PLEIADES
Smarter Plant Decommissioning

Innovation Action

H2020-NFRP-2019-2020

D1.1 – Requirements for the design of the PLEIADES concept

WP1 - Task 1.1

Date [M6]

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Table of contents

Abbreviations and acronyms

Acronym	Description
AECO	Architecture, Engineering, Construction and Operations
ALARA	As Low as Reasonably Achievable
API	Application Programme Interface
BCOT	Base Chaude Opérationnelle du Tricastin: a nuclear installation located on the Tricastin nuclear site specializing in nuclear maintenance. It maintains and stores equipment and tools from circuits and contaminated equipment in nuclear power reactors, excluding fuel elements, and in particular guide tubes, intervention tools, equipment dedicated to dismantling and vessel covers.
BIM	Building Information Modelling/Management
BoQ	Bill of Quantities
CDE	Common Data Environment
ChNPP	Chernobyl Nuclear Plant
D&D	Decommissioning and Dismantling
DES	Discrete Event Simulation
DQO	Data Quality Objectives
DWH	Data Warehouse
ERP	Expert Review Panel
HC NPP	José Cabrera Nuclear Power Station
IFC	Industry Foundation Classes, a data model intended to describe architectural, building and construction industry data
ISDC	International Structure for Decommissioning Costing of Nuclear Installations
KM	Knowledge Management
KPI	Key Performance Indicator
KPIM	Knowledge Centric Plant Information Modelling/Management
LNPP	Leningrad Nuclear Plant
MC	Monte Carlo
REX	Registered Exported System
RFQ	Request for Quote
SAR	Safety Evaluation Report
SMG NPP	Santa María de Garoña Nuclear Power Station
SSC	System Structures and Components
WM	Waste Management
WP	Work Package

Figures and Tables

1. Introduction

The main overarching aim of the PLEIADES project is to demonstrate a modular software ecosystem based on interconnection of front-line support tools through a decommissioning specific ontology building upon open BIM.

The expected results of the project are foreseen to:

- Improve safety, specifically by providing improvements in radiological protection, communication between stakeholders and training of workers.
- Reduce costs by enabling better and more standardized costing, as well as higher optimization of the waste management process.

There are three central ideas / motivations behind the PLEIADES project:

1. **Support for holistic approach**

The use of 3D modelling and simulation based innovative concepts are increasingly emerging, but most examples are for specific use cases. More general adoption is, however, hindered by the lack of clear evidence proving cost efficiency (the business case) for using such advanced 3D techniques.
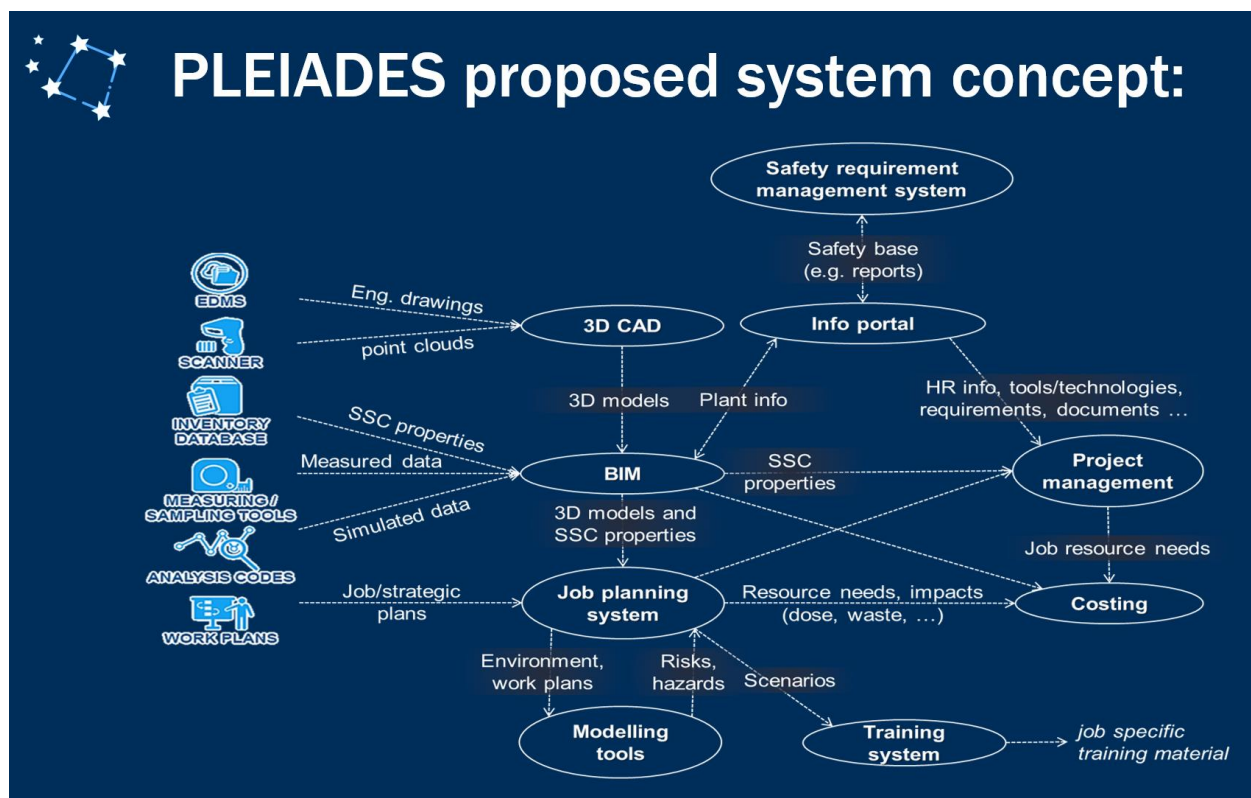

Figure 1 PLEIADES concept – software ecosystem for holistic, safety focused, support

At the same time, it seems quite clear that the business case for the use of 3D concepts can be much improved simply by thinking about the use of 3D models as an asset in various tasks including

information management, costing, planning, communication, etc. Hence, one of the core ideas behind the PLEIADES project, is demonstrating the use of 3D models in a holistic approach as a general project implementation tool, rather than a specific solution for a specific task. In this approach, 3D models and associated data provides input for an ecosystem of more general and purpose-built tools providing capabilities for key decommissioning tasks. Figure 1 visualizes a high-level system design for such an ecosystem of support tool types that can benefit from information stored in information rich 3D models.

2. **Higher independence from vendors**

As mentioned above, modern techniques based on the use of 3D models are emerging. Due to the lack of standardization in the nuclear industry for the use of 3D modeling and simulation based techniques users are typically constrained by the offerings of a specific technology provider. Vendors providing various 3D modelling and simulation based innovative solutions are emerging and it is foreseen that solutions offered by such vendors will, in the near future, cover most of the tasks where 3D models can provide benefits. However, the use of several such tools typically requires extensive manual efforts for data/information transfer between the tools or massive in-house system integration efforts. Hence, another core strategic aim of PLEIADES is demonstrating how systems/solutions from various vendors (in this project those represented by the project consortium members) can be semantically integrated into a software ecosystem using a nuclear decommissioning specific *ontology*. Figure 2 shows how the 12 modules of the PLEIADES ecosystem can cover the whole value chain ranging from data acquisition, through decision making and up to training. Such compatibility between modern 3D modeling based and other support tools would provide independence of the users from technology providers, the users being able to use modern concepts across various tasks in the project and even explore alternative tools designed for similar purposes taking advantage of the specific strengths of various tools.

Data/info acquisition and management

Characterization and Job planning

Decisions, Costing, Waste management

Demonstration and Training

1. **3DScanPF (KIT)**: Robotic platform for 3D scans and imaging
2. **DIM (EDF)**: Dismantling Info Modelling system for storing all facility data
3. **Bimsync (CATENDA)**: IFC[1] compatible BIM platform used in construction
4. **iUS IMS (iUS)**: Semantic wiki based nuclear info system
5. **RadPIM (IFE)**: Radiological characterisation tool (part of VRdose family)
6. **VRdose (IFE)**: Detailed job planning tool with a radiological model library
7. **DEMplus (CYCLIFE DS)**: Decision-support tool combined with 3D simulation
8. **Aquila costing (WAI)**: ISDC[2] compatible client-server based costing tool
9. **iDROP (CEA)**: VR dismantling simulation with collision & radiological modelling
10. **LLWAA-DECOM (Tractebel)**: Low Level Waste Activity Assessment tool
11. **ALVAR (VTT)**: AR[3] training platform with advanced tracking capabilities
12. **INTERACT (LS)**: XR[4] platform with physics engine

[1] *IFC: Industry Foundation Classes*
[2] *ISDC: International Stricture for Decommissioning Costing*
[3] *AR: Augmented Reality*
[4] *XR: Mixed Reality*

Figure 2 PLEIADES software modules provided by the project consortium members

3. **Advanced tech support**

The third core idea behind PLEIADES is to demonstrate integration of advanced tools representing the cutting-edge technology available in a modular concept. This modular approach is in contrast to some other solutions offered, typically by large vendors, that integrate all functionalities in one single multi-purpose tool. In the PLEIADES concept the user can apply each module independently or in parallel as required by the goal / discipline of the user and according to the current needs of the project.

This task 1.1 establishes the requirements for the PLEIADES concept in line with the expected outcomes of this project. The task includes:

- Consolidation of the main application areas to be addressed in the project. This includes a review of high priority gaps in current decommissioning capabilities with focus on opportunities for application of 3D based digital concepts.
- Determination of the new capabilities envisaged to be enabled by integration of the PLEIADES concept into the project management approaches currently applied in nuclear decommissioning.
- Determination of the requirements for establishing such new capabilities based on a PLEIADES concept from a system perspective. This includes identification of the possible hindrances that need to be overcome from technical, human, organizational and regulatory viewpoints.
- Development of high-level requirements for the PLEIADES concept for testing the new capabilities determined.
- Determination of requirements related to the test environment and input data/information needed for testing the PLEIADES concept, including safety aspects (data/information needed for software used to support safety analysis or independent reviews)
- Definition of suitable key performance indicators (KPI) for evaluating the efficiency of the PLEIADES concept to be demonstrated.

1.1 State of the art

State of the art as defined by the partners at project initiation:

CATENDA: BIM is used more often and deeper in the AECO (Architecture, Engineering, Construction and Operations) industries. Catenda is very active in buildingSMART International (who develops the open BIM standards, like IFC, bsDD, BCF etc.). BIM, especially open BIM, models are much richer in information than traditional CAD Drawings, and they are also much more suited for collaboration across different teams and different software since that has been a primary design goal from the start. This can have great value for nuclear decommissioning and also for new plants.

CEA: In recent years, a couple of use cases implementing a BIM approach have been tested at CEA on decommissioning projects using standard tools and a non-nuclear ontology. The challenge will be to reinforce this approach by adding to existing tools the specificities of decommissioning via relevant input data while increasing interoperability.

EDF implemented and has applied digital tools/assets like databases (1D inventories, point clouds), based on the commercial 3D experience solution from Dassault Systemes, as well as 3D models based on the SolidWorks and Revit tools. However, the following difficulties with using 3D models remain to be investigated: 1. ensure consistency between 3D models with the data repository. Today, EDF models are not directly connected with the repository. 2. The way to update the 3D models with inventories or following dismantling projects on the installations to have the most up-to-date model possible. 3. The way of merging models with each other. Many beneficiaries who carry out field works start by making their own model specific to their company environment.

Cyclife DS: Decision support tools using 3D simulation technology for interventions in the nuclear field are emerging on the market. Such scenario simulation tools provide costs, planning, dose and waste assessment support. Cyclife-DS is one of the developers of such technology.

ENRESA: Tools using digital models exist and have been used in decommissioning. However, many things still need to be developed. Acquisition of the 3D data is a key task for enabling use of digital models. Improvements required for advancing state of the art are mainly related to providing capabilities for using 3D models in a deeper way i.e., for multiple purposes: safety, WM, equipment management, tracking of assets, etc…

IFE: Individual pieces of the PLEIADES concept have been around for a while (are being further improved) or are close to reaching a field applicable maturity level and are being increasingly applied for individual tasks. Integration of project management capabilities in BIM tools exists. Sporadic examples of other integrations emerge in the literature. Trend for 'super tools' integrating all capabilities in one solution failed. International extended (i.e., beyond the scope of IFC) ontology is need for enabling modularity.

IRSN: PLEIADES type concepts are used in other industries for sharing information, but not in nuclear decommissioning. In decommissioning, it is observed that 3D models and related data are developed by the licensee and can be used to support the optimization of the dismantling scenarios and the safety demonstration. In such situation, it can be envisaged to share the 3D model and the related data with the Regulatory Authority and/or its Technical support organization. Currently there is no tool or processes to facilitate this exchange. IRSN investigated the use of 3D simulation based tools for supporting the regulatory process. One of the challenges is ensuring the relevance of the data. The data can be original as collected or can be treated by the licensee. Ensuring quality of the data is the responsibility of the licensee. The treatment of the data is not the duty of the regulator/TSO, but the regulator or its TSO must be ensured the data have been processed appropriately.

iUS: Semantic technologies are used since more than 10 years now in the industry. IUS has developed in practical application a semantic framework that allows the efficient planning and controlling of decommissioning projects for our customers and the management of our own company. The integrated management system allows to efficiently run our projects for our customers and handle their assets. In parallel we developed several entities of semantic frameworks for knowledge management in decommissioning i.e., for the German Federal Government and IAEA. Nevertheless, our system has only a sparse implementation of building information. It is the aim of our contribution to implement a IFC compatible version in order to allow to use the very user-friendly semantic system with the added benefits of 3D and BIM features.

KIT: KIT has experience in 3D-scanning and processing the resulting 3D point cloud data, as well as 3D CAD modelling. Integration of such data into decision/training support platform is needed.

LS: 3D modelling, 3D scans and BIM has been used in decommissioning. VR technology based support systems have also been used in decommissioning. Integration of these capabilities with complementary technologies/tools is required.

TRACTEBEL: Open BIM has been applied in other areas (outside nuclear decommissioning). For decommissioning, mainly different kinds of databases are used. BIM can be adopted for decommissioning tasks. To our knowledge, no commercial tools exist for central information management and planning support. 3D models are used for decommissioning. However, each contractor/licensee are using their own tools and these tools don't communicate well.

VTT: Use of augmented reality based prototype has been tested in national research projects. A national research project is in progress for supporting field deployment of tools using digital models. Decommissioning of VTT's research reactor FiR1 in progress, where use of digital tools will be piloted.

WAI: ISDC, providing an international standard breakdown of decommissioning activities, has been developed for ensuring comparability of decommissioning projects in terms of cost. The ISDC methodology is very efficient for to calculating overall costs (not only costs for specific dismantling activities) of decommissioning projects, including waste management costs & dose uptake by workers. In addition to the more simplistic and not-flexible excel based tool using ISDC a modular-based client-server application exists (developed by WAI). Integration of this into a tool package is needed for advancing state of the art.

1.2 Project partners relation to WP1

CATENDA is looking for using open BIM technology to make BIM-oriented communication structured, cost reducing and value increasing.

Catenda has deep and long experience with BIM technology in the AECO industry. Based on this, Catenda will provide input about what processes and technologies could be a good fit for this project (and which are not so relevant). Catenda's **Bimsync** open BIM platform supports interactive 2D and 3D visualizations and might also be highly relevant for prototyping. It is used by many companies as middleware.

Catenda is contributing with its knowledge and experience of BIM oriented workflows from the AECO industries. Although AECO and nuclear decommissioning are very different industries, there are also many similarities and some BIM oriented tools and workflows can provide great value in both industries.

CEA is looking for development of a solid framework in this WP to support the other WPs and the whole project in general.

CEA has several years of experience in the use of virtual reality on real dismantling sites through the use of iDROP software. This experience will be utilized to validate digital simulations through pilot projects, real mock-ups and operator training.

EDF is looking for the state-of-the-art definition for her usages in PLEIADES. EDF is awaiting the definition of requirements on which it can rely to specify databases and interactive applications within a common integration platform.

EDF can provide the BCOT installation data package necessary for the definition of the first PLEIADES use case. EDF will also contribute to defining the use cases envisaged for the PLIEADES software kit.

Once WP1 defined the expected content of data-packages for the definition of PLEIADES use cases, EDF can provide the data available for the BCOT nuclear installation. EDF imagines that this definition of the data package is iterative between the partners. EDF also intends to be a reviewer of WP1 and to monitor the relevance of the scenarios envisaged with respect to its operational objectives.

Cyclife-DS is mainly looking for understanding the detail related to the development of the PLEIADES platform.

Cyclife-DS provides knowledge in software development, user-experience from using the DEMplus tool in real-life projects, input specifications for the overall system design, and assistance for data verification.

Cyclife-DS primarily contributes to the definition of the requirements and specifications for the prototype platform development.

Thanks to the specification of the PLEIADES platform and the development of a dedicated ontology, Cyclife-DS will participate to the definition of a standardized process and data model for the D&D project.

ENRESA is looking for getting insight into usefulness of PLEIADES technology for supporting decommissioning in Spain, identification of dangerous materials (including physically dangerous material like asbestos), planning removal of radiological and other material in a safe way and acceptance by the regulator. ENRESA is also looking for opportunities for the use of the PLEIADES technology for sentencing and planning of safe/optimal removal of the components.

ENRESA provides experience from WM and dismantling (related to HC NPP, graphite reactors, and SMG BWR NPP). ENRESA will also provide 3D models from HC NPP and SMG NPP as input for demonstrations.

ENRESA will assist in demonstrations using data from Spain e.g., handling measurement points and facility characterisation in general.

IFE is looking for a model (technical solution) were the modules (tools from partners) of PLEIADES mutually re-enforce each other and enables the foreseen end-users take advantage of the strengths of each of the modules rather than having to explore solving tasks using tools that were not primarily designed for that purpose. A technical solution that enables a collaboration model were partners can concentrate on further development of their existing technology focusing the main specific strengths of their technology and provide overall solutions in a partnership.

IFE contributes with experience and lessons learned from deploying 3D simulation based support systems in real-life projects, mainly planning (based on VRdose) as well as information and training (examples ChNPP1, ChNPP2, KolaNPP, Leningrad NPP, Fugen NPP, Halden Reactor,…). Results from research into integrated support for nuclear decommissioning and know-how from pilot field applications of such concepts. Connection to the synergic **LiveDecom** project with some of the same partners. Link to SHARE and PREDIS projects – specifically input for analyses of industry and user needs. Link to application in connection with robotics, specifically in connection with the RoboDecom industrial innovation project. Ife will also assist with dissemination of results via the IAEA Collaborating Centre hosted by IFE and via the DigiDecom event series.

IRSN is looking for investigating how 3D models and digital data can be share among all stakeholders including authorities to enhance the review process. Use of 3D models can help better understand facility

conditions and planned dismantling processes and to focus discussions among licensee and TSO (follow-up questions etc.) on main safety concerns. IRSN will not develop or collect data in this project.

IRSN can provide input for defining requirements, specifically those related to evaluation of safety analysis reports (SARs), and insight into the process by IRSN for evaluation of SARs. For instance, information about how specialists are involved in the SAR evaluation and how they could use PLEIADES technique for assessment. IRSN uses own software for evaluation. IRSN can assist with eliciting what are the set of data that are necessary for regulatory review.

iUS is looking for establishing a common ontology on decommissioning agreed by all partners and based on international input.

iUS contributes with experience in KM and ontology development, and with specific view on decommissioning from practical side as consultant.

iUS leads development of common ontology. This work includes organizing dedicated workshops for defining the ontology.

KIT is looking for establishing the common concepts and categories in D&D, as well as defining requirements and associated specifications for the PLEIADES concept.

KIT can provide know-how and experience in D&D of nuclear facilities. KIT will participate on workshops for gathering input and verification of the consolidated requirements. KIT can also help with establish a link with a robotics related project.

LS will provide a solution that combine VR technology, 3D data processing (CAD and point cloud) and realistic simulation of D&D operation, acting as a virtual twin of the plant to be dismantled. To date, there is no such solution on the market. LS will conduct development on the processing of 3D scans (point clouds), especially reconstruction of surfaces to drastically reduce the effort needed to manually create 3D models.

TRACTEBEL is looking for establishing interoperability between the software tools supporting different tasks taking advantage of IFC. TRACTEBEL is interested in how information can be centralized in a form of a central digital twin of units to be dismantled.

TRACTEBEL can contribute with experience from assisting decommissioning and WM in Belgium, and also at Ignalina NPP, with various technologies, mainly for planning and cost estimation for early planning. This is mainly based on activation estimation using MC and other methods, encompassing all calculations required for safety planning. TRACTEBEL is also assisting in definition of the nuclear decommissioning ontology with know-how (access to experts) from supporting decommissioning activities.

VTT is looking for high quality specifications for development of a prototype software platform, as well as KPIs to be used for evaluation of this platform the against pre-defined quality objectives.

VTT can contribute with expertise in augmented reality development, and robotic solution for gathering data for decommissioning planning. VTT will contribute to development of specifications for use augmented reality in decommissioning. VTT will also contribute to definition of KPIs for the evaluation of results from this project.

WAI is looking for intensive common and open discussion aiming for gathering inputs required for development of the PLEIADES prototype.

WAI will contribute to definition of structures for input and output data in general and specifically those related to decommissioning costing. WAI has deep experience in DWH implementation practices as well as, cost calculations for research reactors from the IAEA DACCORD project.

1.3 Relation of Task 1.1 to other activities in the project

WP 1: Requirement analysis, specification and test design

WP Leader: IFE

Partners: CEA, EDF, ENRESA, IFE, IRSN, iUS, KIT, LGI, LS, CDS, VTT, TRACTEBEL, WAI, CATENDA = All partners

Main objectives:

- *Define requirements and associated specs for demonstrating the PLEIADES concept.*
    - Establish **requirements** for concept design
    - Develop **specs** for prototyping and demo / testing
        - Provide a nuclear decom specific extended **ontology**
    - Provide **input** base for testing and demo

WP 1: Task 1.1 Requirements set-up for the design of the PLEIADES concept (Leader: IFE) (M1 – M6)

Partners: **IFE,** IRSN, CEA, CDS, EDF, LS, iUS, KIT, WAI, TRACTEBEL, CATENDA

Outcomes:

1. Main **application areas** to be addressed, incl. quick review of **high priority gaps** in current decom capabilities (focus on 3D BIM concepts)
2. **New capabilities** enabled by integration of the PLEIADES concept into current decom project management approaches
3. **Requirements for deploying** such new capabilities from a systemic perspective, incl. possible hindrances to overcome.
4. **Requirements for test environments and input data/info**, incl. **safety aspects**
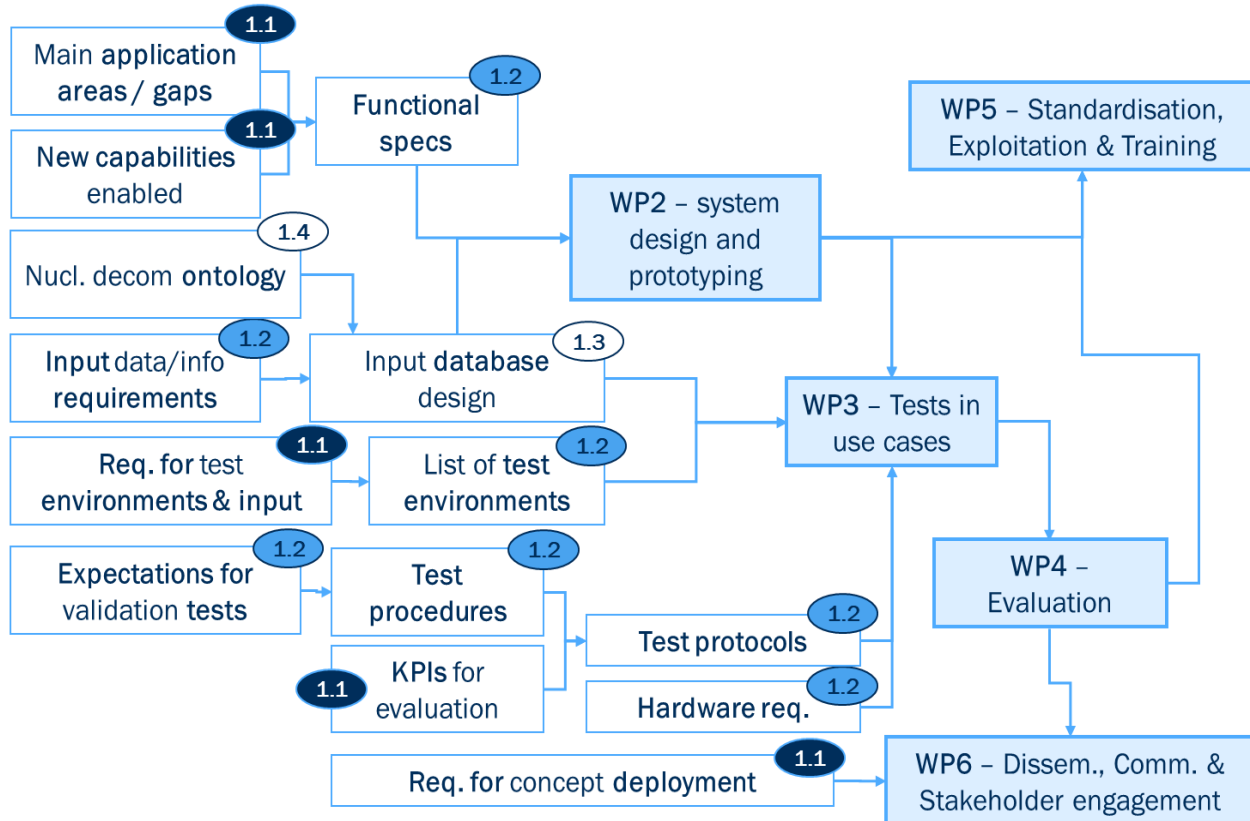5. **KPIs for evaluation** of the PLEIADES concept.

Figure 3 Flow chart showing relation of tasks to each other within WP 1 and their relation to other WPs in the Project

2   Gap analysis method

2.1 Purpose of the gap analysis

The objective of the survey performed within this Task 1.1 was to acquire input about current practices and stakeholder needs specifically related to the integrated decommissioning support ecosystem proposed by the project.

More specifically, the survey aimed at getting input from a large audience on

- **User needs**: What are the general tasks were foreseen end-users would expect a major positive impact from the use of the outcomes of the PLEADES project?
- **Expectations**: What specific improvements (e.g., new capabilities/functionalities) is the PLEIADES concept expected to bring in various phases of the decommissioning project?
- **KPIs**: Specific indicators that could be used to quantify improvements from the PLEIADES concept.
- **Requirements**, including both those to the end-user, as well as the technology provider, that need to be fulfilled for ensuring feasibility of the application of the PLEIADES concept.

This result of this analysis will be used

- as a base for developing a system architecture for the software prototype to be developed in this project,
- for designing the validation tests aiming at verifying compliance of the resulting system prototype with the related user/industry needs.

On a practical level, it was decided that user stories will be developed to transport the results of this gap analysis into the system and test designs. The user stories will cover as much of the needs and requirements identified in this task as possible and will be part of the results of task 1.2. By implementing the user stories, the system design and prototyping can be more streamlined and focused on developing a protype platform , because the user expectations derived from this gap analysis can be addressed in a natural and logical way. Beyond this, the system design and prototyping can be extended to cover more elements resulting from Task 1.1 if allowed by the frame of the project.

2.2 Methodology for gap analysis

Methods for data collection

Methods for data collection in this project were defined in collaboration with all partners of the project at the early starting phase. The consortium concluded on using a combination of the following data collection methods:

1. **Questionnaire** (see details in the following chapter)

2. Gathering input from the **audience on relevant events** (see details about related group discussions on DigiDecom 2021 in the following chapters), and

3. **Guided interviews** with selected experts

In order to ensure that respondents to the questionnaire had a sufficient understanding of the PLEIADES project and concept (without having to read through extensive material) and also to ensure that respondents had the same knowledge base before providing responses a short, clear and concise presentation of the project has been developed (see Attachment 6.1). This presentation can also be used for interviews and presenting the project to the audience on events for gathering further input beyond this point.

Target groups for input

When it comes to the **target group(s)** for gathering input for the project the PLEIADES consortium agreed on the following sources for input information:

- **Partners** of the PLEIADES Project
- Expert Review Panel (**ERP**) for the PLEIADES Project
- Experts within the field of nuclear decommissioning including,
    - **Licensees**,
    - **Contractors**, and

-     o   **Regulators/TSOs**
- **Projects** with synergic goals or results
- **Events** with synergic aims and outcomes

Channels for distribution of the Questionnaire

Partners of the PLEIADES Project and ERP: All Project partners and members of the ERP were asked to fill in the questionnaire the same way as any other respondent. Responses were anonymous. Hence, there was no difference how results were considered compared to other respondents.

Experts within the field of nuclear decommissioning (Licensees, Contractors, and Regulators/TSOs): Each partner of the PLEIADES project reached out to their contacts personally for requesting input via the questionnaire.

In addition, the questionnaire was also distributed via social media and in combination with other announcements. For instance, invitation for filling in the questionnaire was sent out as part of invitations to the DigiDecom 2021 event where a day was dedicated to the basic concept behind PLEIADES.

A soft deadline for filling in the questionnaire was set for end of January 2021. An extended deadline has been provided later by the end of February 2021. This was motivated by the low number of responses received. There are a number of other international initiatives that also request input from the community (typically through questionnaires). The PLEIADES questionnaire is relatively extensive and specific compared to some of the other questionnaires mentioned above.

Responses acquired by the extended deadline were used for this analysis. However, the consortium will be open to receiving further responses (including through the questionnaire) for consideration in the PLEIADES project. It is envisaged that an update of this document will be produced considering the responses received after the end of February 2021.

The consortium decided that persons who were contacted by members of the consortium for requestion input will not be tracked or registered in order to comply with the Art 5 Nr.1 c) "Data minimisation".

Projects to consider

A number of projects were identified that can be considered for gathering input for (as well as for dissemination of results from) PLEIADES project:

- **LiveDecom:** can provide *specifically relevant input* on comprehensive modular digital systems for decommissioning support. In fact, this national project was initiated just one year before the start of the PLEIADES project and was based on the same idea that later resulted in the PLEIADES project application. IFE, iUS, WAI and Catenda are partners in LiveDecom and, hence, can provide connection to this project. A whole day session of DigiDecom 2021 was dedicated to the PLEIADES project. This session provided knowledge exchange from the LiveDecom project and the concept behind PLEIADES and LiveDecom.

- **SHARE:** The SHARE project was in parallel performing a more general survey related to innovation needs for nuclear decommissioning. A questionnaire aiming at providing an international picture of priorities (importance and urgency ratings) given by the respondents to pre-determined thematic and sub-thematic areas has been developed in the SHARE project. Analyses of the responses to this

questionnaire were presented on DigiDecom 2021 and are considered as input for PLEIADES. Further results from this project, specifically a gap analysis between needs and existing solutions / international initiatives' were also presented at DigiDecom 2021 and have been used as input for PLEIADES. However, it should be noted that results from the SHARE project are typically very general, while the PLEIADES project needs specific input related to use of digital models for decommissioning. Nevertheless, for instance, priorities given to sub-thematic areas closely related to digitalisation may be useful indicators to be considered in the PLEIADES project.

- **DACCORD II**: This project may provide relevant input on costing for decommissioning. WAI is associated with this project and will provide relevant input.

- **dECOmm** project: This project may provide relevant input on use of robots for inventory management, WM, business models and risks. VTT is closely associate with this project and can provide relevant input.

- **PREDIS:** This project may provide input on data types (input for the PLEIADES ontology) used in waste management, including those related to emerging WM technologies. VTT is leading this project and, hence, can provide a connection. This project may also provide input related to digital decision platforms for WM. IFE is responsible for this task in PREDIS and can provide input related to this in the future.

- **IAEA initiative related to connection of international knowledge platforms and use connection/extension of the IDN Wiki with a 3D modelling / BIM enabled international knowledge platform.** IFE and iUS initiated this activity and, hence, can provide connection and input information.

- **IAEA/EU/OECD-**NEA initiative on aligning their efforts on knowledge management and exchange between their communities of practice. iUS is actively involved in this project (mainly with the activities in WP 1.4).

- **IAEA KPIM** report: input can be acquired from IAEA-TECDOC-1919

- **INNO4GRAPH**: This EU-funded project will develop a set physical and digital tools and methods to be used in European graphite reactor dismantling projects. Specifically, it will design 3D modelling of dismantling scenarios as well as measurement tools for the mechanical and physical properties. The project's tools and methods will be put to the test at a full-scale graphite power plant demonstrator in Chinon, France, in 2022, facilitating their uptake and further development. EDF is associated with this project and will provide input to the PLEIADES consortium**.**

- **LD-SAFE**: This project is focusing on laser dismantling and provide input on requirements for generic safety assessment with outlook onto opportunities for use in PLEIADES. IRSN is associated with this project and will provide input to the PLEIADES consortium.

Events to consider for acquiring input and disseminating results

1. DigiDecom-ELINDER-2020 – PLEIADES was presented by IFE, iUS and WAI

2. SHARE meeting – Dec 1-3 2020 – Results from questionnaire and Mural sessions could be checked for fishing out specific relevant information for PLEIADES

3. DigiDecom 2021 – Presentations and discussions were planned in collaboration with the whole project consortium. Group discussion summaries from day 2 of the event will be primarily produced for the PLEIADES project.

4. ICOND 2020 - TRACTEBEL participated

5. SFEN-DEM 2021 – Avignon – CEA and IFE will participate

6. SFEN INDEX 2021 – INDEX 2020 link – Cyclife-DS will participate

7. KONTEC 2021 (08/21) – iUS will participate

8. NWMDER Canada – NWMDER 2019 link- WAI will participate

9. ICOND 2021 – iUS and IFE will participate

In case of DigiDecom 2021, a session specifically relevant for PLEIADES will be organized including moderated group discussion sessions where moderators will provide a summary report from the discussion. These summary reports will be directly useful for the PLEIADES project and will be considered as important sources for defining user requirements and technical specifications. These summary reports are planned to be included in this report.

Input from future events may be provided as notes taken by participants of the PLEIADES consortium. The spread of the idea behind PLEIADES in these events is also likely to provide more input for the project by additional questionnaires filled or additional exchange with interested parties.

Analysis of the questionnaire results

The PLEIADES consortium agreed on application of a combination of the following methods for analysing the results of the responses form the questionnaire:

- **Statistical analyses:** Such analyses included, for instance, analysis of the number of respondents per categories chosen in the respondent profiling form (see Attachment 6.2 for details). This analysis is providing indication about how/if 3D models are used by the respondent and their organisation as well as, needs related to the PLEIADES concept, per respondent type. Such information can be used for defining target end-user groups for the exploitation of the results from the PLEIADES project, elucidate the depth of current use of 3D models within these groups, and general neds PLEIADES could respond to per these user groups. Statistical analysis functionalities built into Google Forms were used for such analyses with the possibility for further analysis using Excel.

- **Requirement analyses**: This was primarily an unstructured analysis of the free responses provided via the questionnaire (by individual members of the consortium and/or validation the results in groups), aiming at generating a list of specific requirements to be considered in developing technical specification for the PLEIADES system architecture, the user stories and defining validation test procedures and protocols including definition of KPIs for evaluation.

- **Keyword occurrence/co-occurrence analysis:** In the early phase of the project, the consortium decided that such analysis maybe be performed in addition to the two other analysis methods above in case time allows. However, such analysis was not performed since the other analysis activities provided sufficient input.

The consortium also noted that the project must be prepared for **changes in the system design requirements during the project**. Hence, the consortium decided that new responses to the questionnaire will be considered at later stages.

In addition, respondents of the questionnaire were asked to indicate if they were willing to be contacted again for following up the progress of the project and providing more input to the consortium. In line with the strategic plan of the project, we are planning to perform **guided interviews** with experts who indicated interest in being contacted personally by the project. The aim is to get specific feedback from these experts on results from the project for informing further development and the final outcomes of PLEIADES. These interviews are foreseen to be performed within WP2 and/or WP3 of the project, when demonstrable results from the prototyping activities are available.

2.3 The PLEIADES questionnaire

As discussed in the previous chapters, a questionnaire based on-line survey was chosen by the consortium as the first method for gathering input from the international community. Questionnaire based survey is a standard method for gathering input from a large audience. However, depending on the desired results, questionnaires have to be carefully formulated in different ways. The nature and quality of the responses depends very strongly on how the questionnaire if formulated.

Method:

The questionnaire was drafted and consolidated in interactive sessions were all the consortium members were invited. A first early draft version was provided by the leader of the task (Task 1.1) that has been hosted open for real time editing and commenting by all partners. In between each session, the leader of this task prepared an update, considering all comments inserted into the draft. The online sessions were then mainly used for consolidating the new version as well as, on-line editing by the task leader based on recommendations from the meeting participants.

The PLEIADES project has specific goals of technical and innovative nature. Due to this, this project needed more detailed and specific responses rather than many general responses. Based on our estimation the questionnaire takes in average 30 minutes to complete.

It is worth mentioning that a survey covering the entire nuclear decommissioning is being performed in the SHARE H2020 project. In the PLEIADES project our approach to the questionnaire was very different, focusing on specific questions directly relevant for the technology addressed by PLEIADES and allowing a lot of free answers where adequate details can be provided, in addition to some pre-selected (in our case Yes/No) answers.

Due to the complexity and innovative nature of the concept behind the project, development of the questionnaire that was suitable for getting detailed and technical answers from professionals with literacy in this topic but, also suitable for getting responses from the large audience with no technical background was a challenge. However, the resulting questionnaire can, potentially, be used a base by other projects with synergic goals.

Some of the main decisions related to the questionnaire are listed below:

- The questionnaire was anonymous, unless the respondent provided contact information for being contacted by the consortium in the future

- The chosen technical platform for the questionnaire was Google Forms
- The questionnaire was hosted on project main page
- Invitations (and links) to the questionnaire were distributed in personal emails, social media and other channels

2.4 Moderated topical group discussions on DigiDecom 2021

The DigiDecom 2021 workshop supported a number of European and national innovation projects within the field of nuclear decommissioning, as well as the work of NEA's EGRRS Expert Group on the application of Robotics and Remote-Systems in the nuclear back end.

The whole second day of DigiDecom 2021 was dedicated to the PLEIADES project and other strongly related initiatives.

DigiDecom 2021 provided important opportunities for:

- disseminating results (achieved to date) from the PLEIADES project,

- establishing links with relevant EU and national initiatives (see the banners above),

- gathering general know-how relevant for further developments in the projects (from relevant presentations by people outside the PLEIADES consortium), and

- gathering further input from a large cross-disciplinary audience for concluding the PLEIADES analysis of needs and requirements.

The last bullet point in the above list was the most important goal for the project. This goal has been supported by a series of presentations for providing a good understanding for the audience of the PLEIADES project strategic goals and results achieved to date. Below is a list of presentations that provided input information for the audience on the PLEIADES project:

Table 1: PLEIADES related speeches at DigiDecom 2021

Tuesday - 23 March: Innovation needs, solutions and initiatives
International needs and opportunities for innovation *István Szőke (IFE, Norway)*
Overview presentation of the PLEIADES project on PLatform based on Emerging and Interoperable Applications for enhanced Decommissioning processes *Caroline Chabal (CEA, France) and István Szőke (IFE, Norway) (presented by István Sz.)*

Wednesday - 24 March: Innovation needs, solutions and initiatives related to digital transformation of decommissioning and waste management Chairs: Erika Holt (VTT) and Ole Jakob Ottestad (NND)
Surveys by the PLEIADES project related to use of digital models in decommissioning http://pleiades-platform.eu/2021/01/13/pleaides-survey/
Digital transformation of decommissioning *István Szőke (IFE, Norway)*
Towards an international nuclear decommissioning ontology – Results from work in PLEIADES and co-operation among IAEA collaborating centres *Franz Borrmann (iUS, Germany)*
Technical aspects of digital integrated decommissioning support systems and prospects with ISDC (International Structure for Decommissioning Costing of Nuclear Installations) based costing *Dusan Daniska (WAI – Aquila Costing, Slovakia)*
3D Digital Simulation of complex D&D projects - Use case: Chinon A2 dismantling project *Paola Ontiveros (Cyclife Digital Solutions, France)*
How BIM is used in the construction industry – prospects for use in nuclear decommissioning *Dag Fjeld Edvardsen et. al. (Catenda, Norway)*
Digital transformation – A TSO point of view *Patrice François (IRSN, France)*

After presentations from the PLEIADES project partners (see above) topical group discussions were organized in the second half of the second day of the workshop specifically designed for providing input on needs and requirements by the audience to the project consortium. Each topical group addressed needs and requirements from a different perspective and were moderated by 2 or 3 moderators always including one moderator from the PLEIADES project consortium. The group discussions took advantage of the Mural on-line tool for facilitating acquisition of input from the audience. Below is a structure of how the group discussions were organized and moderated.

<div align="center">Table 2: Digidecom breakout group discussions</div>

16:20	Discussion of innovation needs and possible solutions related to digital transformation of decommissioning
	Chairs present of the objectives of the group sessions
	Moderators shortly present the topic of their group and some food for thought (e.g., outcomes from PLEIADES)
	<u>Breakout to groups</u>:
	Group 1 Regulatory/TSO aspects for use of BIM based of modular integrated software systems
	Moderators: Patrice Francois and Malgorzata Sneve
	Group 2 Technical barriers and needs for implementation of BIM based modular integrated software systems
	Moderators: Dušan Daniška, Dag Fjeld Edvardsen and Ole Jakob Ottestad
	Group 3 Human and organisational barriers and needs for implementation of BIM and digital twin based support systems for decommissioning and waste management
	Moderators: Erika Holt, Martin Andreasson and José Antonio R Cabrerizo (KIT)
	Group 4 International nuclear decommissioning ontology
	Moderators: Franz Borrmann and Maarten Becker (iUS)
	Group 5 Use of digital models and simulations for international knowledge exchange
	Moderators: Patrick O'Sullivan and István Szőke
	Moderators will steer discussions and prepare final summary report from the session. Mural rooms will be used for collecting and summarizing input from the participants.
	Instruction for moderators: Focus on identifying user requirements (and, possibly, associated tech requirements) for use of 3D digital modes.
	Short summaries from the group discussions presented in Plenary by the Moderators (5 min each) & Plenary Discussion
	Moderators and Session Chairs

In addition to the presentations listed above (for more details please visit www.ife.no/DigiDecom2021) a short (4 slide) presentation (similar to that in Attachment 6.1) was presented at the beginning of each group discussion by the moderators. Each group discussion aimed at gathering the following types on input from the audience:

1. User requirements for **new capabilities** enabled by PLEIADES

2. **KPI**s* for measuring improvements provided by these new capabilities

3. **Requirements** for deployment

4. **Barriers** and **enablers**

The mural sessions were structured in 4 distinct steps:

1. Introduction (providing input for the participants)

2. Collecting Thoughts – Brainstorming

3. Sorting provided input into the following 4 categories: Capabilities, Requirements, KPIs, Blockers and Enablers

4. Voting session for identifying common high priority comments

2.5 Guided interviews with selected experts

Guided interviews with selected experts are planned to be performed at a later stage (as part of subsequent work packages) to gather direct input from potential end-users when preliminary prototype implementations and technology demonstrations are available. Such input will be used for informing continued prototype implementations and for validation of the final prototypes to be developed against the user requirements and KPIs listed in this report.

3 Gap analysis results

This chapter will provide results from the analysis activities introduced in Chapter 2. Chapter 2 describes that a keyword occurrence analysis may be done if seems necessary. However, keyword analysis was not implemented and hence results from such analysis will not be presented in this chapter.

3.1 Statistical analysis of questionnaire responses

Below, chart are provided showing the distribution of the 34 responses received as a function of the responses provided in the respondent profiling section of the questionnaire.

Chart #1: Responses by country

The location of the respondents is distributed worldwide with most occurrence of European countries and including also non-European countries like United States and Pakistan.
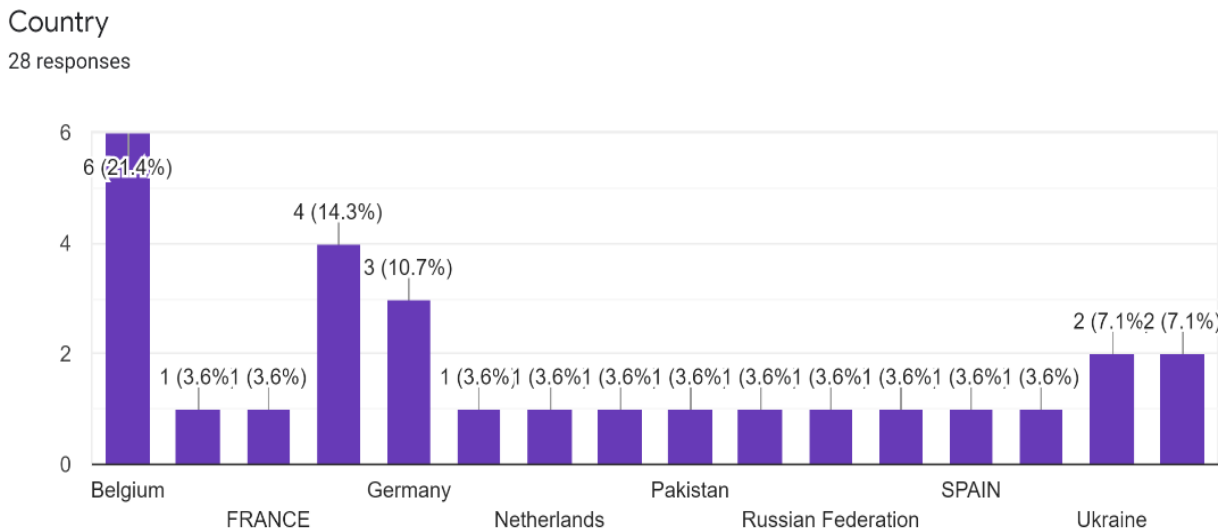

Figure 4 Distribution of the number of respondents by countries

Chart #2: Responses by size of company

Following answers for the size of the respondent's company were predefined: less that 50 employees, between 50 and 500 employees and more than 500 employees. Figure below illustrates the distribution of the answers with the significantly largest representation of large companies with over 500 employees.
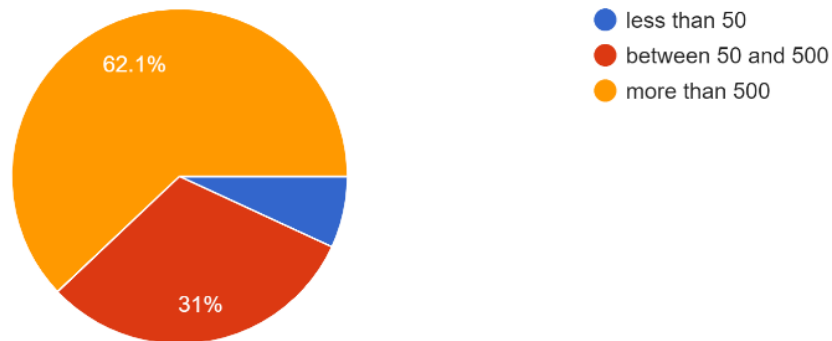

Figure 5 Distribution of the number of respondents by size of the company

Chart #3: Responses by type of organization

Following answers for the type of the respondent's company were predefined: Industry, Operator, University, Consultancy, International Organization, Research Organization, Regulator, Standardization Organization, TSO and WMO. Figure below illustrates the distribution of the answers. Three most represented types (Industry, Operator, Research organization) cover almost half of the answers.
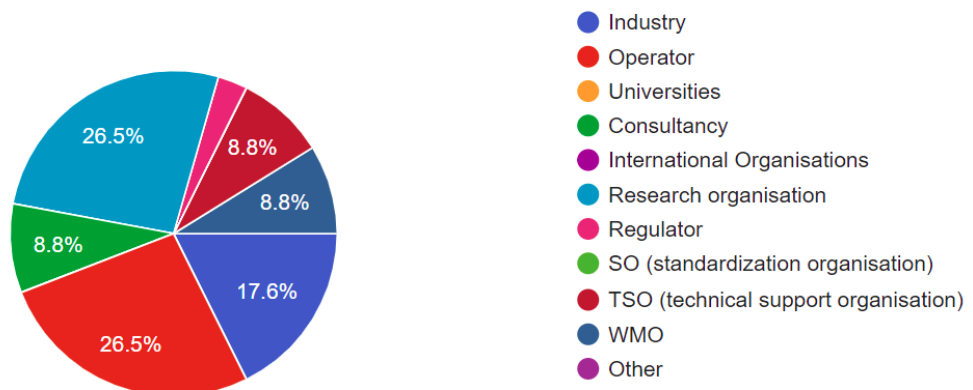

Figure 6 Distribution of the number of respondents by type of organization

3.2 Analyses of free text questionnaire responses

Questions in the on-line questionnaire were grouped into 7 topical categories (core question groups), each containing several questions as sub-topics. The 7 question groups were:

- Topic 1/8: *- Experience with using digital models for site and facility management:*
- Topic 2/8: *- Experience of using digital models with Decom & WM:*
- Topic 3/8: *- Experience with the use of digital models for specific tasks:*
- Topic 4/8: *- Availability of a central collaborative data/information storage system:*
- Topic 5/8: *- Development and optimisation of decom/WM plans*
- Topic 6/8: *– Specific key requirements for the PLEIADES concept*
- Topic 7/8: What major barriers do you expect for adoption of the PLEIADES concept

The 8th question group consisted of questions asking the respondent if they would be willing to be contacted by the consortium with follow questions and for getting further and/or more specific input when preliminary development results are available.

3.2.1 Management of facility information (questionnaire topics 1, 2 and 4)

Topic 1 - Experience with using digital models for site and facility management:

- Most respondents have at least some experiences in working with digital models;
- (1.7) & (1.8) Those who answered having no experience could see an interest but cite the additional costs and a not so obvious added value as barrier to develop project around digitals models.

(1.1)   Digital models are reported to be encoded in various formats: CAD files, 3D scans (point clouds / 360 picture), extended to BIM when data is linked to the models

(1.2)   Management of 3D models is ensured by engineering teams, supported with a drafting office. Specific functions can be defined like the BIM manager, BIM coordinator. There can be different departments responsible for the 3D models and the databases that are linked to the models.

(1.3)   The general rule is that access is granted to stakeholders needing the information to do their work: project coordinators, 'draftsmen', engineering teams, middle management, etc. Some kind of access control is provided through the Common Data Environment.

(1.4)   Periodicity of model updates was answered specific to each project, and project phase. Update on a monthly basis was the most frequent answer.

(1.5) & (1.6): The respondents indicated that models are usually updated semi-automatically, or manually. Some data can be gathered automatically in the model (e.g., through sensors). This is rather the

case for newer models. But in practice, a human intervention is often necessary in the process. For manual data collection, the respondents referred to gathering information from existing databases and documentation, information exchanged during project meetings, on-site walkdowns, scan campaigns. Some respondents also mentioned the quality controls that validates the data entering the models. Overall model update process can be defined in the BIM execution plan.

(1.9) Concerning the tools used by the respondents not (yet) working with digital models, the mainstream software suites are mentioned (next to in-house tools): MS Excel, MS SQL, Oracle, AutoCad,…

Topic 2 - Experience of using digital models with Decom & WM:

- About 2/3 of the respondents indicated having some experience with digital models in the context of Decom & WM.
- (2.7) & (2.8) Similarly to question Q1, those who answered having no experience could see an interest but cited the additional cost, and no particular need for the moment.

(2.1) Many kinds of data are mentioned as being (or to be) linked to the digital models for Decom & WM:

- construction files, documents, manuals, lesson learned;
- material properties, inventories (list nr, mass, volume), radiological data, isotope vectors, radiation/dose rates, calculated data on contamination, calculated data on activation, chemical data, hazardous materials;
- historical data of operation, events, real time data from sensor;
- Images, videos;
- Logistic requirements, waste streams, evaluated costs.

(2.2) The models and data are encoded in all sorts of files formats, there is no common basis in the answers of the respondents:

- proprietary or open formats for the geometries, with or without embedded data;
- Excel, csv, Access, Relational databases, Word, …
- image or pdf scans from paper or microfilms
- specific formats from in-house applications

Additional meta-data can be added to the files through the Common Data Environment functionalities.

(2.3) Some standards are cited for organizing models and data: ISO 19650 series, PAS 1192 series, Industry Foundation Classes (IFC). But many respondents do not apply particular standards, or do not know.

(2.4) There is in general no fixed frequency for the updates. The models and data are updated when needed.

(2.5) The tools for managing the data rely generally on a data repository, providing some kind of document management system and access to the databases (minimum feature), or a more elaborated Common Data Environment with associated management functionalities. In-house management procedures determine how the data can be accessed and updated. This can be specified through a BIM execution plan.

Topic 4 - Availability of a central collaborative data/information storage system:

- About half of the respondents indicated having such centralized data storage system. Those respondents did not receive other questions in part Q4.
- For the respondents who indicate not having such centralized data storage system, additional questions were asked:

(4.1) Without a centralized collaborative systems, information is collected by employee on integrated document management system, server directories, subject specific databases. Finding the information can be done through search tools, or by reaching out key people. (Q4.5): The information is communicated to external partners through data repositories dedicated to the project, or email exchanges.

(4.2) Information is communicated to the regulators through paper copies, pdf sent by email, or meetings. The information undergoes an approval process prior to communication.

(4.3) Public communication is usually realized through the company website. Newsletters, info sessions, or public consultations can be used in particular circumstances.

(4.4) Information is not share with other licensees on a regular basis. Sharing of information would take place for example through conferences, peer reviews, EPRI workgroups, WENRA, IRS reporting system.

3.2.2 Use of digital models for decommissioning support (questionnaire topics 3 and 5)

The use of digital models offers a great advantage for planning decommissioning and waste management. Tasks like scheduling, resource allocation, training, costing, work planning/assistance, visualization and monitoring of activities can be carried out in a more efficient way thanks to the use of the BIM methodology.

Topic 3 - Experience with the use of digital models for specific tasks:

Does your organisation have experience with using digital models for specific tasks (e.g. those mentioned above)?
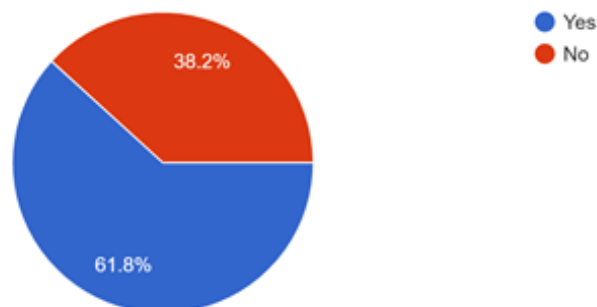
34 responses

- Yes
- No

38.2%

61.8%

Figure 7 Number of respondents that have experience with using digital models for specific tasks

13/34 of the respondents have no experience with using digital models for specific tasks, while **21/34** of them do have. Only these last ones provided information in questions 3.1 - 3.4. These questions were completely open and the majority of the respondents gave several answers.

(3.1)   What are digital models used for:

- Nearly half of the respondents having experience with the use of digital models (10/21) use them for planning – including detailed planning – and scheduling. Other applications named more than once are costing/cost estimation (3), training (3) and waste streams (2).
- Other given answers were: calculations, clash detection, contamination, data management, decommissioning scenarios, design of new facilities, planning dismantling sequences, implementation, localization, logistic aspects, maintenance, operation, optimization, plant configuration management, resource estimation, resource allocation, robotic systems, sharing information, short/long term scheduling, tasks explanation, virtual visits and visualization –with CAD models – work assistance.

(3.2)   Types of used key data/ information:

- The most used key data/ information is: radiological inventory (5), geometrical data (4), cost data/evaluation (3), characteristics/type of material (3) and 3D models (2).
- Other answers given by the respondents were: activation database, activity, angles, contamination, decommissioning speed, dimensions of the SSC, dimensions, distances, execution time estimates, follow up, historical exploitation data, inventory, masses, material properties –like surfaces and textures – engineering data, neutron flux, physical data, physical inventory, planning data, progress measurement, property sets, quantity, radiological characterization, scenario development, schedule management, segmentation, tools and equipment selected for dismantling, volumes and waste acceptance criteria.

(3.3)   Kind of software and tools used by the respondents:

- Several of the respondents use software which is not specific for the nuclear field, like: CAD drawing software (7), Excel (5), MS Project (5), MS Access (2), Sketchup (2), databases (2), Plant-4D, Revit, SAP, Solidworks or Vircore platform.
- Specific sofware used by the respondents are: ChNPP Planner, Dassault System 3D experience Enovia + Exalead, DEMplus, Geant4, Microshield and Neobotix platform for mobile 3D scanning system.
- Other tools used by the respondents are: MCNP, communication tools, contamination and activation models, geometrical viewers, in-house software, measurement tools, navigation tools, proprietary scheduling software, radiation tools and scheduling programs.

(3.4)   Respondents were also asked for what other purposes they would recommend the use of digital models. Answers that had already been given by the same respondent in question 3.1 were not taken into account:

- The most recommended purposed were: BIM (2), costing/cost estimation (2) and training (2).
- Other purposes recommended by the respondents are: 3D Simulation, ALARA modelling, kinematics of large component retrieval, clash solving, contractors management, decision making, definition of radiological characterization and sample collection, flow simulation – as

DES –, planning decommissioning work, production of videos, request for quote, resource allocation, risk management – high level risks strategy –, scenario modelling, selective decommissioning, specialized decom information systems, virtual twin and VR applications.

Conclusion on the use of digital models for specific tasks:

Nearly half of the respondents that have experience with the use of digital models use them for planning and scheduling. Costing/cost estimation and training are also important purposes as 5 of these respondents already use digital models or recommend their use for that.

Radiological data are the most commonly used by the respondents, but almost none of them use digital models for this. Therefore, here we find a possible gap and we will have to work in this regard.

The majority of the used software is not specifically designed for the nuclear field. Here we can conclude that PLEIADES should be a platform that allows interoperability with standard data and programs that are already used in the market at a standard way.

Topic 5 - Development and optimisation of decom/WM plans

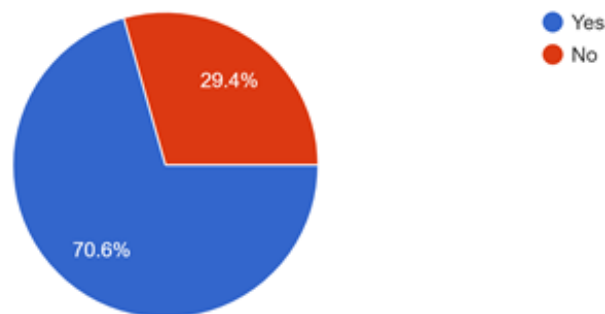Does your organisation have experience with development of decom/WM plans?
34 responses

Figure 8 Number of respondents that have experience with development of decommissioning / WM plans

10/34 of the respondents have no experience with development of decom/WM plans, while **24/34** of them do have. Only the latter provided information in questions 5.1 - 5.6. These questions were completely open and the majority of the respondents gave several answers.

(5.1) Tools and methods used to analyse and/or optimize waste streams:

- 3 of the respondents use or develop digital models – 3D and CAD for this purpose.
- Some of the respondents indicated that they outsource services with experts/experienced personnel (2), specialised analysis by expert subcontractor, external consultants/tools or

application for recognition via national institute for radioactive waste, while other respondents use their own developed tools and codes (2).

- Estimation of radiological inventory and the different wastes – based on inventory –, waste streams, quantity and costs – with Excel data.
- 3 respondents make calculations to estimate the activity – total activity in Bq or specific activity in [Bq/g] or [Bq/cm²] –, estimate the material streams – including quantity and cost – or radiological aspects.
- Destructive testing and sampling with analysis in laboratory or non-destructive testing with dose rate measurements in the installations – prior to dismantling – are also answers given.
- Other answers given indicated: acceptance criteria valid for waste processing facilities as well as waste storage/disposal facilities, according valid waste catalogue, analysis – gamma and DTM, characterization, compliance with the requirements of the regulator, definition of problematic waste streams, DEMplus, development of guidance documentation, dose rate measurements in the installations (prior to dismantling), extensive waste inventory (prior to dismantling), handling for legacy waste tasks, identification of specific cases by the eng. team (while preparing decom), in-house software tool, linked databases on inventories and measurements, management with general procedures, modelling of activities, planning, procedures from Integrated Management System, radiological and chemical data with the inventory, radiological surveys, segmentation and packaging plans for the activated and most contaminated equipment, separation of conventional waste (materials ready to release), statistical analysis of data (geostatistical analysis), storage of physical and radiological data, survey of waste volumes/types, system to collect liquid radioactive effluents with underground pond to store before to sending to other ponds from treatment plant for radioactive waste by pipes – waste streams from primary circuit, secondary circuit, reactor block, horizontal and vertical channels, core zone –, waste type, Wasteapp.

(5.2) Tools and methods used to estimate costing and benchmarking of the selected strategies:

- 4 of the respondents support as external resources by making preliminary cost estimation based on waste management obligations, using tools that include price databases, estimating cost based on price benchmarking or consulting data-based program systems like CORA-CALCOM.
- In 3 of the responses the services are outsourced with external consultants, experts or REX, while 2 of the respondents answered that they use home-made/in-house made tools.
- 4 of the respondents use internal information like internal inventory lists and radiological data, estimated amount of radioactive waste produced, internal REX or existing data from former projects – time consumption of hands-on decommissioning activities.
- 2 of the respondents use Excel for cost estimate with or without an ISDC – like cost estimate methodology implemented.
- Other answers by the respondents were: AI data analytics – for benchmarking –, case by case, contract with a NPP to receive the radioactive waste, cost/benefits analyses, experience of nuclear engineers, ISDC, project manager, use the data from maintenance and repair from NPP – cost estimate for immediate dismantling –, waste types.

(5.3) Tools and methods used to optimize works plan (scenarios):

- 3 of the respondents use cost/benefits analysis, calculation or evaluation.

- 2 of the respondents use risk analysis and in other 2 cases ALARA is used for evaluation or optimization.
- Tools based on technical feasibility like: constructability/deconstructability assessments, engineering judgement, feasibility studies, as well as 3D and CAD models/drawings – Sketchup, Plant-4D, Vircore – are used.
- Other given answers were: case by case, DEMplus, future development of specific software (integration into Vircore), HAZOP/HAZIP exercises, in house software tool + MS Project, integrated work control process, Microshield, planning meetings – staff involved in decom –, project manager, regular interaction by the programme management and the operators, scenario approval by different intern services – iterative process, different points of view –, scenario approval by the national institute of radioactive waste – meeting criteria before acceptance –, scenario development, Visiplan, visualisations, work plans written by experienced personnel.

(5.4) Respondents were also asked for other tools and methods used for decom/WM planning. Answers that had already been given by the same respondent in question 5.1 were not taken into account:

- 7 of the respondents use standard/ not specialized tools like: MS Project (3), Excel, ad hoc tools, document management systems, Project Management tools, SAP systems - for cost accounting, while 2 of them use specific or internal tools like CORA-CALCOM or own developed logistic tools.
- Other given answers were: ALARA, animations, Gantt diagrams, hazard reduction.

(5.5) Tasks supported by digital models:

- 7 of the respondents use digital models to support calculations and estimations like: activation calculations, contamination estimation, engineering calculations, inventory estimation, kinematic of operations/ studies or waste estimations.
- 5 of the respondents use digital models for planning and logistics like: design of new facilities, dismantling planning, logistics, segmentation plans and work planning.
- 4 of the respondents use digital models to support decision making tasks like: ALARA studies (2), dismantling scenarios or selection of strategies.
- 2 respondents use digital models for training/dissemination or simulation of dismantling works.
- Other tasks mentioned that are also supported by digital models: activated components management, basic design of the installations and systems, briefings, cost calculations, geostatistical tool, high hazard, inventory of materials unconditional release and materials sent as radioactive waste, planning phase of sampling/cutting, preparation for work performance, radiological characterization, routes and flux of the materials resulting from decommissioning, tasks for dismantling and segmentation - primary and secondary circuit, reactor block, core zone, vessels, horizontal and vertical channels.

(5.6) Other digital tools used for this purpose:

- 8 of the respondents use specialized/specific tools for decommissioning costs, dismantling management systems (SGDES), scientific software for radioactive waste management (SGR) or special modules and applications (INFLUVIAL), like MERCURAD, Genie 2000 Software or ChNPP Planner.

- 5 of them use standard digital tools like: Autocad (2), Sketchup, information /data management systems with some special modules or relational databases.
- Other digital tools used for decom/WM planning are: design of final survey, electronic recordings, geostatistical simulations, shielding evaluations, VR.

Conclusion on the use of digital models for development and optimisation of decom/WM plans:

According to these answers we can see that nuclear is a field in which many services are outsourced. Therefore, PLEIADES should be a platform that takes this into account and therefore allows the exchange with external service providers.

Conclusion on the use of digital models for decom support:

As questions belonging to the group 3 were quite specific, the answers were mainly with short terms and quite a few repetitions were identified. Therefore, the results could be analysed in a more quantitative way.

On the other hand, as questions 5.1 to 5.6 were more open the responses were much longer and varied, with hardly any repetition. Hence, this analysis is more qualitative.

3.2.3 Specific expectations for the PLEIADES prototype (questionnaire topics 6 and 7)

Topic 6 – Specific key requirements for the PLEIADES concept

(6.1) Key input data/information that should be supported:

- Specific formats like: .access, .csv, .dwg, .excel, .rft, .xml, and 3D models based on BIM (like .ifc, .rfa, .rvt, .rte) (2).
- Data containing the geometrical information of the existing like: 3D scan, point clouds / point cloud file formats (like .fls) (3), volume, 3D model (2), geometry, 2D and 3D drawings / layout of the facilities (2).
- Information related to: activation, contamination, dose rate, dosimetry, physical, physical-chemical characteristics, properties of the different waste treatment and conditioning process steps, radiological / radiological data/characteristics (2), radiological characterization, radiological data, material characteristics (incl. hazardous) (2).
- Inventory (3), historical data.
- Cost / costing / economic parameters (3).
- Other given answers were: all data as mentioned in IAEA SSG-47, Item 7.14 (p.47), APIs* to common databases, building and infrastructure characteristics, CDE* as a single source of information, civil engineering (concrete quantities, contamination), deep geological repository, drawings CAD 3D/SSC composition (metal, concrete, radiological data, tools and equipment used for dismantling, material management, monitoring personnel dosimetry data, radiological and industrial safety for any SSC), facilities and equipment data (length, weight, material,

contamination), hazards, information about the ventilation concept, intermediate level waste, mass, material streams, resources, risks, schedule, timelines, treatments, waste acceptance criteria, work order (historical and future).

(6.2) Key functionalities that should be supported:

- Mass calculations, sum (waste/material/surface/type), material recognition.
- Cost analysis, costs savings, cost estimation/control, 5D costing estimation.
- Functionalities related to tracking like: locations, material flow and fluxes, traceability (material streams, items), traceability of waste/materials.
- Functionalities related to modelling like: 3D CAD and 3D BIM models, 3D model federation, 3D model viewing, deep geological repository modelling, flexible modelling, integration of 3D scans/point clouds,
- Contamination information, physical and radiological database, radiological and physical inventory management, support for radiological characterization campaigns (including planning, sampling, labelling, connecting data from analyses/ measurements),
- Other given answers were: (Project) Planning / Scheduling (2), 4D planning, access control, activity inventory, activity reduction, ALARA / ALARA watchouts for workers/equipment (2), approval workflows by regulator, AR functionality, assistance to strategy selection, BIM functionalities offered, kinematic of operations, CDE, connection to other platforms through APIs, data preservation, document management, enhancement of 3D model with historical data, establishing all material evacuation files (waste declaration, clearance, recycling), facilitate exchanges between applications, facility characterization, graphs, information access rights management, maintain currently configuration of SSC, mark-up and comments on cloud-based models (real time), offer standardized interfaces, permit add new information, possibility of partial use, product Lifecycle Management platform, provide easy management, resource management linked to item dismounting/processing/measuring, resource planning costing, scenario modelling, search engines, secured information, space management, structured information, support for change impact on safety studies, support for decom planning, optimization of decom based on capacity in waste routes, support for robotic/autonomous operations, support for visualization of different levels of details and with a mixed input of datatypes (point clouds, gamma cloud mixed with 3D drawings), training, uncertainty management, verification of acceptance criteria for final waste packages, visibility to regulator, visualization, waste estimations, waste management (database), links between infrastructure and measurement data.

(6.3) Key output data/information that should be provided:

- Information concerning: plan / planning (2), schedule, timeline plans, BIM visualizations of timelines, timing.
- Information related to radioactivity: dose budgets, radiological data, dosimetry, contamination, activation, workers exposure status, radiation mapping (real time when performing decom actions), indication on radioactivity,
- Information related to waste quantification and traceability like: amount of radioactive waste, waste estimation, BoQ, material evacuation files, material management, radioactive and

conventional waste inventories and routes, logistic routes, item traceability (identity, material, origin, radiological content, evacuation route, packaging).

- Information related to uncertainty and risk like: safety recommendations, uncertainties, inputs to safety studies.
- Other answers given by the respondents were: exporting decom plans, geometry, material characteristics, cost / cost estimation (4), resources (2), drawings, graphs, KPIs*, technical documents, specifications, drawings (like MEP, structures, views, sections), physical inventory (dimensions), reports (2), data aggregation and visualization 3D, outputs for Excel and .pdf, item costs (dismounting, processing, measuring, engineering labour), provide pictures from digital models, display models in 3D, status of nuclear installation configuration, comparison of planned/executed, financial information, training status, equipment/tools used, maintenance / periodical verification, calibration, consumables status, 3D models, drawings / pictures (2), Gant diagrams, data tables, advanced information research, inventory, work orders, CAD Model, indication on pipes, indication on installations.

(6.4) Other key requirements:

- Requirements concerning flexibility of working mode like: adaptation to new technologies, flexibility of model, flexible compatibility, work in the cloud, work locally.
- Requirements related to support and training: multiple languages, multi-language support (2), support system, training (8), tutorials (5).
- Requirements related to security and responsibilities like: responsibilities and access level of stakeholders, security / cyber security (6), security of data, software update, strong safety model, information security.
- Requirements concerning operations and calculations: ALARA calculations, radiological calculations, structural calculations.
- Other key requirements given by the respondents were: ability to enhance data with historical data, catering for local information security requirements, compatibility between digital models, compatibility between systems (3), compatibility with systems, digital representation, document support, implementation and maintenance of digital models, information (2), information exchange, integrated management system (operator and different organizations), obsolescence risk management, open integration model, role and/or activity based access models applied to all functionality and data access, supplementary costs, support equipment, support for data access audits, timeline phasing, waste information modelling, information control, digital rights management.

**Topic 7 – Barriers** (see barriers listed in the tables in chapter 3.4)

3.3 User needs and requirements - questionnaire analysis summary

Below is a table listing all the user need and requirements that were identified by the project based on the outcomes of the questionnaire survey analysis. Separate tables were provided for specific requirements related expected compatibilities of the PLEIADES concept with tools and data types.

List of identified user needs/requirements (High priority were considered to have higher priority/relevance for the project by the consortium members)

Facility/site information/configuration management

High priority	3D view providing spatial information (e.g. contamination) with integration of different formats (point cloud, 3D CAD, BIM model, …)
	Visualization using 3D CAD models
	Keep IFC/BIM model up-to-date
	Sharing facility/site information
	Mark-up and comments on cloud based models so revision and modification can be addressed during online meetings
	Multi-dimensional planning (4D planning, 5D with cost estimations, …)
	Product lifecycle management (PLM)
	Facility configuration management
	Document management
	Integration of 3D scans / point clouds, 3D CAD and 3D BIM models
	Long-term data management (data preservation, backups, …)
	Enhancement of 3D model with historical data (operational information, legacy waste, accidents, …)
	Safety demonstrations (e.g. visibility to regulators and approvals)
	Common data environment
	Common information structuring enabling further filtering and searching
	Secure information management
	Exposing standardized API for connecting different software tools
Low priority	Designing and building new facilities supporting the decom project (waste storage, DGR, aux facilities, …)
	Physical measurements in 3D model
	Provide a digital twin based view of the facility
	3D model federation
	Certification of new designs (given by design authorities, e.g. for new facilities, equipment, …)
	User permissions / access rights

Facility/site characterization (physical and radiological)

High priority	Radiological inventory data management (e.g. surface contamination, activity, …)
	Management of sampling & measurements (e.g. labelling, connecting data from analyses/measurements to SSCs)
	Physical & chemical inventory data management (e.g. dimensions, mass, chemical properties, …)
Low priority	Detailed inventory data management
	Management of sampling activities
	Statistical analysis of radiological characterization data
	Recognition of material types

Strategic planning and PM

	BIM-based decommissioning approach

High priority	Informed decision making and strategy selection Time estimation Issue management for task scheduling General long term project scheduling Task scheduling (Gantt chart views) Resource estimation and allocation Costs estimates for decom Comparison of costs for different scenarios Linking resources with facility configuration / items / equipment
Low priority	High-level risk management Management of subcontracting activities Browsing historical cost data Monitoring actual costs in comparison with planned estimates ("as-planned" vs. "as-performed" comparison) Re-planning in case unexpected events / accidents Uncertainty management Impact of changes in safety studies

Work planning and implementation

High priority	Source of information for approving the decom tasks ALARA safety evaluations / optimisations (planning of protection equipment, remote works, …) 3D simulation based work scenario planning Duration estimates for decom tasks (e.g. info on duration of previous activities) Information management for work implementation Optimization of work plans AR-based view on facility information
Low priority	3D simulation with kinematics (e.g. removal of large components, clash detection, …) Discrete event simulations Information management and robotic (autonomous, semi-autonomous) mission planning logistic operations (transport routes, waste buffer areas, equipment utilisation, working group placement, …)

Training/briefing

High priority	Virtual visits Visualisation of work plans (videos, …) 3D simulation based videos (e.g. of work plans)
Low priority	AR/VR-based training Personal trainings

Waste management

High priority	3D-based waste management Waste management cost estimations Waste quantity estimation (surface, input material, output waste material/type, …) Waste stream/route analysis and optimisation

Segmentation and RAW packaging plans
Visualisation of temporary waste storage areas
Waste amount minimization
Waste characterization

Low priority
Location and traceability of waste items (fragment, piece, …)
Optimisation of waste packaging (distribution of activity inside the waste package, …)
Waste material flow analysis
Checking the conformity with waste acceptance criteria
Waste transportation logistics (e.g. optimisation based on capacity in waste routes)
Documentation for waste release & recycling

Expected compatibilities with tools / databases / models

3D scan / point cloud tools
3D scenario simulation based tools
3D viewer tools
4D support tools
BIM-based decom support tools
Characterisation support tools
Contamination and activation models
GEANT4 (GEometry ANd Tracking)
In-house / proprietary software tools
MCMP (Multicloud Management Platform)
Microshield (Radiation software)
MS Access
MS Excel
Neutron flux
Plant databases
SAP
Sketchup
Specialized decom support tools
Standard 3D modelling / CAD tools
Standard PM software (e.g., MS Project, Primavera, Merlin)
Standard PM software (e.g., MS Project, Primavera, Merlin)
Team collaboration tools
WM tools

Expected compatibilities data types

3D BIM models
3D CAD models
chemical inventory data
costing data (cost estimations, actual project costs)
data related to project progress
data related to waste acceptance criteria (WAC)

data related to waste management (input material, output material, quantities)
data required for planning
geometrical/3D data
historical site assessment data
neutron flux
physical inventory data
point clouds
radiological inventory data
risk and uncertainty related data
task scheduling data

The tables above were provided on-line for the participants of the DigiDecom 2021 group discussions aiming at identifying high priority user needs and requirements for further developments in the project. Participants of the group discussions were free to use information in the tables directly (copy and paste items into the on-line collaboration platform used) or as food-for-thought for providing input inspired by the information in the tables.

3.4 Outcomes of DigiDecom 2021 group discussions

The columns labelled 'Votes' in the tables below represent the number of individual votes the input received from all the participants of the group exercise who provided their votes. Input from the participants were visible to all the participants as digital sticky-notes (see online explanation for the Mural on-line collaboration tool). Note, that each participant had the same number of votes that they could distribute between any number of sticky-notes in any way i.e., all votes could be given to one specific note or one vote for several notes or any other combination.

Group 1: Regulatory/TSO aspects for use of BIM based of modular integrated software systems

CAPABILITIES	Votes
• Improve communication between policy makers, management, technical implementers, worker representatives, regulators, …	5
• Sharing of good practice and learning from experience • Understand impacts of possible alternative options	2
• Visualisation and optimisation of Radiation monitoring Personnel dose database Personnel dose analysis Dose assessment Work planning Work optimization Training of personnel • Optimisation of radiation situation • Communicate to wider non-technical stakeholders	1
• Possibility to simulate afterwards incidents, near-misses and other events --> enhanced learning	0

- The information should be easy to explore and share with others, so that it can be discussed and decisions made.
- visualisation of different options
- Planning of the risky operations

REQUIREMENTS	Votes
• Provision of evidence for inspectors to use during assessments	4
• Capabilities should include the sources of information	2
• I would like a variety of options for reducing risk to be presented so I can understand the thinking of those presenting the information • Validated radiation/dose calculation models	1
• Requirements to exchange data between stakeholders	0

KPIs	Votes
• Regulator review time/ effort	4
• Validation/verification that the software works	2
• Better communication between operator and regulator - flexibility	1
• Collective dose from operations planned using BMI-enhanced software (vs. traditional planning) • Change on decom plan in volume and Bq Check Sum on Change during transport of waste Checksum on volumes before and after dismantling, track components	0

BLOCKERS AND ENABLERS	Votes
• Potential blockers include the correctness of information - how will it be verified?	2
• A potential blocker is whether the information provided is complete (i.e., that nothing important is missing or not represented) • Potential blocker: Acceptability of software as a safety justification • Clearly improved common understanding - visual representation over text	1
• Track and add change of owners of the waste Calculate summation of dose on volumes in (interim) storage • Require a measure of model fidelity • Institutional inertia; fear of the new; having old people in charge • Sharing of good practice and learning from experience	0

Group 2: Technical barriers and needs for implementation of BIM based modular integrated software systems

CAPABILITIES	Votes

• Ability to make changes that won't affect data from multiple sources (example add new RP data, updating SSC removal, etc.)	3
• Help develop work plans using BIM • Must be able to update BIM model as site is decommissioned • Clear ties and interfaces to waste management - decommissioning is not enough • Security, privacy etc, must be an integral part of the system • Make radiological measurements follow SSCs when they are moved around and when they go into waste streams (waste treatments)	2
• How can point clouds be used? No IFC support. Also needs to be updated when rescanned • Convert "legacy" formats to long-term formats when possible. Detect problems early with content while organization memory can validate content	1

REQUIREMENTS	Votes
• Streamline radiological information gathering and connect in 3D geometry of BIM model. • Able to survive for decades.	4
• Validate that format is future compatible, preferably open standards that are actually in use should be preferred. • Able to be used in any device.	3
• Ability to manage differences between coordinate systems. • Ability to support updates according with IFC improvements. • User friendly interface.	2
• Ability to incorporate new scans over time as work progresses. • Secure access to BIM.	1
• IFC don't cover all data needed in decom. Need a standardized way of linking data between external databases and BIM/IFC. • Ability to work against cloud and/or On Premise. • Ability to manage large quantities of data (like Point cloud).	0

KPIs	Votes
• KPI - Demonstrate dose reduction, cost savings, time • Quantifying benefits is key: cost, exposure reduction, schedule improvement, effective use of resources, more effective training, more flexible planning, etc.	4
• Measurements of efficiency - quantify benefits	0

BLOCKERS AND ENABLERS	Votes
• Critical evaluation of experiences needed; too much focus on just positive aspects. • Can a cloud or mixed solution be the best solution. Or no-go due to legal requirements (formal vs real security?).	3

• Formal standard. • Security barriers in networks bars possible interworking between systems.	2
• Must bring the cost benefit to the decision makers. • Need to develop cost models for implementing to get buy-in, to demonstrate cost benefits. • Able to keep up with technological developments. • Ecosystems around the BIM is immature - and will they mature to be Nuclear ready? • Defining the quality of data needed: better quality data takes more time to assemble. • Ontology is on a high level. Standardising on property level is challenging. • Getting detailed information from vendors. • Data inconsistency.	1
• Maintain security in on premise installation for a long time (will vendors support on-prem in the future). • How to deal with changing needs / requirements. • Review of task specific versus global application. • Data compatibility for sharing or exchange.	0

Group 3: Human and organisational barriers and needs for implementation of BIM and digital twin based support systems for decommissioning and waste management

CAPABILITIES	Votes
• Possibility to test new ways of doing things without actually tampering with the infrastructure	4
• Simulations	3
• Compatibility, historical data • Situational awareness • Overview of BIM capabilities / constraints and decommissioning • 3D immersive visualization • Keep it up to date	2
• Persuasion of management to implement BIM • Mixed reality Visualization in context (e.g., MR overlaid onto real site) • Possibility to interest new generation of employees • Public presentation • Compatibility with existing, complex and established work process • Living documentation • Sustainable planning (e.g., long-term, integration of changes, updates)	1

• Training possibility means increased safety • AI and automation • Both as designed/as planned and as-built representations • Data should be ready for interchange • Acceptability to deeper learning (advanced IT possibilities) • Safety cases easier (regulatory approval faster)	0

REQUIREMENTS	Votes
• Digital Twins • Interest from management • The result should be accepted by the regulator	3
• Keep it up to date • Training on BIM related to decommissioning • Long-term BIM/Decommissioning Program • Training • Acceptability • Compatible with robotics and instrumentation tools	2
• Living documentation • 4D Planning • Training and appropriation • Optimized workflow • Harmonization of standards • Safety	1
• Model update procedure should be test • Tracking • Customized views/access per role type • Consider inter-organizational needs • Workers open for new ways of doing things • Readiness to change • Security • Dependency from the software (software supplier) • Training on BIM related to decommissioning	0

KPIs	Votes
• Speed of moving forward, in company and also regulatory approval/licensing • Radiation exposure of workers	4
• Cost benefit analysis	3
• Total cost of the decom project • Overall project safety • Motivation	2

• Reduced accidents • Cumulated dose uptake • Benefit versus effort of the user	1
• Increase savings of personnel costs • Costs at scale • Accuracy of waste volumes • Safety assessment prepared for publishing • Security • Decom Project duration • Amount accidents	0

BLOCKERS AND ENABLERS	Votes
• Management buy-in (approval)	5
• Initial cost & time, upfront investment • Compatibility with actual versus future tools/needs?	3
• A too strong confidence in technology • Need for education • Technology acceptance • Usability • Time required to get acquainted with system and to keep up-to-date	2
• Mindset • Control and ownership of data	1
• Training for various user categories • Integration of various BIM modules • Software experience • Experts needed to create the model • Conservative thinking • Consider intra- and inter- organizational needs • Budget constraints • Hazard reduction • Lack of skills • ICT + decommissioning knowledgeable personnel • Accessibility of data • Budget for implementing BIM • GDPR • Budget constraints	0

Group 4: International nuclear decommissioning ontology

CAPABILITIES	Votes
• Capability to ensure a consistent approach irrespective of site	5
• A common ontology will make reports from different organizations more comparable	3
• Clear wording • Ontology development will also foster the development of common thesauri and definitions	2
• Connect knowledge • Standardise knowledge • Common ontology makes it easier to communicate to the public using the same terminology • Common understanding of processes, assets	1
• Knowledge exchange • Base of AI • Good to connect with process and vocabulary being developed at NEA	0

REQUIREMENTS	Votes
• Unambiguous and clear identifiers (Names) Definitions	6
• Interoperability can be achieved on a semantic level, not on data structures • Necessary depth of detail	3
• Need to be in accordance with ISDC • Need to take into account predisposal and WAKs • Ability to deliver a good decommissioning strategy • How to manage different set of data (for owners, for implementer and for industrials? • Need for mixed groups all along the value chain to define ontology • How to take into account risks, provisions, and changes of scenarios	1
• Interoperability can be achieved on a semantic level, not on data structures • need to benchmark outside nuclear • Compare costs or waste estimation at every stage (link between provisional software and software used during implementations and management of the differences	0

KPIs	Votes
• A common ontology avoids duplication of reports with different terminology but same content	4
• Net for list of synonyms / vocabulary in different languages	0

BLOCKERS AND ENABLERS	Votes
• Organisations and persons might not be interested to share their knowledge	4
• The concept of ontologies might be new for many people • Not same data used by owners and by industries in matter or cost, planning, etc (some having margins and risks: different tools different data) • Need to take into account new built facilities for waste treatment and storage on site or out of site • People & organisations tend to stick to their wording and terminology	2
• Data bases are not the same when previsions (inventories) and when implementing on site • How to manage different revisions of data after each new campaign of characterisation, or new inventory or new workshop, etc.	0

Group 5: Use of digital models and simulations for international knowledge exchange

CAPABILITIES	Votes
• Quality control and traceability, transmission of data to the end customer. how to process knowledge	5
• Simulations of strategies for certain tasks • Ability to benchmark simulations across a spectrum of similar parameter specifications	3
• The ability to exchange ready-made 3-D models • Current good practice methodologies • The possibility to convert between different 3D data representations (triangular meshes, parametric surfaces, voxel-based, etc.) on the fly	2
• Capture experience • Visual representation of technology • Creation of a team of specialists who are able to examine an object and create its digital twin. The effectiveness of such a team increases with each subsequent modelling object. • The ability to search for specialists who are ready to perform a particular job	1
• PLEIADES is mainly a platform for choosing scenarios, but in decommissioning there are not only choices to be made. Many phases are indispensable. Where will they be linked?	0

REQUIREMENTS	Votes
• User friendly	5
• IT-security is a must	3

• Standardized formats like IFC • The system must have some standards, so that everyone uses the same data base for example • Model should accept a range of parameters for simulation customisation	2
• The system must be extremely open for changes as there will be a big number of different data types • It is verry good if Wi-Fi could be used • Positioning system must be implemented • Easily accessible, if possible, via phone	1
• Data must not be too large, so it becomes too heavy to run • Flexibility • Time should be possible to enable to get a "today value" of activity from known nuclide specific measurements	0

KPIs	Votes
• Control of data management	4
• How is the inputted information, such as demonstrations or claims validated before acceptance onto the knowledge base wiki	3
• Accuracy of models and data have to be checked • Benefit from knowledge base vs cost of maintaining the knowledge base	1
• Who is the target audience, the operator on site, the decision-maker at headquarters, the engineering engineer or the field engineer? • Supports regulatory process	0

BLOCKERS AND ENABLERS	Votes
• Lack of entry data • Sensitive information	4
• Needs to be comprehensive or will not be used	2
• Speed is important to gain acceptance • A large cost is a stopper	1
• Not the same regulatory rules in various countries • It may become an administrative nightmare • Difficulty to directly understand the data structures present in IGES/STEP files • Not all stakeholders will have the competence and resources to use the tool • Language characters issue (Asian VS European for example)	0

3.5 User need analysis based on IFE's assistance projects under the Norwegian Government's Action Plan for Nuclear Safety and Security in Russia, Ukraine and other countries in Eurasia.

3.5.1 User needs based on assistance to Kola NPP.

In the assistance program by IFE (Norway) to Kola NPP (Russia) the VRdose^{TM} (3D ALARA Planning, Briefing and Training) tool family has been used as the main technology platform. However, information about user needs and requirements from these projects are highly relevant for the development of the PLEIADES prototype software ecosystem.

User needs:

- Planning and preparation of work in radiological environments
- Preparation of work permit requests and preparation of radiological work permits
- Briefing of staff, contractors, and other stakeholders
- Post-job analysis and reporting
- Education and training in radiation protection and ALARA mind-set
- Testing and visually assessing the results of new dose calculation models

Expectations and requirements:

- Use existing 3D-models of facilities (in this case Main Pump Room) with focus on risks (radiological)
- Aggregate radiological data from multiple sources
- 3D modelling based platform for
  - Modelling and characterizing nuclear environments
  - Planning a sequence of activities in the modelled environment
  - Optimizing protection against radiation
  - Producing job plan reports with dose estimates
- Scenario simulation for analysis/optimization of work plans
  - ALARA evaluation of work plans
  - Planning of protection
  - Testing & comparison of alternatives in terms safety, cost, …
- Safety and risk management
  - Specific focus on *safety demonstration*
- Monitoring
  - Monitoring dose rates of staff, contractors and other stakeholders

KPIs:

- Kola NPP has during the project achieved the following results related to the defined KPI's
  - Exposure reduction

- o Schedule improvement (speed)
- o Time/effort
  - ▪ More efficient planning for jobs in radiological environments
  - ▪ More efficient preparation of work permit requests and preparation of radiological work permits
- o Training/Briefing effectiveness
- o Effective use of resources (number of people, waiting time, …?)
- o More flexible planning (time for update in case of deviation) for work in radiological environments
- o Cost reduction
- Next step for Kola NPP is to extend the project to other part of the nuclear facility

3.5.2 User needs based on assistance to Leningrad and Chernobyl NPPs.

In the assistance program by IFE (Norway) to Leningrad and Chernobyl NPPs the VRdose™ (3D ALARA Planning, Briefing and Training) tool family has been used as the main technology platform. However, information about user needs and requirements from these projects are highly relevant for the development of the PLEIADES prototype software ecosystem.

User needs:

- Planning and preparation of work in radiological environments
- Collecting data about the environment and the radiological situation
- Development of 3D models and scenarios
- Safe preservation of new and old documentation for future use
- Training of staff, contractors, and other stakeholders
- Post-job analysis and reporting
- Education and training in radiation protection and ALARA mind-set

Expectations and requirements:

- Development of 3D-models of facilities and other data based on old documentation and collection in the field
- Aggregate radiological data from multiple sources
- 3D modelling based platform for
  - o Modelling and characterizing nuclear environments
  - o Planning a sequence of activities in the modelled environment
  - o Optimizing protection against radiation
  - o Producing job plan reports with dose estimates
- Scenario simulation for analysis/optimization of work plans
  - o ALARA evaluation of work plans
  - o Planning of protection
  - o Testing & comparison of alternatives in terms safety, cost, …
- Safety and risk management

- o   Safety demonstration
- Monitoring
  - o   Monitoring dose rates of staff, contractors and other stakeholders

KPIs:

- LNPP and ChNPP have through a number of projects achieved the following results related to the defined KPI's
  - o   Better overview of the radiological environments
  - o   Got a good basis for planning complex operations
  - o   Training/Briefing effectiveness
  - o   More flexible planning (time for update in case of deviation) for work in radiological environments
  - o   Cost reduction when doing repeated tasks
- Next step for LNPP and ChNPP are extend the software in cooperation with IFE for more efficient use and better radiological calculations

4   Conclusions

Below is a bulleted summary resulting from the need and requirement analysis activities performed, up to date, in this project. This summary is prepared by summarizing (and grouping) the input that received at least 3 votes at the group session dedicated to PLEIADES on the DigiDecom 2021 workshop. Since the summarized and prioritized results of the questionnaire survey was provided as a base for informing the group discussions, these conclusions also integrate results from the questionnaire survey and direct input provided by the project consortium partners.

Below is a stepwise description of how the final concussions were obtained from the questionnaire analysis results:

1. Gathering responses through the questionnaire: Project consortium partners were also allowed to complete the questionnaire.

2. Summarizing the questionnaire results in interactive sessions with the consortium partners: Project partners provided direct input through complementing or interpreting responses to the questionnaire. Results of this step is presented in chapter 3.3.

3. Use the questionnaire results for identifying high priority needs and requirement, as well as KPIs, blockers and enablers thought topical interactive on-line group sessions at DigiDecom 2021.

4. Prepare conclusions: Input that received 3 or more votes were summarized by the consortium partners.

Needs

3D/BIM based inventory management with focus on risks (e.g., radiological)

- Connect radiological and other inventory info to SSCs

- Aggregate data from multiple sources

- Update inventory (new data, change to facility/site)

- Export for providing data to third parties

- Enable informed communication between all stakeholders

Scenario simulation for analysis/optimisation of work plans

- ALARA evaluation of work plans

- Planning of protection

- Testing & comparison of alternatives in terms safety, cost, …

- Sensitivity analysis

- Benchmarking across a spectrum of similar parameter specs

Safety and risk management

- Safety demonstration

- Support for safety inspections

- Uncertainty management

Waste route planning

Monitoring

- Costs in comparison with plans

- Tracing waste items from initial to final location

- Quality control

Expectations

3D/BIM based inventory management with focus on risks (e.g., radiological)

- Aggregate all radiological data in a 3D model based interface including historical data

- Filter radiological data (for SSCs, time, status, DQOs)

- Improved control over data management

- Mapping completeness of inventory (filter: missing / estimated / validated)

Scenario simulation for analysis/optimisation of plans

- Compare alternative detailed plans in terms of dose

- Better understand work plans

- Detect physical clashes

- Estimate radiological exposure to workers

- Improved training by use of 3D visualization

Safety and risk management

- Improve current safety demonstration practice

- 3D model based facility/site overview of risks (risk register) – identify critical risks, filter risk info

- Improved uncertainly estimations

- Better anticipation of unforeseens

- Identify parameters with highest impact onto project performance (sensitivity analysis)

- Trace back decisions (who, why,…)

Monitoring

- Compare 'as planned' with 'as performed' data

- Detect discrepancy between predicted ALARA estimates and data from monitoring during implementation

- Benchmark cost estimates using data from completed tasks

- Improve updating of cost estimates in case of deviation from assumed inventory

- Regularly updated info on location of items – traceability from initial to final location

Waste route planning

- Optimize wate streams

- Compare alternative waste routes (costs, time, …)

KPIs

- Cost reduction

- Exposure reduction

- Schedule improvement (speed)

- Time/effort for regulatory/review approval (licensing)

- Waste reduction/optimization

- Training effectiveness

- Effective use of resources *(nr of people, waiting time, …?)*

- More flexible planning *(time for update in case of deviation?)*

VS

- Investment (time, cost) required

Requirements

To the end-user:

- Level of <u>expertise</u> in (e.g., rad. protection)

- Unique <u>identifiers</u> for items (SSCs), their segments and waste packages

- Availability of <u>input</u> for modelling waste streams (waste factors, etc...)

- Capabilities for keeping information <u>up to date</u>

- Dedication of internal human and other <u>resources</u>

- <u>Timing</u> of system implementation (earlier is better)

To the technology provider:

- Positive <u>economic feasibility</u> (investment vs. benefits)

- <u>Acceptance</u> by different stakeholders (regulators, TSO, management)

- Long term <u>support</u> by the system provider

- Intuitive <u>user-friendly</u> interface

- <u>Data security</u> (security updates, secure data transfer, barriers between software modules, access rights/control, cloud solution vs. local installation)

- System <u>flexibility</u>

    - Platform / op. system <u>independent</u>

    - <u>Configurable</u> to various customer environments

    - Compatibility with <u>future</u> needs and future tools (future formats - open standards) – future system updates

- Common <u>data environment</u>

- <u>Version/revision</u> control

5 Suggested further reading related to the project

Below are links to material presented on the DigiDecom 2021 workshop that are directly related to the PLEIADES project are were presented by the project partners.

- *István Szőke (IFE, Norway)* International needs and opportunities for innovation https://ife.no/wp-content/uploads/2021/03/1.03-Istvan-Szoke-Innov.-needs.pdf

- *Caroline Chabal (CEA, France) and István Szőke (IFE, Norway) (presented by István Sz.)* Overview presentation of the PLEIADES project on PLatform based on Emerging and Interoperable Applications for enhanced Decommissioning processes https://ife.no/wp-content/uploads/2021/03/1.06-Istvan-Szoke-PLEIADES.pdf

- *István Szőke (IFE, Norway)* Digital transformation of decommissioning https://ife.no/wp-content/uploads/2021/03/2.02-Istvan-Szoke.pdf

- *Franz Borrmann (iUS, Germany)* Towards an international nuclear decommissioning ontology – Results from work in PLEIADES and co-operation among IAEA collaborating centres https://ife.no/wp-content/uploads/2021/03/2.04-Franz-Borrmann.pdf

- *Dusan Daniska (WAI – Aquila Costing, Slovakia)* Technical aspects of digital integrated decommissioning support systems and prospects with ISDC (International Structure for Decommissioning Costing of Nuclear Installations) based costing https://ife.no/wp-content/uploads/2021/03/2.05-Dusan-Daniska.pdf

- *Paola Ontiveros (Cyclife Digital Solutions, France)* 3D Digital Simulation of complex D&D projects – Use case: Chinon A2 dismantling project https://ife.no/wp-content/uploads/2021/03/2.06-Paola-Ontiveros.pdf

- *Dag Fjeld Edvardsen et. al. (Catenda, Norway)* How BIM is used in the construction industry – prospects for use in nuclear decommissioning https://ife.no/wp-content/uploads/2021/03/2.07-Dag-Fjeld-Edvardsen.pdf

- *Patrice François (IRSN, France)* Digital transformation – A TSO point of view https://ife.no/wp-content/uploads/2021/03/2.08-Patrice-Francois.pdf

6 Attachments

6.1 Short presentation of the PLEIADES concept/project (for respondents of the questionnaire and group discussions)

PLEIADES: validation/demonstration cases

ENRESA reactor

IFE research reactor

EDF facility

DATA COLLECTION

PLEIADES platform

Cost and planning

Radiation exposure estimation

Scenario studies

Waste assessment

4 Topical areas for validation tests

Simulation results

Comparison

Referential results

3

Expected results

1. User requirements for **new capabilities** enabled by PLEIADES

2. **KPIs*** for measuring improvements provided by these new capabilities

3. **Requirements** for deployment

4. **Barriers** and **enablers**

Group 1 **Regulatory/TSO*** aspects for use of digital models

Group 2 **Technical** barriers for use of digital models

Group 3 **HTO*** aspects for use of digital models

Group 4 Decom ontology enabling use of digital models

Group 5 Use of digital models for international knowledge exchange

*   TSO: Technical support organisation
    KPI: Key Performance Indicator
    HTO: Human Technology Organisation

4

6.2 The PLEIADES questionnaire

PLEIADES - Smarter Plant Decommissioning - questionnaire

Dear respondent,

We are requesting your expert opinion on behalf of the PLEIADES EU project consortium. The acronym stands for "PLatform based on Emerging and Interoperable Applications for enhanced Decommissioning processES". The main goal of this project is to demonstrate a modular decommissioning support ecosystem based on interconnection of tools provided by the partners through a decommissioning specific ontology building upon open BIM. Our strategic goal is making decommissioning of nuclear facilities safe and more efficient.

We kindly ask you to spend some of your valuable time for providing us input so that the project outcomes meet the requirements of practitioners. The questionnaire is anonymous unless you provide us with your contact information to keep you informed about further progress in the project.

We also kindly ask you to help us with further distributing this questionnaire.

We aim to start analysing the results in the beginning of February. Hence, we would greatly appreciate if you could answer by the end of January. Results from this questionnaire will be presented on DigiDecom 2021 (www.ife.no/digidecom2021) and DEM 2021 (www.sfen-dem2021.org) conferences.
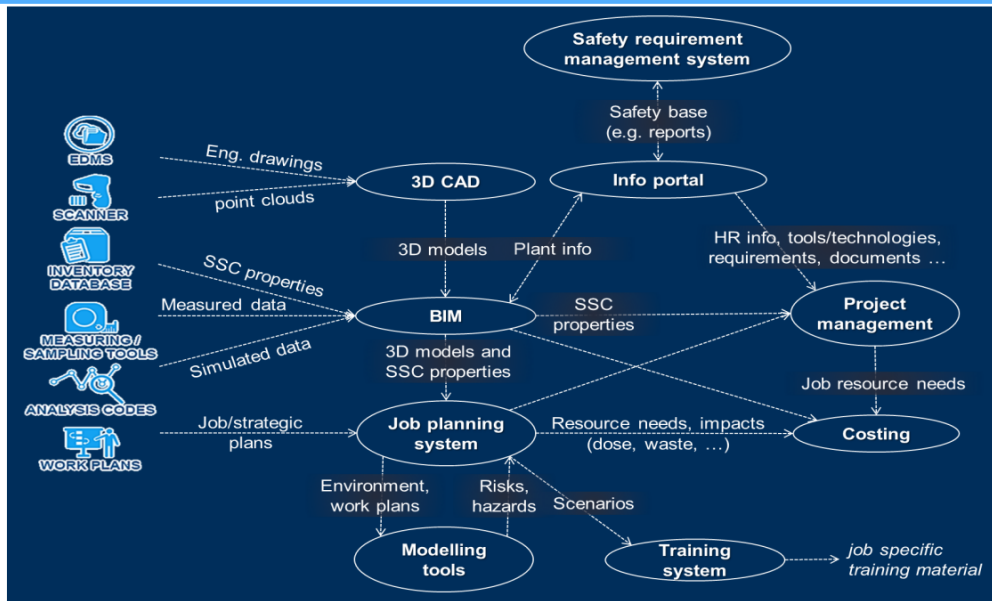
We thank you and greatly appreciate your cooperation.

Please proceed to the next page.

The "PLEIADES" team.
*Required

PLEIADES: Proposed system concept

Objective of this survey

The objective of this survey is to acquire input about current practices and stakeholder needs specifically related to the integrated decommissioning support ecosystem proposed by the PLEIADES H2020 Euratom project. This input will be used as a base for designing our system prototype and demonstrations.

Terminology

In this survey:

Decom & WM refers to Decommissioning and Waste Management
Digital models refer to 3D SCAN (point cloud), 3D CAD or 3D BIM* models
Data management refers to how data is collected, updated, stored, shared and used.

* Building information modelling (BIM) is a process supported by various tools, technologies and contracts involving the generation and management of digital representations of physical and functional characteristics of places. Building information models (BIMs) are computer files (often but not always in proprietary formats and containing proprietary data) which can be extracted, exchanged or networked to support decision-making regarding a built asset. BIM software is used by individuals, businesses and government agencies who plan, design, construct, operate and maintain buildings and diverse physical infrastructures, such as water, refuse, electricity, gas, communication utilities, roads, railways, bridges, ports and tunnels.

Stakeholder profile

1. Respondent Name [First name and family name]

   _____

2. Organisation [complete name]

   _____

3. Organisation [abbreviated name]

   _____

4. Country

   _____

5. Number of employees

   Mark only one oval.

   ⬭ less than 50

   ⬭ between 50 and 500

   ⬭ more than 500

6. Type of Organisation *

    Mark only one oval.

    ( ) Industry

    ( ) Operator

    ( ) Universities

    ( ) Consultancy

    ( ) International Organisations

    ( ) Research organisation

    ( ) Regulator

    ( ) SO (standardization organisation)

    ( ) TSO (technical support organisation)

    ( ) WMO

    ( ) Other

7. Type of facilities *

    Tick all that apply.

    ☐ power reactor
    ☐ research reactor
    ☐ fuel cycle facility
    Other: ☐ _____

8. Status of decommissioning project(s)

    Tick all that apply.

    ☐ none
    ☐ planning
    ☐ on-going
    ☐ completed/nearly completed

9. Discipline of Respondent

Tick all that apply.

- [ ] program management
- [ ] licensing
- [ ] radiation protection
- [ ] waste management
- [ ] research
- [ ] human resource management
- [ ] financial management
- [ ] other

Survey
Instructions

If your organisation has multiple roles (e.g. owner and operator) and owns multiple types of facilities, then multiple questionnaires can be provided from different perspectives (e.g. by different people) at your organisation.

No answer is required if a topic is not relevant for your organisation.

This survey should take about 30 minutes. Thank you for your valuable time.

You can go back at any time during the questionnaire and change your answers.

Please do not hesitate to contact your person-of-contact within the project's consortium for further assistance or if you wish to provide additional input to the project.

Topic 1/8: Management of facility/site information related to design, e.g. engineering drawings, facility configuration (including as-built information)

10. Does your organisation have experience with using digital models of your site/facility? (further questions will depend on your answer) *

Mark only one oval.

- [ ] Yes   *Skip to question 11*
- [ ] No   *Skip to question 17*

Topic 1/8: Management of facility/site information related to design, e.g. engineering drawings, facility configuration (including as-built information)

11.　1.1 What formats of digital models are used?

Tick all that apply.

☐ 3D SCANs / Point clouds
☐ CAD
☐ BIM
Other: ☐ _____

12.　1.2 Which department or position, if any, is responsible for management of the digital models?

_____

_____

_____

_____

_____

13.　1.3 Who has/had access to the digital models?

Tick all that apply.

☐ Engineers
☐ Middle management
☐ Executives
☐ Stakeholders
☐ Other groups of people (please describe below)
Other: ☐ _____

14. 1.4 How often are/were digital models updated?

Mark only one oval.

- ⬭ On a weekly basis
- ⬭ On a monthly basis
- ⬭ Once per 6 months
- ⬭ Annually
- ⬭ Other: _____

15. 1.5 How are/were digital models updated?

Tick all that apply.

- ☐ Using fully automatic technologies
- ☐ Using semi-automatic technologies (e.g. data is collected automatically and then manually introduced into the model)
- ☐ Manually

Other: ☐ _____

16. 1.6 Please describe the process (e.g. data is collected automatically and then manually introduced into the model)

_____

_____

_____

_____

_____

Skip to question 20

Topic 1/8: Management of facility/site information related to design, e.g. engineering drawings, facility configuration (including as-built information)

17. 1.7 Why are digital models not used for this purpose? (management of facility/site information related to design)

_____

_____

_____

_____

_____

18. 1.8 Would you recommend using digital models for this purpose?

Mark only one oval.

⬭ Yes

⬭ No

⬭ Maybe

19. 1.9 What other methods/tools are/will be used for design information management? (e.g. MS Excel, MS Access, Oracle, ...)

_____

_____

_____

_____

Topic 2/8: Management of facility information relevant for Decom & WM (e.g. physical, chemical and radiological data, return of experience, lessons learned about specific site/facility components, ...).

20. Does your organisation have experience with using digital models for supporting Decom & WM? (further questions will depend on your answer) *

Mark only one oval.

○ Yes   *Skip to question 21*

○ No   *Skip to question 26*

Topic 2/8: Management of facility information relevant for Decom & WM (e.g. physical, chemical and radiological data, return of experience, lessons learned about specific site/facility components, ...).

21. 2.1 What kind of digital data is used together with the digital model?

_____

_____

_____

_____

_____

22. 2.2 In what format is this data stored?

_____

_____

_____

_____

_____

23. 2.3 What, if any, standards do you follow/are aware of/expect?

_____

_____

_____

_____

_____

24. 2.4 How often is/was the data updated?

Mark only one oval.

○ On a weekly basis

○ On a monthly basis

○ Once per 6 months

○ Annually

○ Other: _____

25. 2.5 What tools and methods were used for managing the data?

_____

_____

_____

_____

_____

Topic 2/8: Management of facility information relevant for Decom & WM (e.g. physical, chemical and radiological data, return of experience, lessons learned about specific site/facility components, ...).

26. 2.6 Why are/were digital models not used for this purpose? (management of facility information relevant to Decom & WM)

_____

_____

_____

_____

_____

27. 2.7 Would you recommend using digital models for this purpose?

Mark only one oval.

( ) Yes

( ) No

( ) Maybe

28. 2.8 What other methods/tools are/will be used for design information management?

_____

_____

_____

_____

_____

Skip to question 29

Topic 3/8: Planning decom/WM tasks with use of digital models (e.g. scheduling, resource allocation, training, costing, work planning/assistance...)

29. Does your organisation have experience with using digital models for specific tasks (e.g. those mentioned above)? *

Mark only one oval.

◯ Yes   *Skip to question 30*

◯ No   *Skip to question 34*

Topic 3: Planning decom/WM tasks with use of digital models (e.g. scheduling, resource allocation, training, costing, work planning/assistance...)

30. 3.1 What are the digital models used for? (list key tasks)

_____

_____

_____

_____

_____

31. 3.2 What key data/information types are used?

_____

_____

_____

_____

_____

32. 3.3 What kind of tools (e.g. data/information tools) are used?

_____

_____

_____

_____

_____

33. 3.4 What, if any, other purposes would you recommend using digital models for?

_____

_____

_____

_____

_____

Topic 4/8: Sharing data/information required for decom/WM across your organisation and to other stakeholders (i.e. different actors like contractors, regulators, local community, other operators...)

34. Is there a central collaborative data/information store available at your organisation? *

   Mark only one oval.

   ⬭ Yes   _Skip to question 40_

   ⬭ No   _Skip to question 35_

Topic 4: Sharing data/information required for decom/WM across your organisation and to other stakeholders (i.e. different actors like contractors, regulators, local community, other operators...)

35. 4.1 How can employees find information they need?

_____

_____

_____

_____

36. 4.2 How is (e.g. in what form) information provided to the regulator?

_____

_____

_____

_____

_____

37. 4.3 How is (e.g. in what form) information provided to the local community/public?

_____

_____

_____

_____

_____

38. 4.4 How is (e.g. in what form) information provided to other operators (licensees)?

_____

_____

_____

_____

_____

39. 4.5 How is (e.g. in what form) information provided to other external stakeholders?

_____

_____

_____

_____

_____

Topic 5/8: Development and optimisation of decom/WM plan

40. Does your organisation have experience with development of decom/WM plans? *

   Mark only one oval.

   ( ) Yes   *Skip to question 41*

   ( ) No   *Skip to question 47*

   Topic 5/8: Development and optimisation of decom/WM plan

41. 5.1 How are waste streams analysed/optimized? (list tools and methods used)

   _____

   _____

   _____

   _____

   _____

42. 5.2 How is costing of the selected strategy estimated and benchmarked at your organisation? (list tools and methods used)

   _____

   _____

   _____

   _____

   _____

43. 5.3 How are work plans (scenarios) optimized? (list tools and methods used)

   _____

   _____

   _____

   _____

   _____

44.   5.4 What other tools/methods are used for decom/WM planning? (list tools and methods used)

_____

_____

_____

_____

_____

45.   5.5 What tasks, if any, are supported by use of digital models? (list tasks)

_____

_____

_____

_____

_____

46.   5.6 What other digital tools are used for this purpose in your organisation?

_____

_____

_____

_____

_____

Topic 6/8: The PLEIADES concept offers integration of advanced decom/WM tools/techniques through use of a digital models. Please specify your key requirements for such integrated software ecosystems from PLEIADES would have to satisfy before it could be applied in real-life projects.

47. 6.1 What key input data/information types should be supported? (list data/info types)

_____

_____

_____

_____

_____

48. 6.2 What key functionalities should be supported? (list functionalities)

_____

_____

_____

_____

_____

49. 6.3 What key output data/information types should be provided? (list output types)

_____

_____

_____

_____

_____

50. 6.4 What other key requirements can you think of, e.g. multi-language support, information, security, need for training and tutorials, compatibility with systems, ...? (list requirements)

_____

_____

_____

_____

Topic 7/8: What major barriers do you expect for adoption of the PLEIADES concept (e.g. security, legal, ethical, lack of computer literacy, financial and other issues)? Please list them in order of importance and suggest a possible solution where you can.

51.   Barrier 1: Please describe the barrier.

52.   Barrier 1: How can the barrier be solved?

53.   Barrier 2: Please describe the barrier.

54.   Barrier 2: How can the barrier be solved?

55. Barrier 3: Please describe the barrier.

_____

_____

_____

_____

_____

56. Barrier 3: How can the barrier be solved?

_____

_____

_____

_____

_____

57. Barrier 4: Please describe the barrier.

_____

_____

_____

_____

_____

58. Barrier 4: How can the barrier be solved?

_____

_____

_____

_____

_____

59. Barrier 5: Please describe the barrier.

_____

_____

_____

_____

_____

60. Barrier 5: How can the barrier be solved?

_____

_____

_____

_____

_____

61. Barrier 6: Please describe the barrier.

_____

_____

_____

_____

_____

62. Barrier 6: How can the barrier be solved?

_____

_____

_____

_____

_____

63. Barrier 7: Please describe the barrier.

_____

_____

_____

_____

_____

64. Barrier 7: How can the barrier be solved?

_____

_____

_____

_____

_____

65. Barrier 8: Please describe the barrier.

_____

_____

_____

_____

_____

66. Barrier 8: How can the barrier be solved?

_____

_____

_____

_____

_____

67. Barrier 9: Please describe the barrier.

68. Barrier 9: How can the barrier be solved?

69. Barrier 10: Please describe the barrier.

70. Barrier 10: How can the barrier be solved?

Topic 8/8: Further communication

71. Can we contact you later when preliminary results from the project are available (e.g. demonstrations)? If yes, please send an email to istvan.szoke@ife.no.

Mark only one oval.

◯ Yes

◯ No

72. Would you be willing to assist in a pilot test of the PLEIADES platform? If yes, please confirm this in an email to istvan.szoke@ife.no.

Mark only one oval.

◯ Yes

◯ No