**The D&D of nuclear facilities: a systemic approach for project organization and monitoring**

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**Abstract**

The Decontamination and Decommissioning (D&D) of nuclear facilities takes place under circumstances which make it a very complex field. On the one hand, more and more facilities of widely varying types are concerned, and many D&D projects are currently running or planned. A nuclear facility’s life cycle is often very long and the building may be modified or impacted by incidents during its operation. These changes need to be known and taken into account for the D&D, in order to ensure safety at all times. In addition, the numerous stakeholders impose many requirements. These encompass various points of view, and data from different detail levels must be managed to satisfactorily meet them. On the other hand, legacy data (including records, plans etc.) is a recurring issue for D&D projects. The quality and availability of data regarding the different phases of the nuclear facility lifetime may be insufficient, mainly due to the lack of traceability practices in the past. The uncertainty level is not always specified and explained, old documents can be damaged and are not necessarily digitized, etc. It is therefore particularly important to define the relevant type of raw data to be collected and traced for D&D projects as early as possible.

In this context, CEA (Commissariat à l'Énergie Atomique et aux Énergies Alternatives) has been analyzing past D&D projects for many years. The goal is to facilitate reproducibility by generalizing best practices and promoting efficient organizational rules and technical solutions.

Furthermore, a new method is currently being studied to help project managers to prepare specifications for future D&D operations and improve both the efficiency and the relevance of the decommissioning strategy throughout each project, depending on the expected quality of its end-state. This method first consists in formalizing and specifying the entire set of requirements to be taken into consideration, *e.g.* technical, operational, logistical, regulatory, financial, organizational, safety and security, human, ethical, or, naturally, environmental aspects. Second, based on these requirements, it will enable the project team to structure, check, and then to demonstrate the coherence and feasibility of the project from both the technological and organizational points of view. Lastly, the method will enable the evaluation of the various possible solutions for the management of dismantling products, for instance, regarding the waste outlets: direct disposal or interim storage. To conclude, the method should permit a constant re-evaluation of the D&D strategy depending on the possible evolution of the stakeholders’ requirements, and thus it should optimize the monitoring of D&D projects.

CEA has retained systemic and systems thinking approaches as a support for the design and implementation of this method. These approaches, especially thanks to systems engineering, enable the building of a formalized representation of a so-called “*D&D system*”. Such a D&D system is defined as “*a set of elements of various and heterogeneous nature that interact in order to decommission a nuclear facility*”. Its model implements a set of concepts through some coherent and consistent views:

* functional view, to model requested activities, processes, resources and capabilities;
* physical view, to model technical means, tools and techniques, and their interactions during D&D operation, as well as the particular skills and know-how to be put in practice;
* operational view, to model both the various scenarios describing the numerous future project evolutions, and the various configurations and functioning modes of the nuclear facility to be decommissioned;
* risk management view, to model various events that could occur and to evaluate their impact on the project, on the resources involved and so on;
* requirements management view, to model and check the entire set of requirements for the D&D system. In particular, it is mandatory here to give details concerning the requirements and the constraints related to each type of waste to be handled and considered.

First, these concepts and relationships are gathered, syntactically and semantically described in a meta-model, and the vocabulary used is unified. This meta-model remains open to new concepts. It is modifiable and adaptable considering, for instance, the nuclear facility type. Moreover, it enables the specification of a set of ontological resources, and it has to ensure cross-knowledge management for all the D&D stakeholders.

Domain Specific Modeling Languages (DSML) can then be defined thanks to these concepts for each previously described view. Project managers will be able to model D&D systems and share their models throughout the project. These DSML must therefore be ergonomic and understandable by experts from various business fields who are not necessarily expert in the modeling domain.

At the end, this evolving D&D meta-model will provide a framework for the design, implementation and maintenance of the information system, which will be particularly convenient for the overall management of D&D projects.