and knowledge transfer to inform future decisions, as well as addressing the challenge of developing effective learning heuristics.

→ **Long-term Planning:** The long-term nature of decommissioning projects requires long-term financial planning, sustainable waste management strategies, and the development of a skilled workforce.

Insights from the Discussion:

→ Participants explored the complexities of socio-technical systems, emphasizing the importance of understanding the interactions between human factors, organizational structures, and technical aspects. Prof. Andreas Nachbagauer highlighted the need for consistency across all levels and the potential for shaping the environment to positively influence these interactions.

→ The discussion also addressed the limitations of traditional crisis planning, stressing that reliance on pre-established plans can be counterproductive in complex situations. Prof. Nachbagauer underscored the importance of "conceptual slack" — the ability to adapt and improvise during a crisis.

→ Participants recognized the value of simple rules and heuristics in navigating complex situations, acknowledging that these tools are grounded in experience and that there must be a balance between speed and accuracy.

→ Finally, the discussions concluded that decommissioning projects present a unique set of challenges requiring specialized skills, a flexible mindset, and a long-term perspective. Effective training programs are essential for equipping professionals with the technical expertise and leadership skills needed to navigate these complexities. A systemic approach that embraces uncertainty, fosters collaboration, and promotes continuous learning is critical to ensuring the safety and success of decommissioning projects. Overall, the discussion emphasized the need to embrace complexity, encourage collaboration, and remain adaptable to changing circumstances in the field of decommissioning.

Ethics and Stakeholder Engagement (Group-work session 2)

Group A. Key-note speaker: Prof. Darren A. McCauley

(1) Prof. Darren A. McCauley's presentation

Prof. McCauley's presentation focused on the importance of understanding ethics and stakeholder engagement in the context of decommissioning nuclear installations. He argued

that decommissioning projects present unique challenges compared to new nuclear builds, especially in relation to stakeholder engagement. He highlighted the following key points:

→ **The challenge of decommissioning and stakeholder engagement**

Prof. McCauley stressed that decommissioning is inherently more complex and challenging than building new nuclear power plants. It's less about excitement and more about managing the uncertainties and legacies of past decisions. He also emphasized that building and maintaining trust with stakeholders is essential to successfully navigate the ethical and practical difficulties inherent in decommissioning. Furthermore, decommissioning projects are often met with a lack of public excitement. This makes building buy-in and positive engagement much harder than with new builds, which often carry a promise of progress and economic benefits.

→ **Expanding the definition of stakeholders**

Prof. McCauley challenged the traditional view of stakeholders in decommissioning, arguing it often focuses too narrowly on those directly involved in the technical and operational aspects. He suggested embracing broader definitions, incorporating “communities of interest” (those with a vested interest in the project due to environmental, health, or societal impacts) and “communities of responsibility” (those who will be affected by long-term consequences, including future generations). He highlighted the particular importance of considering future generations in the stakeholder landscape, as they will bear the long-term consequences of decommissioning decisions.

→ **Ethics: beyond a tick-Box exercise**

Prof. McCauley challenged the tendency to approach ethics as a simple compliance requirement. He argued for a more proactive and transformative approach to ethical considerations, one that goes beyond preventing harm and focuses on creating a positive legacy for the future. He stressed that embedding ethical considerations is essential for building trust and facilitating meaningful engagement with stakeholders. He also emphasized that ethical considerations in decommissioning can drive policy and regulatory changes, ensuring greater accountability and sustainable practices.

→ **Building trust and long-term relationships**

Prof. McCauley emphasized the need to build and nurture long-term relationships with stakeholders in the decommissioning process. This requires ongoing communication, transparency, and a commitment to understanding and addressing their concerns. He highlighted the importance of clear and transparent communication as a foundation for building trust. Furthermore, he cautioned against viewing stakeholder engagement as a purely public relations strategy. Real engagement requires genuine effort to understand and address the needs and concerns of diverse stakeholder groups.

→ **The role of ethics in management and leadership for safety**

Prof. McCauley emphasized that management and leadership for safety in decommissioning requires a deep understanding of ethical considerations, a commitment to transparency, and a willingness to engage with the full spectrum of stakeholders. He suggested that safety

considerations should extend beyond the immediate workplace and encompass long-term environmental and social impacts. Finally, he indicated that management for safety is evolving to incorporate more ethical dimensions, responding to the changing needs of society and the increasing awareness of the environmental and social consequences of decommissioning.

To stimulate discussion, Prof. McCauley posed the following question to the group: "How can we better understand the role of ethics and stakeholder engagement in decommissioning?"

(2) Working Group Discussion: Key Insights

The discussion centered around the following key challenges, their implications for management and leadership for safety, and the subsequent implications for the training program:

Challenges:

- → The discussion acknowledged the complexity of defining stakeholders in decommissioning projects. Current approaches often rely on narrow definitions that focus on technical and operational aspects, neglecting broader implications. Participants suggested exploring alternative frameworks to better capture the full spectrum of stakeholders. Above all, stakeholders must be considered as subjects.
- → The discussion highlighted the potential disconnect between procedural fairness in decommissioning processes and public perception of those processes. Participants emphasized the need to ensure not only procedural justice but also distributional justice, recognizing the long-term impacts of decommissioning projects and addressing concerns of affected communities.
- → The importance of trust in navigating ethical considerations and achieving successful stakeholder engagement was emphasized. Participants discussed the necessity for proactive communication, transparency, and building long-term relationships with stakeholders, particularly in light of a history of mistrust in the nuclear industry.
- → The discussion highlighted the tendency to prioritize prohibitive ethics (i.e., preventing harm) rather than transformative ethics (i.e., positive action for the future). Participants argued that a more holistic approach to ethical considerations is needed in decommissioning, considering long-term environmental and societal impacts.

Implications for Management and Leadership for Safety:

- → Leaders need to adopt an ethically-driven approach, acknowledging the broader stakeholder landscape and considering the long-term impacts of decommissioning decisions. This requires a shift from purely technical and operational leadership to a more inclusive and ethically-informed approach.
- → Effective management and leadership for safety in decommissioning necessitate building and maintaining trust with stakeholders through clear communication, transparency, and proactive engagement.

- → Management for safety should embrace long-term perspectives, fostering continuous dialogue and collaboration with stakeholders throughout the decommissioning process.
- → *Integrating ethical considerations in decision-making*: management for safety processes need to explicitly integrate ethical considerations, moving beyond technical compliance to embrace broader social and environmental responsibilities.

Implications for the Training Program:

- → The training program should equip future leaders with a comprehensive understanding of stakeholder engagement in decommissioning, exploring various frameworks and approaches (e.g., mapping technique), and promoting a broader definition of stakeholders.
- → The training program should emphasize the importance of ethical considerations in leadership for safety and equip future leaders with the skills to navigate complex ethical dilemmas, build trust, and promote fairness in stakeholder engagement.
- → The training program should focus on developing strong communication and relationship-building skills to enable leaders to effectively engage with diverse stakeholders and build long-term relationships.
- → The training program should incorporate real-world case studies and simulations to provide practical experience in navigating ethical dilemmas and applying stakeholder engagement techniques in decommissioning contexts.

Group B. Key-note speaker: Dr. François Diaz-Maurin

(1) Dr. François Diaz-Maurin's Presentation

Dr. Francois Diaz-Maurin presented *Ethics & stakeholder engagement in nuclear decommissioning*. The presentation started with the seven characteristics of complex socio-technical problems, considering decommissioning as a complex socio-technical problem itself. Following that, Dr. Francois Diaz-Maurin addressed ethics in engineering, connecting ethics with radiological risk in its different forms and governance. Then, the four objectives of stakeholder management were listed and explained. In the last part, Dr. Francois Diaz Maurin presented the Socio-technical multi-criteria evaluation (STMCE): definition – what it is, and how it works. The management of spent nuclear fuel in the U.S. was shown as example. Finally, desirable methods, and potential applications of STMCE were listed and explained in a conclusion.

(2) Working Group Discussion: Key Insights

The outputs of the discussion group regarding the challenges, implication for Management and Leadership for Safety, as well as for the training program, are presented here below:

Challenges:

→ The working group agreed that social acceptance is essential to build trust. Trust is a process that can contribute to giving sense to safety. There is a gap between nuclear and other communities, so communication on risk perception must be strengthened to reinforce acceptance. How to perceive safety in the long term is very important and must be integrated into the decision-making process with the stakeholders. The STMCE (Socio-Technical Multi-Criteria Evaluation) is a very good way to progress in that way.

→ The participants of the session also emphasized that stakeholders must be identified, and it is needed to obtain willingness to participate. Rebuilding trust - create, manage... - is a key challenge.

→ The group acknowledged that time is needed for this engagement; people need to recover the sense of control. For that, it is needed to deal with power relations and manage the "irrational" among other challenges. This must be done in a context-dependent process.

Implications for Management and Leadership for Safety:

→ According to the participants, the role of Leadership may be strengthened by embedding ethics in the process of management.

- It was also suggested during the group discussion, that acknowledging and understanding different stakeholders and their perspectives may give a sense to safety / risk management. Indeed, safety and risks perceptions are social constructs.

Implications for the Training Program:

→ The working group identified the need for training that can provide awareness of the decommissioning process to the participants. For that, tools are needed to support and structure the training.

→ The training should identify a general pattern while considering local specificities. Regarding pedagogy, role play and face-to-face are suggested.

→ The audience of the training must be targeted, risk perception and communication must be clear.

Group C. Key-note speaker: Tetiana Kilochytska

(1) Tetiana Kilochytska's Presentation

Tetiana Kilochytska's presentation explored the ethical considerations and stakeholder engagement essential for the successful decommissioning of nuclear facilities. Drawing on the IAEA's fundamental safety principles and standards, she emphasized the ethical foundations

necessary for radiological protection. These principles, which require thorough economic and social planning, are pivotal for building public trust in the nuclear sector.

The presenter highlighted the critical role of stakeholder engagement in decommissioning, referencing various IAEA safety standards and supporting publications that compile international experiences, principles, methods, and lessons learned. She emphasized that stakeholder involvement is embedded within IAEA requirements and that successful decommissioning relies on the active participation of interested parties.

Mrs. Kilochytska's presentation included practical examples of stakeholder engagement from international projects, such as the decommissioning and long-term closure of the Sandy Ridge Project in Australia and the Dounreay site in the UK. These cases underscored the need for clear communication plans, continuous stakeholder involvement, and socioeconomic development strategies post-decommissioning. Mrs. Kilochytska also addressed the financial aspects of decommissioning, emphasizing the importance of accurate cost estimation, secure funding, and financial management throughout the project lifecycle.

In conclusion, Tetiana Kilochytska stressed that a deep understanding of ethics is essential for effective stakeholder engagement. Leaders in decommissioning projects need to be well-versed in the ethical, cultural, and communicative aspects of their roles to build and maintain trust with stakeholders.

(2) Working Group Discussion: Key Insights

Challenges:

- → A primary challenge is understanding and managing the complexity of ethical considerations in a dynamic and multicultural environment. Ethics is not a fixed standard but evolves over time and varies across cultures. This variability necessitates finding common ground while respecting the unique values and norms of different stakeholders.
- → Another challenge is ensuring effective communication. Stakeholders must be engaged in a manner that considers their specific contexts, which requires a deep understanding of their backgrounds, expectations, and concerns. The ability to reset and re-establish communication if initial efforts fail is also crucial.
- → The group highlighted the difficulty in communicating ethical standards and cultural values to a level that is universally accepted, emphasizing the importance of prioritizing messages that reflect core values, principles, and safety standards.

Implications for Management and Leadership for Safety:

- → The discussion underscored the need for an ethical foundation in problem-solving within decommissioning projects. While IAEA standards provide a framework, they are

not exhaustive. The integration of ethics, cultural understanding, and practical experience is essential for comprehensive stakeholder engagement.

→ Leaders must be prepared to manage communication effectively during crises, whether political, financial, or technical. This involves not only reacting to crises but also proactively fostering an environment of trust and openness. Including participants from various sectors, such as regulators, license holders, and suppliers, in communication and decision-making processes is vital for a holistic approach to safety and leadership.

Implications for the Training Program:

→ Training programs must emphasize the importance of ethics in stakeholder engagement, preparing future leaders to be open-minded and adaptable. Trainees should learn to manage crises across different dimensions, including political, financial, and technical aspects. An understanding of the basics of communication and the ability to detect weak signals are critical skills that need to be developed.

→ Practical training sessions, such as simulations and workshops, are essential for preparing leaders to handle real-world scenarios. This training should include tools for analyzing the context and developing effective communication plans and stakeholder engagement strategies. By focusing on these areas, the training program can ensure that leaders are well-equipped to navigate the complexities of decommissioning projects, maintain safety, and build lasting trust with stakeholders.

Debriefing of the group work session

The discussion that followed the group session 2 was very rich. Here are the various points raised:

→ The group acknowledged the difficulty in identifying all relevant stakeholders for decommissioning projects, particularly given the long timelines and potential impact on various actors.

→ The group emphasised the importance of stakeholder mapping as a starting point for engagement. However, they stressed that mapping alone is insufficient and requires further considerations such as engagement timelines and the need to go beyond merely identifying stakeholders.

→ Eliciting different notions of fairness (procedural fairness, recognition fairness, and distributive fairness) was deemed crucial. The group emphasized the importance of understanding the various rationalities that inform stakeholder perspectives, particularly when it comes to safety and risk perception. A procedural approach to stakeholder engagement, which involves engaging with stakeholders at the right time in the right way, is essential but should be combined with a deeper understanding of the ethical considerations involved.

- Trust must be built and considered as a process of engaging with a wide range of stakeholders.
- The length of decommissioning projects poses a significant challenge for stakeholder engagement, and the group highlighted the importance of managing expectations and communicating clearly throughout the process.
- The group emphasized the need to prepare leaders to deal with irrationality and emotional responses from stakeholders, particularly in situations where there is a lack of understanding or trust.
- Ethics can be used as a standard for problem-solving and decision-making in decommissioning projects.
- The importance of prioritizing messages and communicating effectively based on stakeholder needs and perspectives was discussed.
- The group stressed that leaders should be actively engaged in the field and not solely rely on office-based communication.
- The need to engage with anti-nuclear stakeholders and understand their concerns was highlighted.
- The importance of identifying patterns in stakeholder engagement and applying these patterns across different projects and contexts was stressed.
- The group acknowledged the significance of institutional contacts and their potential for influencing stakeholder engagement.
- The importance of maintaining a positive mindset and framing decommissioning projects in a way that acknowledges the potential benefits was emphasized.
- The group discussed the applicability of stakeholder engagement strategies used in other sectors, such as the development of vaccines.
- The group discussed the importance of engaging with regulators early in the process, rather than seeing them as an external body that only needs to be notified after decisions have been made.
- The group discussed the importance of giving stakeholders a sense of control over the decommissioning process. This can be achieved through transparent communication, clear explanations of risks and benefits, and opportunities for input and feedback.
- The group emphasized the importance of engaging with “silent stakeholders” who may not be actively vocal but are still impacted by the decommissioning process.
- The discussion identified some interesting ideas for the training program:

- The group recommended incorporating role-playing exercises into the training program to help students understand the perspectives of different stakeholders.
- The training program should go beyond understanding safety to include the aspect of giving sense to safety for the different stakeholders involved.
- Safety must be understood as a social construct rather than a purely technical issue. This understanding requires training on the ethical dimensions of safety and the influence of perception on safety outcomes.
- The training program should incorporate stakeholder mapping, stakeholder involvement roadmap development, and an understanding of stakeholders as human beings with complex interests, concerns, and fears.
- Training should include modules on effective communication techniques, including how to adapt communication styles to different audiences and how to build trust and rapport with stakeholders

Knowledge Management (Group-work session 3)

Group A. Key-note speaker: Prof. Martin J. Eppler

(1) Prof. Martin J. Eppler's Presentation

Prof. Eppler's highlighted the unique challenges associated with nuclear decommissioning project, emphasizing the need for careful knowledge capture, management, and sharing to ensure safety and avoid potential pitfalls. He presented four practices that he believes are useful for effective knowledge management in a nuclear decommissioning project:

→ **Knowledge mapping**

Prof. Eppler highlighted the importance of mapping out the knowledge landscape of an organization, identifying experts, key concepts, tools, and potential knowledge gaps. He provided examples of knowledge maps from various industries, emphasizing their value in visualizing the organization's intellectual capital. This practice also helps address the "knowledge illusion" or Dunning-Kruger effect, where individuals overestimate their own knowledge and expertise.

→ **Knowledge sharing**

Prof. Eppler emphasized the challenge of effectively sharing knowledge within an organization, particularly in the complex and time-sensitive environment of decommissioning. He promoted the use of simple and accessible formats, including visual tools like message maps and quad charts, to facilitate knowledge transfer and engagement.

→ **Lessons learned**

He discussed the importance of capturing and analyzing lessons learned from past projects and events, both successes and failures. He argued for a structured and continuous process of reviewing and documenting these learnings, using visual tools and engaging stakeholders to ensure a robust knowledge base.

→ **Knowledge networking**

Prof. Eppler stressed the need to build a strong knowledge network within an organization, fostering collaboration and communication among individuals and teams. He presented examples of large group methods like World Cafés and Open Space events to facilitate knowledge sharing, breaking down silos and fostering a sense of community.

Finally, Prof. Eppler emphasized the importance of addressing the "Curse of Knowledge," a cognitive bias where individuals assume others possess the same knowledge and understanding. He suggested visual tools and collaborative techniques to overcome this challenge and enhance effective knowledge transfer.

(2) Working Group Discussion: Key Insights

The group discussion is built on Prof. Eppler's presentation, exploring the practical application of knowledge management principles in the decommissioning context. The following key points emerged, outlining the challenges, their implications for management and leadership for safety, and the subsequent implications for the training program:

Challenges:

- → The group recognized the significant volume of knowledge generated throughout a decommissioning project, spanning multiple phases and involving diverse stakeholders. The challenge lies in efficiently capturing, organizing, and utilizing this information for ongoing decision-making.
- → Participants acknowledged the need to integrate physical knowledge (related to the nuclear installation and its operation) with social knowledge (perceptions, concerns, and experiences of stakeholders) for effective decision-making. This requires a multi-disciplinary approach to knowledge management.
- → The group emphasized the need for a continuously updated and dynamic knowledge base to adapt to changing circumstances and ensure that learnings from past events are readily available to guide future decisions.
- → The discussion highlighted the importance of recognizing and integrating both formal knowledge (documented procedures and manuals) and informal knowledge (practical expertise and tacit knowledge) for successful knowledge management.

- → Participants highlighted the difficulty of engaging with diverse stakeholders, particularly those who may hold conflicting views on safety and decommissioning practices.

Implications for Management and Leadership for Safety:

- → Effective management and leadership for safety in decommissioning require fostering a culture that embraces continuous learning, actively seeks out lessons learned, and utilizes them to improve decision-making and enhance safety practices.
- → Leaders need to champion the use of visual tools and collaborative methods to facilitate knowledge sharing and ensure that knowledge is accessible and understandable to all stakeholders.
- → Leaders need to actively engage with all stakeholders, understanding their perspectives, concerns, and needs, to build trust and facilitate informed decision-making.
- → Management for safety in decommissioning necessitates a flexible and dynamic approach, combining technical and social perspectives to integrate all relevant knowledge sources.

Implications for the Training Program:

- → The training program should include practical training in knowledge management techniques, equipping future leaders with the skills to map knowledge, share information effectively, and utilize lessons learned.
- → The program should highlight the crucial role of stakeholder engagement in knowledge management, teaching future leaders how to effectively interact with diverse groups and understand their perspectives.
- → Training should encourage collaboration and communication among different disciplines to facilitate a more holistic approach to knowledge management.
- → The program should include practical case studies and simulations to illustrate the application of knowledge management principles in decommissioning projects and to provide opportunities to practice these skills.

Group B. Key-note speaker: Franz Borrmann

(1) Franz Borrmann's Presentation

Mr. Borrmann's presentation, titled **"Knowledge Management about and for Decommissioning"**, began with a definition of knowledge and its three types: explicit, implicit, and tacit. He then discussed Knowledge Management (KM) and its connection to Safety Management. Mr. Borrmann outlined the various elements of knowledge essential for decommissioning, spanning past, present, and future insights. A comparison between

Operation and Decommissioning in the nuclear field followed, focusing on KM needs for Decommissioning and Environmental Remediation (Decom & ER) — specifically, agility, timescales, and effective knowledge transfer. Mr. Borrmann also explained the importance of critical knowledge, taxonomies, ontologies, and SKOS, referencing the PLEIADES project (Platform based on Emerging and Interoperable Applications for enhanced Decommissioning processes - https://pleiades-platform.eu/) as an example of ontology in action.

The presentation concluded with insights on agile knowledge management and the role of Artificial Intelligence (AI) in enhancing these processes.

(2) Working Group Discussion: Key Insights

The participants in the discussion group highlighted the following key points regarding the challenges, management and leadership implications for safety, and training program requirements:

Challenges:

- The discussion group identified the integration of different types of knowledge—explicit, implicit, tacit, and agile—within a management system (Integrated Management System, IMS) as a core challenge. This integration, facilitated by data science, must encompass areas such as Project Management, Data Management, Knowledge Management, and Quality Management, with robustness, reliability, and accuracy as essential elements.
- The participants agreed that clear information and effective knowledge sharing among the various stakeholders in New Development Projects (NDPs) is essential. Sensitive data must be managed appropriately regarding Intellectual Property and security to prevent excessive caution or "paranoia."
- The participants also identified intergenerational knowledge sharing over the medium to long term as a key challenge.

Implications for Management and Leadership for Safety:

- Participants highlighted the need for a strong safety culture, emphasizing that safety should be integral to leadership. This safety culture must be reinforced by critical knowledge that meets the needs of stakeholders.
- The participants also underscored the importance of fostering knowledge networks at an international level as essential for effective management and leadership in safety. They noted that approaches to Knowledge Management vary, influenced by cultural factors and other considerations.

Implications for the Training Program:

- → The training program should provide an overview of the potential and limitations of using data science and Artificial Intelligence (AI) in management tools.
- → Participants also agreed that the program should reinforce both safety culture and knowledge culture, emphasizing the identification and preservation of critical knowledge. Additionally, training in Knowledge Management should address its limitations, including uncertainties and data accuracy, underscoring the importance of using data responsibly.

Group C. Key-note speaker: Dr. Franck Wastin

(1) Dr. Franck Wastin's Presentation

Dr. Franck Wastin, from the EC Joint Research Center (JRC), began by outlining the responsibilities, roles, and sites of the JRC, highlighting the complexities involved in managing knowledge within such a multifaceted organization. He explained that the JRC does not "own" knowledge but rather acts as a broker, facilitating the extraction, filtering, and dissemination of information to support EU policymaking.

Dr. Franck Wastin emphasised the challenge of managing knowledge, especially given the diverse and complex nature of the JRC's operations, which span across different sites with varying nuclear policies, legislation, and types of infrastructure. He discussed the intricacies involved in knowledge management, from acquiring and categorising knowledge inputs to storing, developing, sharing, and improving them. Key points included the importance of creating a culture that encourages knowledge sharing, using effective tools, and organising events to disseminate knowledge. He also stressed the need for a system that can effectively archive and manage electronic data to ensure knowledge is accessible when needed.

(2) Working Group Discussion: Key Insights

Challenges:

- → Identifying and capturing both explicit and tacit knowledge is crucial but challenging.
- → There is a need to balance formal knowledge processes with ad-hoc learning.
- → The obsolescence of traditional archive systems poses a significant challenge.
- → Ensuring the availability and accessibility of knowledge when needed is critical.
- → There is a competitive aspect to knowledge sharing, balancing it between new operations and decommissioning.
- → Long-term retention of knowledge and ensuring the knowledge receiver understands its value are vital.

Implications for Management and Leadership for Safety:

- → Implementing effective knowledge-sharing tools, such as workshops and informal gatherings, is essential.
- → Managers need a clear understanding of what constitutes knowledge (e.g., tacit vs explicit knowledge), and the processes required to manage it (process of knowledge sharing, process of knowledge formalization, identifying what needs to be captured, categorized and how to store it).
- → Data handling tools, including databases and 3D models, should be utilized.
- → Encouraging a culture of learning and knowledge acquisition within the organization is important.
- → There should be a willingness to share knowledge beyond company boundaries, fostering a broader knowledge-sharing culture.

Implications for the Training Programme:

- → Students need to understand the risks, opportunities, and necessities of knowledge management, supported by practical case studies. They need to understand the different processes of knowledge management.
- → Emphasizing the importance of sharing knowledge as a cultural responsibility is crucial.
- → The training should include developing tools for effective communication and crisis management, understanding the basics of knowledge management, and identifying weak signals in knowledge processes.
- → Practical workshops and simulations should be integral parts of the training to ensure the application of theoretical knowledge in real-world scenarios.

These insights underscore the importance of fostering a robust knowledge management culture within organizations, particularly in complex and regulated fields such as nuclear decommissioning.

Debriefing of the group work session 3

The discussion that followed group sessions 3 was very insightful. Here are the key points raised:

- → The significant volume of knowledge generated throughout a decommissioning project, spanning multiple phases and involving diverse stakeholders. Data handling tools, including databases and 3D models, should be utilised. However, it is important to recognise and integrate both formal knowledge (documented procedures and manuals) and informal knowledge (practical expertise and tacit knowledge) for successful knowledge management.

→ There is a competitive aspect to knowledge sharing, balancing it between new operations and decommissioning.

→ Clarification of information and knowledge sharing between the different stakeholders in NDPs is needed. Leaders need to champion the use of visual tools and collaborative methods to facilitate knowledge sharing and ensure that knowledge is accessible and understandable to all stakeholders.

→ Knowledge sharing over different generations in a medium – long term was also a key challenge that was identified by the participants who participated in this discussion group.

→ Effective management and leadership for safety in decommissioning requires fostering a culture of learning and knowledge acquisition within the organization.

→ Ideas for the training program:

- The training program should include practical training in **knowledge management techniques**: 1) it should include practical case studies and simulations to illustrate the application of knowledge management principles in decommissioning projects and to provide opportunities to practice these skills; 2) it may give an overview of the potential and limits of the use of data science, as well as the use of AI (Artificial Intelligence) in the management tools.
- The program should highlight **the crucial role of stakeholder engagement** in knowledge management, teaching future leaders how to effectively interact with diverse groups and understand their perspectives.
- Training may reinforce safety culture and **knowledge culture** through the recognition of critical knowledge and the importance of sharing knowledge as a cultural responsibility.

Nuclear Decommissioning projects: Related challenges (Group-work session 4)

Group A. "Digital technology" Key-note speaker: Dr. Lucas Stephane

(1) Dr. Lucas Stephane's Presentation

Dr. Lucas Stephane presented the state-of-the-art and key challenges of digital technology in decommissioning. He started with training frameworks – Systematic Approach to Training (SAT), On the Job Training (OJT). Then, he presented the Learning Management System (LMS) and Plant Information Model (PIM), and their connection with Asset Management. Furthermore, Dr. Lucas Stephane addressed the concept of Digital Twin – Digital Twin Prototype (DTP), Digital Twin Instance (DTI), Digital Twin Environment (DTE), and explained

robotic mobile platforms. Finally, Dr. Lucas Stephane presented the different professional tools used and developed by IFE (Institute for Energy Technology) - VR Dose, ColaRIS, or IFE InstrucT -, focusing on scenarios, DT, people, planning, radiation protection, visualization, remote monitoring, and remote support.

(2) Working Group Discussion: Key Insights

The outputs of the discussion group are:

Challenges:

- → The discussion group identified that the interaction of various and different digital technologies with humans is a big challenge; how to integrate the use of digital technologies is critical.
- → Participants acknowledge Digital Twins (DTs) as one of the big challenges of the current era. A process approach to DTs is needed, especially in the transition from operations to decommissioning. Here, the scenarios are very important for the design. However, establishing scenarios is very challenging when we have to assess uncertainty.
- → The Cost and motivation of digitalization in decommissioning are quite challenging, according to the participants. Modelling should combine existing knowledge and real-time tracking.

Implications for Management and Leadership for Safety:

- → It was agreed by the group that verification and validation are needed, to reduce errors and avoid inconsistencies.
- → Digital technologies may be very helpful to deal with Regulated Safety (RS) and Managed Safety (MS) at a high level. For that, participants underlined that rigor is needed. Therefore, level of accuracy, link with Knowledge Management (KM) and link with engagement should be defined.
- → The use of small models interconnected – known as "BIM federated models" - may be very beneficial for management and leadership for safety. Moreover, the use of Agent-based Modelling seems to be relevant.

Implications for the Training Program

- → The discussion group stated that the training program should give an overview of the different digital technologies that can be used in nuclear decommissioning projects and their interaction with humans – end users point of view.

→ Trainees must develop an interrogative attitude – train for a new mindset – into a multidisciplinary approach. New leaders should be prepared to continuously improve when facing situations that were not foreseen before.

Group B. "Waste management" Key-note speaker: Dr. Jörg Feinhals

(1) Dr. Jörg Feinhals's Presentation

Dr. Jörg Feinhals gave a presentation on the role of waste management during decommissioning. He highlighted the fact that waste management during the decommissioning phase is based on a clearance process: the clearance option is now the daily work for the waste management in the power plant. The clearance process can be described as the 'removal of radioactive control by the regulatory body for radioactive material or objects from within notified or authorized facilities and activities' (IAEA Glossary). This process is based on the 'de minimis concept', which means that the law does not care about trivial things. The clearance process is based on the following steps: (1) characterization, (2) dismantling, (3) pre-measurement, (4) decontamination treatment, (5) decision measurement, (6) choice of clearance pathways and (7) approval by authority.

Dr. Jörg Feinhals showed that German regulations on general clearance are based on levels and values defined by the IAEA and the European Union. He highlighted that the ability to measure the level of radioactivity is a challenge for the implementation of clearance. Clearance requires the adaptation of the instrumentation in the facilities and the training of the personnel who will be responsible for implementing it. The clearance process has a major impact on waste recycling. His presentation highlighted the major historical stages that led to the introduction of international clearance regulations. Finally, he presented the waste management process applied in France, which remains the only country not to apply clearance.

(2) Working Group Discussion: Key Insights

Challenges:

→ Waste generation must be kept to the minimum practicable.

→ Need to balance capacity, cost, safety and public acceptance.

→ Waste management goes beyond the decommissioning project.

→ There is a need for decommissioning expertise and to attract young people.

→ International IAEA standards are key.

Implications for Management and Leadership for Safety:

→ Acceptance of the clearance process is a challenge.

→ The issue of waste acceptance criteria suggests a link with ethics and stakeholder engagement.

→ Waste management should be part of an integrated management system.

Implications for the Training Program:

→ Ensure that everyone has a general understanding of waste management and the clearance process.

→ Provide training on general aspects of radiological waste management

→ Discuss acceptance and waste management issues related to decommissioning projects.

Group C. "Human resources management" Key-note speakers: Jorge Borque Linan

(1) Jorge Borque Linan's Presentation

Jorge Borque Linan presented the experience of ENRESA in managing the decommissioning of two nuclear power plants in Spain: José Cabrera and Santa Maria de Garoña.

José Cabrera is the first nuclear power plant to be built in Spain (in the 1960s). It was decommissioned in 2006. The decommissioning process for José Cabrera was the first complete immediate decommissioning project to be executed in Spain. The project highlighted the challenges related to managing the transition from operational phase to decommissioning and the importance of a strong collaboration between ENRESA and the utility company.

Santa Maria de Garoña was shut down in 2006 and the decommissioning process is ongoing. The project is characterized by the need to manage a large amount of spent fuel, which will be stored on-site, and by the challenges of managing the transition from operational phase to decommissioning.

ENRESA has established specific management systems for the decommissioning of nuclear facilities. These systems encompass various aspects, including waste management, safety, regulatory compliance, and personnel management. The company emphasizes the importance of collaboration with utility companies and other stakeholders to ensure smooth and safe decommissioning processes.

ENRESA faces human resources and organizational challenges related to the complexity of managing the transition from operational phase to decommissioning:

- Adapting the organizational structures: the shift from operational to decommissioning phases requires significant organizational changes.

- Managing a large number of contracts with specialized contractors.
- Ensuring a smooth transfer of knowledge and expertise from the utility company to ENRESA.
- Integration of different skillsets: the decommissioning project involved personnel from ENRESA, the utility, and other specialized contractors, necessitating careful coordination and communication.
- Retaining experienced personnel from the operational phase and managing the availability of skilled personnel due to the long timeframe of decommissioning projects and the retirement of personnel with experience from the operational phase.
- Maintaining a safe and qualified workforce: ENRESA hired new personnel to learn the specific skills required for decommissioning, providing them with the necessary training and licenses.

(2) Working Group Discussion: Key Insights

The keynote speaker's presentation generated a lively discussion. Several key challenges and their implications for management and leadership for safety and for training were identified.

Challenges:

→ The transition from operation to decommissioning is a complex process requiring significant coordination between the utility company and the decommissioning organization. It involves a change in mindset and culture, as well as a shift in responsibilities and priorities. This transition requires careful planning, communication, and coordination to ensure a seamless and safe handover.

→ The human resources management is a major challenge (attract and retain qualified people with specialist expertise in decommissioning, train new personnel to fill the gaps left by retiring personnel, address potential resistance to change from personnel accustomed to the operational phase, etc.). There is a need to identify and plan for personnel needs in advance, particularly regarding the availability of skilled personnel with licenses and specific expertise.

→ Managing a large number of contractors and ensuring a unified safety culture across all entities involved in the decommissioning process can pose significant challenges.

Implications for Management and Leadership for Safety:

→ Strong communication and collaboration are essential between the utility company, decommissioning organization, regulators, and contractors.

- Leadership plays a crucial role in fostering a safety culture that emphasizes the long-term perspectives of decommissioning and the need for sustainable solutions. Leadership for safety must be demonstrated at all levels of the organization, ensuring that everyone understands their role in maintaining safety standards throughout the decommissioning process.
- Change management strategies are crucial to address the transition from operational phase to decommissioning. This requires involving personnel at all levels in the change process, ensuring transparency and clear communication.
- A proactive approach to human resources management is necessary to ensure the availability of skilled personnel throughout the decommissioning process. This includes developing long-term plans for recruitment, training, and retention of personnel.

Implications for the Training Program:

- The training program should include modules dedicated to managing the transition from operational to decommissioning phases, including organizational structure and roles, communication and stakeholder engagement, human resource planning and development.
- The training should emphasize the importance of effective communication, collaboration, and teamwork, particularly between the utility company and the decommissioning organization.
- The training should include modules on leadership for safety, fostering a strong safety culture, and the principles of responsible decommissioning.

Debriefing of the group work session

The discussion after group session 4 brought out some interesting points on each of the challenges identified.

Digital Technology:

- The debriefing session highlighted the growing importance of digital twins in the decommissioning context. Participants agreed that digital twins can provide a valuable tool for managing safety, planning operations, and simulating various scenarios. However, challenges include ensuring data accuracy, integrating different data sources, and managing the complexity of these models.
- A key challenge is ensuring a robust interaction between human operators and the increasingly sophisticated digital tools. Participants discussed the need for training programs that address the specific skills and knowledge required to operate and interpret these technologies effectively, and how to prevent digital technologies from becoming a barrier to safe and efficient decommissioning.
- The debriefing stressed the importance of integrating scenario-based design into the development and use of digital technologies for decommissioning. Participants

highlighted the need for robust methods to create and analyze scenarios, especially for complex and uncertain situations that might arise during decommissioning.

Waste Management

- The group emphasized the crucial role of clearance procedures in minimizing radioactive waste generation. Participants acknowledged the need for consistent, internationally recognized standards for clearance and discussed the ongoing evolution of these standards.
- The group recognized the long-term challenges of waste management and the importance of sustainable solutions. Participants highlighted the need to consider the long-term storage, monitoring, and disposal of waste, and the need for continuous research and development of innovative waste management solutions.
- Participants discussed the importance of public acceptance and ethical considerations in waste management. The group emphasized the need for transparent communication, stakeholder engagement, and ethical considerations in all aspects of waste management practices.

Human Resources Management

- The group identified the need for specific skills and training for personnel involved in decommissioning projects. Participants discussed the need for training programs that incorporate a multidisciplinary approach, including engineering, safety, waste management, and leadership skills.
- Participants highlighted the importance of motivating personnel involved in decommissioning projects, which often involve long-term commitments and challenging working conditions. The discussion explored the need for appropriate compensation packages, career development opportunities, and recognition programs to maintain a motivated and skilled workforce.
- Participants emphasized the importance of fostering a positive and collaborative organizational culture that promotes effective communication, teamwork, and a shared commitment to safety. This is particularly relevant for decommissioning projects, where the integration of personnel from different backgrounds and disciplines is essential.

Finally, the discussions from this debriefing session provide some insights for the training program:

- The course should provide students with a solid understanding of relevant digital technologies, including digital twins, BIM, and plant information modelling, and their potential applications in decommissioning.
- The curriculum should encompass the complexities of waste management, including clearance procedures, radioactive waste minimization, and the long-term sustainability of waste management solutions.

→ The program should equip students with the skills needed to manage and motivate diverse workforces, to build a positive and collaborative organizational culture, and to address the specific challenges of human resource management in decommissioning projects.

Conclusion

The DMaLSE International Scientific Workshop underscored the intricate and multifaceted nature of nuclear decommissioning projects. Throughout the workshop, participants engaged in an extensive examination of challenges related to complex project management, stakeholder engagement, knowledge management, as well as digital technologies, waste management and HR issues. These discussions highlighted the essential shift needed from traditional, routine operational practices to a project-centric approach capable of addressing the uncertainties and long-term implications unique to decommissioning efforts.

Central to the workshop was the recognition that effective management and leadership for safety require more than technical acumen; they demand a profound understanding of stakeholder dynamics, ethical engagement, and adaptive leadership. Presentations and working groups delved into key frameworks and modular approaches that emphasise sensemaking, risk management, and a balance between standardisation and flexibility. This nuanced view reinforces that leadership in decommissioning must be a dynamic process, adapting to changing regulations, societal expectations, and technological advancements.

The discussions on stakeholder engagement emphasised that stakeholder trust and proactive communication are non-negotiable for project success. The workshop recognised that stakeholder groups must be expanded beyond conventional operational confines to include communities affected by long-term project outcomes, future generations, and regulatory bodies. Building trust was noted as a continuous process, integral to addressing ethical concerns and fostering an environment of transparency and cooperation. The workshop's insights stressed that ethics in decommissioning should move beyond procedural compliance to encompass transformative practices that secure a positive legacy for all involved.

Knowledge management emerged as another critical pillar. The workshop’s sessions underscored the challenge of integrating both explicit, documented knowledge and the tacit, experience-based expertise held by professionals. Effective strategies such as knowledge mapping, knowledge networking, and the incorporation of digital tools were identified as vital for ensuring that knowledge is effectively captured, shared, and applied across long project timelines. Addressing the “curse of knowledge” through clear communication and collaborative learning environments was highlighted as essential for fostering a robust culture of knowledge sharing and continuous improvement.

Furthermore, the integration of digital technologies, such as the use of Digital Twins and Learning Management Systems (LMS), was recognized as both a challenge and an opportunity.

These technologies hold promise for enhancing decommissioning efficiency, providing real-time data for decision-making, and supporting training through interactive simulations. However, the need for rigorous validation and careful management to prevent reliance on unverified data was noted as a prerequisite for their successful implementation. The workshop discussions also pointed to the importance of fostering an interrogative mindset and an adaptive approach among future leaders, preparing them to handle unforeseen challenges in real-world scenarios.

The DMaLSE workshop concluded with a strong consensus on the need for comprehensive training programs that integrate these multifaceted insights. Future training initiatives should incorporate practical elements such as case studies, simulations, and role-playing exercises to help participants develop skills in problem-solving, communication, and ethical decision-making. Emphasis on stakeholder mapping and inclusive engagement strategies should be coupled with modules on knowledge management tools and the safe application of digital technologies.

In summary, the DMaLSE workshop successfully laid the groundwork for reshaping leadership and management training in nuclear decommissioning. By fostering a culture that values interdisciplinary collaboration, continuous learning, and ethical engagement, DMaLSE aims to equip professionals with the tools needed to manage complex projects effectively. This approach will contribute to safer, more sustainable decommissioning practices that maintain public trust and promote a shared commitment to long-term safety and environmental stewardship.

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