Feedback from D&D projects – Improvement through preparation

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ABSTRACT

This paper describes feedback from AREVA's experience in all stages of decommissioning projects (from end of life to greenfield), focusing on the recommendations for initial actions to be taken early in the project and in the preparation phase. Such initiatives can be summarized in the following four points: (i) Build a strong and specific Decommissioning Team composed of the plant staff together with D&D specialists that shall take the lead and promote the culture change within the remaining staff; (ii) Insist on pre-work as well as real-time Radiological Characterization to optimize waste production; (iii) Develop a tailored Decommissioning Manual streamlined from the legacy Operation Manual (that is no longer appropriate); (iv) Replace the plant's legacy support systems (e.g. ventilation, water treatment, electricity, lighting etc.) with modular and lighter systems better fit for the D&D purpose and allowing to accelerate the cutting and knocking down ("straight backwards") operations.

Introduction

As an owner-operator of nuclear facilities worldwide – as well as service provider to customers – AREVA has accumulated vast experience in decommissioning nuclear facilities. Drawing from this experience, the present paper summarizes the main lessons we learned and the derived dispositions we would recommend to consider in the preparation phase in order to enhance project execution.

Our experience ranges from research and power reactor decommissioning as well as large radio-chemical plants and fuel cycle facilities, including hot-cells with highly radio-active material. We have been and are currently involved in many D&D projects from end-of-life to greenfield, in many countries including: France, US, UK, Germany, Sweden, Japan, Switzerland, The Netherlands, South Africa, Australia, Lithuania, Spain, Belgium, and Slovenia.

The main lessons we learned is that a decommissioning phase is very different from the operating phase. And this fact needs to be recognized as early as possible and at every level in order to take the right decisions at the right time and optimize the costs. The whole organization has to move from an operation structure to a project structure which is not straightforward. In addition this is about deconstruction, not about keeping an expensive asset in its best conditions to produce cash.

For example the strategy for D&D can hardly be based on a simple modification of the “good old” operation systems by the plant personnel. Another example is logistic, which need to be completely reconsidered for decommissioning, e.g. provide new routes, buffer areas and openings to facilitate transfers to allow for moving large components out instead of cutting them into small pieces inside the plant. It may not be necessarily well understood at program inception (following shutdown) and would lead to huge cost implications later on.

We believe that the strategy needs to be direct and streamlined as developed in the next sections, starting with setting up a dedicated and specialized decommissioning team that will define optimized approaches. Then the importance of characterization is to be highlighted, with a special focus on “real-time” confirmation of the initial data. The Manual describing how the Plant would be operated while decommissioning takes place (from shutdown to greenfield) is a critical document that must be challenged by the decommissioning team. Finally our recommendation is to decommission all systems, including the legacy “utilities and operations support systems“ at the same time, and replace these functions with external, mobile, modular and fit-to-purpose standalone systems.

Lessons Learned

We learned that the most important actions to undertake in the early stages of a decommissioning program (i.e. during end-of-life and before actual shutdown of a plant) in order to be successful in the dismantling field works, include:

1. Build a “Decommissioning Team”;
2. Prepare a thorough “Radiological Characterization”;
3. Develop a specific “Decommissioning Manual”;
4. Replace the legacy operation support systems with new “Decommissioning Support Systems”.

The following sections further develop these recommendations.

1. Decommissioning Team

The key to success in decommissioning projects is to establish the right team, with skills that are well adapted to the specifics of decommissioning and dismantling works. Beyond the technical competences themselves, a very important factor is also to secure the morale and attitude of the personnel including their confidence in their own future.

An efficient team should be composed first of former operational staff together with personnel with specific expertise and corresponding references in decommissioning activities. The first category of personnel will provide knowledge of the site specifics, especially historical circumstances. This is most important to improve the as-built knowledge of the plant, to establish efficient communication channels inside of the former operator’s organization and access to undocumented information. All elements are mandatory to develop a robust plan and avoid – as much as possible – unexpected serious late “discoveries” that would hold the project down with significant cost and schedule impacts.

The D&D specialists will bring their “deconstruction” mindset to the team in addition to their specific experience in the methods, tooling, ways and means to perform the work. Indeed when transitioning from operation to dismantling activities, the objectives and constraints are totally different and this fact has to be fully recognized at every level within the team in charge of the D&D. During operation times the focus and priority is to maintain the plant in its full production capacity while ensuring compliance with the highest degree of safety requirements (fissile material). When shifting to D&D the ultimate goal is to "destroy" the facility, which is something inherently very difficult to accept for workers that have been maintaining it at the highest level for decades.

The D&D specialists – together with the former plant staff – shall develop an optimized decommissioning plan. The optimization consists of reaching the simplest and most cost effective solution while challenging the well-established processes and procedures inherited from the operation days, if they are not strictly mandatory.

A most notable prerequisite is for the utility to promote motivation of its personnel at an early stage in the project, in order to avoid "the longer the better" attitude. It is good to have an incentive plan and to give the staff a perspective (e.g. a transition plan) to provide them with a continued employment perspective after the decommissioning works are finished. Then all members of the "Decommissioning Team" will be likeminded and interested in high performance, leading the D&D project to a full success.

For our decommissioning project at SVAFO, we had the opportunity to including our customer's personnel – very early in the project – into the decommissioning team. Former operational staff of the R2 & R2-0 reactors took part to all the preparatory works including the training phases, where our specific segmentation techniques were tested and the whole on site team trained. This led to a very successful project where solutions to problems were found expeditiously and with a very good team spirit.

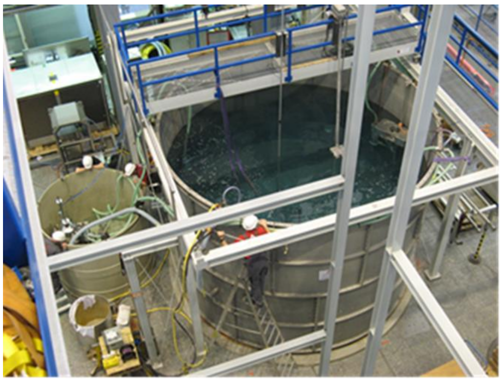


Figure 1: AREVA Training facility in Erlangen, Germany

2. Characterization

Thorough sampling and calculations performed in advance of the detailed engineering and planning of the field works is naturally of high benefit. It can save not only the amount of containers and casks to be procured but also the significant efforts to revise the paper works, drawings, radiological calculations, cutting and packing plans.

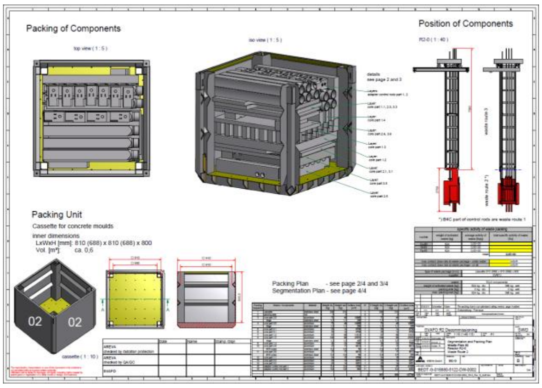


Figure 2: Example packing plan (SVAFO project)

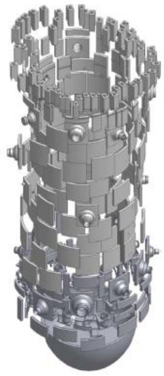


Figure 3: Cutting plan RPV (Würgassen NPP)

However, additional verification of the initial radiological conditions by complementary samplings and calculations at an early stage of the project was found to be critical in order to secure the cutting and packing plans and the overall schedule of the project.

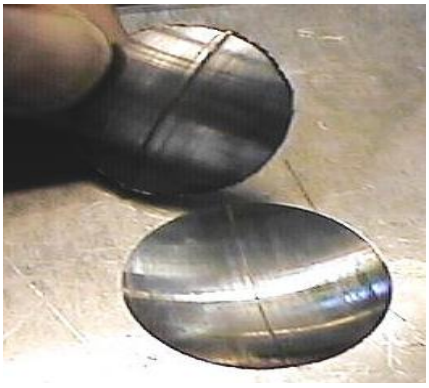


Figure 4: Sampling lense (AREVA equipment)

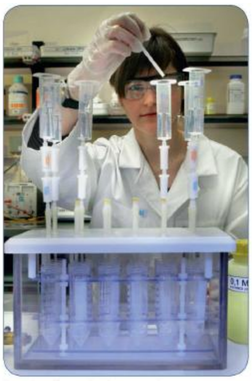


Figure 5: Analyses in AREVA's accredited laboratory

Furthermore, confirmation of the radiological characteristics of the waste being segmented should be undertaken at the same time as the cutting operations are being performed. This is performed by dose measurement as well as complementary sampling.

This approach proved to be very successful first to provide additional checking of the actual waste criteria and second to provide for the opportunity to optimize the waste management and packing strategies when actuals show lower or higher figures than expected. Such "real-time" analyses add only marginal costs as only the analytical services are to be considered.

The additional "real-time" sampling and measuring are undertaken by picking samples from the sawing swarfs and sending them to the laboratory for subsequent radiological analyses. These can result in further adjustments of the cutting and packing plan. This "real-time" radiological characterization could allow to reduce the number of casks and to use more economical containers if the actuals show less activity than expected.

Figure 6: Dense packing of segmented component (NPP Würgassen decommissioning project)

We have applied this method and could save several MOSAIK® casks (Type B (U) package for very high level waste) using Konrad containers instead (IP 2 package for medium or low level waste, significantly cheaper than a MOSAIK®). A similar example was developed in our SVAFO project, where we could save about 9% of the packaging "cassettes" as compared to the initial packing plan by measurement and sampling during the R2 / R2-0 reactors dismantling work.

Performing a Full System Decontamination (FSD) operation at the end of the life of the NPP could also be considered before dismantling, in order to reduce the occupational exposure and the contamination of the components, which should be segmented.

An FSD – which simultaneously decontaminate the complete primary circuit and auxiliary circuits – is a technology that removes activity and corrosion products from inner pipes and vessel surfaces. AREVA implemented FSD in several plants such as Unterweser and Neckarwestheim 1 which yielded overall decontamination factors of 80-90 and factors as high as 150 for steam generator tubing.

Figure 7: Demonstrative success of the FSD (Calotte RPV BWR)

3. Decommissioning Manual

The decommissioning operation document (the Decommissioning Manual) needs to be specifically developed. It is similar to the original plant Operation Manual, but shall not be just an amendment of this document. The Decommissioning Manual has to specifically address the simplifications that can and must be made as compared to the initial Operation Manual to optimize schedule and save costs for the D&D phase.

Besides technical matters such as: the reduction of periodic inspections (not required any more due to the change in the source term and safety basis), suppression or reduction of the frequency of sensors calibration, reduction of technical requirements depending on the radiological conditions, the Decommissioning Manual deals mainly with the new transport routes, auxiliary cranes, lifts, buffer areas inside and outside the building as well as decontamination and conditioning facilities to be created.

As the former operation staff is too strongly tightened to the operation of the plant and the corresponding systems (every single line of the Operation Manual was very important over the last decades), the Decommissioning Manual should be written under the leadership of the D&D specialists (external personnel) of the Decommissioning Team. They should condense the paper using all their know-how gained from former D&D projects.

The Decommissioning Manual must be written in an open and flexible manner, also offering a flexible description of the path to the final target. It should be open to using any appropriate technologies as long as the ALARA principle is fulfilled in every single dismantling task and the final target is reached.

Past experience has shown that even if thermal cutting methods are “forbidden” by the plant manual (because it was not part of the licensing documents approved by the authorities), they could indeed be considered as acceptable for dismantling. For example the “dirty” contact arc metal cutting (CAMC) technology was accepted in a recent AREVA project for cutting several holes into the core barrel as it was demonstrated to be the best method compared to others, including ALARA aspects. Once introduced, the same CAMC tool was used later in the project for unconventional cutting of two of the eight core support bolts which could not be loosened by use of the baseline mechanical unscrewing tool.

The plan shall also include alternatives or options in the way to perform the work in order to anticipate for the unavoidable occurrence of unexpected situations (which are common in dismantling activities). Only well experienced D&D personnel will have the vision to evaluate the risks and define the areas where “Plan B” and “Plan C” are needed to provide for the appropriate mitigation responses. This is critical to avoid having to revise the initial plans and corresponding regulatory acceptance, when such situations do occur.

The Decommissioning Manuals should also be standardized as far as practical. The same structure provide for a more convenient use during decommissioning work as well as facilitating the evaluation by the authorities. It was for example advantageous to harmonize the draft versions of the Decommissioning Manuals of two NPPs for the Bavarian authorities.

4. Decommissioning Support Systems

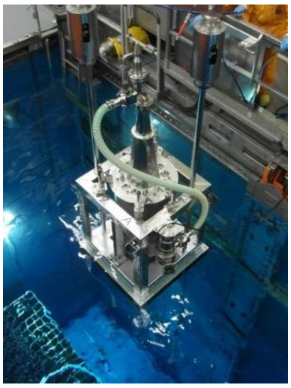
The initial plant's support systems are frequently approaching their own end of operation life, or inappropriately sized (oversized) to fit to the decommissioning phase requirements. Moreover, maintaining them in their supporting role most of the time does interfere seriously with the D&D activities leading to extra complexities and extra costs.

Our experience is that most of these support systems should simply be dismantled as soon as possible and replaced with smaller systems, more flexible, movable (or mobile), standalone and fit for purpose. Such new systems should be also placed outside of the controlled area as far as possible to avoid the creation of additional nuclear waste. This evolution has naturally to be documented in the Decommissioning Manual.

Such "old" operation support systems perform following functions such as: ventilation, emergency ventilation, electrical power supplies, heating, lighting, water treatment etc.

There are several reasons why this approach is recommendable and cost effective: the first one is because of the aging and often inappropriate characteristics of the legacy plant systems. It is costly to operate maintenance and even more costly to modify. Such systems provide also oversized ventilation performances to all of the plant rooms which are not needed. A centralized system is not flexible enough to satisfy D&D project requirements, where each working area needs to be isolated from the adjacent one. As the essence of D&D is to remove equipment out of the plant, all piping, wiring and equipment which are necessary to maintain the legacy systems in operation will create additional interferences with and burden to the D&D field works. Some areas will have to be excluded from the segmentation works in order to preserve the support functions, so the corresponding rooms cannot be completely cleaned until the far end of the project, adding more complexity, time and cost to the project. Finally, maintaining the legacy systems in operation also contribute to maintaining the legacy operating mind set within the staff (e.g. everything piloted from the central control room). Cutting them out facilitates the messaging, and the staff culture transition from operations to decommissioning.

In summary, the target should be to shut down the support systems and the former control room as soon as possible (like in a station black out situation). All D&D needs would be fulfilled with new standalone Decommissioning Systems put in place at an early state of dismantling phase, positioned outside of the buildings and docked to the controlled area. This approach provides superior capabilities to comply with the daily changing boundary conditions, with no interferences, no exceptions and lead finally to a more cost effective project.



<u>Figure 8:</u> Modular water purification system of AREVA

<u>Figure 9:</u> Example for external mobile ventilation system (source: EWN GmbH)

Some examples of real situations that AREVA encountered are provided hereafter:

- Installation of new smaller compressors in the same contaminated room where the old ones were removed from,
- Use of a water treatment system in the controlled area with fixed pipes and cables running through the building. After a relatively short time the system had to be dismantled with all pipes, power lines and signal lines up to the control room removed. But as pressurized air and water treatment was still necessary, flexible mobile Decommissioning Systems were finally installed.
- Ventilation systems were modified by reducing the RPM (Revolutions Per Minute) of the old equipment in a first step by mechanical measures. The next step was the installation of a new mobile ventilation system outside the building which allowed the dismantling of all contaminated ventilation ducts till the end of dismantling.

Conclusion

Early preparation for decommissioning is not only required to ensure appropriate engineering and planning of the future activities, it is also crucial to establish a new "paradigm" and a project focused mind-set, recognizing the quantum leap that D&D represents from the time of operation. Drawing from AREVA's experience in such projects – including dismantling its own facilities – the four main areas to focus on were described here above, with a special emphasis on the early establishment of a specialized "Decommissioning Team" and the consideration of modular "Decommissioning Support Systems" to replace the legacy ones, in order to accelerate the projects and reduce uncertainties in field operations.