MAINTAINING A SAFETY CASE FOR LICENSING – A SWEDISH CASE STUDY

Kristina Gillin and Martina Sturek

Candesco Division of Kinectrics Inc (Candesco), 26 Wellington Street East, 3rd Floor, Toronto, Ontario M5E 1S2, Canada
kristina.gillin@candesco.com

Swedish Nuclear Fuel and Waste Management Co (SKB), Polstjärnan, Box 612, SE-572 27 Oskarshamn, Sweden

When significant delays occur during licensing of a nuclear facility, maintaining the safety case becomes a challenge. To exemplify, retirement of key experts and general staff turnover may erode the pool of knowledge, the overall organization's management and business processes may change, and the regulatory framework and requirements may be enhanced. Unless recognized and mitigated – risks associated with these challenges can lead to further delays. What then can implementing organizations do to mitigate these risks?

By exploring the experience gained in developing and maintaining a safety case for an encapsulation plant for spent fuel in Sweden, typical realities and challenges in the industry are captured. And by viewing these realities and challenges through the lens of emerging trends in sustainable development research – where management under major uncertainty is the norm – recommendations for management of projects that develop and maintain safety cases are offered in five key areas: People, Communication, Documentation, Learning and Planning.

I. INTRODUCTION

Once the safety case that supports a licence application has been completed, developments are often such that the documentation quickly becomes outdated. This may be due to internal project decisions, but more often than not, it is caused by external factors, such as additional operating experience gained at similar facilities, advancements in technology or delays in the implementation of interfacing facilities.

Not uncommonly – and in particular for facilities related to long-term management of nuclear waste – these developments can result in significant delays for the project organization that is tasked with developing and maintaining the safety case. One such example is the Swedish spent fuel encapsulation plant, which is part of the long-term waste management system under development and implementation by the Swedish Nuclear Fuel and Waste Management Co (SKB).

In the Swedish encapsulation plant, the spent fuel will be placed in containers that consist of two main components: an outer copper shell for corrosion resistance and an inner cast iron insert designed to withstand the mechanical stresses in the repository. Each canister is about 5 m long and 1 m in diameter.

The encapsulation plant is planned to be built as an expansion of SKB's central interim storage facility for spent fuel (Clab), which has been in operation since 1985.

Development of the encapsulation plant's design and safety case began more than 20 years ago, and in 1998 the first Preliminary Safety Analysis Report (PSAR) was completed. Since then, the safety case for the encapsulation plant has been modified and reissued a number of times, and it has recently been subject to a complete revision as part of the ongoing licensing process for SKB's KBS-3 system.

II. EVOLUTION OF KEY PROJECT ASPECTS

When SKB launched the encapsulation plant project in 1993,[1] it was envisioned that it would take about 15 years until the first copper container filled with spent fuel would be dispatched from the plant for transport to and subsequent emplacement in a national deep geological repository. Like any project, plans were developed, staff members were engaged and contractors were procured – all based on the assumption that the target end date would be met (that is, that the facility would be licensed and in operation by 2008).

For the first 4-5 years, the project proceeded according to plan, but due to delays in the selection of a site for the repository, the encapsulation plant project had to adapt its pace. To ensure that the work that had been completed to date would not be forgotten, a first safety case was documented – even though it was recognized that the PSAR and other supporting documentation that comprised the safety case in 1998 would not be submitted to the regulator until the site selection of a repository had progressed further.[2]

To explore the differences between then and now, the evolution of key aspects of the encapsulation plant project are highlighted below. It is worth underscoring, however, that the aspects described below to some degree are interrelated.

II.A. Project Staffing

During the early years (in the 1990s), the project was staffed primarily by resources who had been involved in the design, construction, commissioning and operation of the Clab interim storage facility – since the encapsulation plant from the onset was envisioned to be built as an expansion of Clab. The project organization comprised around 7-8 technical experts, complemented with 2-3 staff for administrative support. The age distribution was such that all but one project member was above 50 years of age.

Two main external contractors were engaged for development of the encapsulation process and facility design. Smaller contracts were also signed for specific tasks, such as international peer reviews. Development of the safety case was done in-house.

Two decades later, staffing levels have increased by an estimated factor of 3. The number of external contractors has increased as well, partly due to that the revision of the safety case was contracted out. The age distribution has shifted dramatically, with the vast majority of project staff now being below 50 years of age.

Another noteworthy change is that the project, in the 2000s, relocated from SKB's head office in Stockholm to local offices in Oskarshamn, Sweden (to be close to the Canister Laboratory and the Clab interim storage facility).

II.B. Project Processes

Like the evolution in most other organizations and industries, the processes for project management in the 1990s were significantly simpler and less time-consuming compared to today. This includes processes for quality assurance, records management, financial reporting and procurement.

With the general digitalization of project work, the total volume of documentation produced has also increased significantly compared to when the first safety case was issued in 1998.

II.C. Regulatory Requirements

The Swedish regulatory requirements in the 1990s were primarily set by two different regulatory agencies that oversaw the nuclear industry. Today, these agencies have been combined into one: the Swedish Radiation Safety Authority (SSM). Consequently, the regulatory framework has been revised – and continues to be developed and enhanced.

With regards to dose requirements, the PSAR produced in 1998 and the current safety case do not deviate significantly. The level of detail in the descriptions and assessments are also comparable, but with some notable differences:

- The expectations on safety analysis of external events were minimal in 1998 compared to today.
- In 1998, postulated initiating events had not been identified systematically.
- The safety case in 1998 assumed that the initial licence application would be supported by a PSAR, whereas today, a preceding (and less detailed) safety analysis report is required prior to submitting the complete PSAR.

II.D. Technological Advancements

Throughout the years since the first safety case was documented, SKB has continually developed and refined the technologies used for encapsulation of spent fuel. Much of this work has been performed in-house at SKB's Canister Laboratory in Oskarshamn, Sweden.

Although the design of the canister itself is largely the same as in 1998, an important technological change since then is the switching of welding methods from electron beam welding to friction stir welding – due to the latter's consistent and promising results.

II.E. Operating Experience

With the significant delay in implementation, additional operating experience at existing facilities has been gained – which is of value to the current safety case. Of particular relevance is the additional operating experience from Clab, since the encapsulation plant in practice will be an expansion of that facility.

III. APPLYING AN ADAPTIVE APPROACH

As illustrated by the case study above – when significant delays occur in the development and licensing of a nuclear facility – major changes that could not have been envisioned when initiating the project are bound to emerge. Whether they are internal (such as the complete turnover of staff) or external (such as the addition of a step in the licensing process) – these types of major changes are likely to render the project sub-optimal, since key assumptions upon which the project was launched thereby have changed.

Coupled with the fact that the case study above is not an exception in terms of timeline – but rather a reflection of what experience around the world is showing has become the norm – one might wonder whether traditional project management practices are appropriate for these types of projects. Would it not be more conducive to apply an adaptive approach to project management?

Within sustainable development research, resilience theory is an emerging field that is focused on increasing a system's capacity to deal with unexpected changes.[3] Resilience is defined as the "amount of change a system can undergo (its capacity to absorb disturbance) and remain within the same regime – essentially retaining the same function, structure, and feedbacks."[4] That is, when equipped with high resilience, the system is adaptive and hence more likely to continue to remain functional – even after being subject to major changes. For this reason, projects that need to 'plan for the unplanned' – such as projects for developing and maintaining safety cases – can benefit by applying an adaptive approach inspired by resilience theory.

Although it is recognized that each project has its unique circumstances, general recommendations with regards to increasing a project's resilience and adaptive capacity are offered below. It is worth noting that some of the concepts recommended within resilience theory are already standard practices in nuclear safety applications, such as the principles of redundancy and diversity.

III.A. People

Given the long timeframes normally associated with the licensing, construction and commissioning of a nuclear facility, the project organization tasked with developing and maintaining the safety case needs to consider the risk that key project knowledge will be lost along the way. In practice, the following principles with regards to staffing are therefore recommended to minimize that risk:

- Strive for a broad and even spectrum in staff's age distribution – to facilitate knowledge transfer and avoid risk of retirement among a large portion of the staff within a short period of time.
- Promote diversity with regards to other aspects than age – such as learning style, educational background and previous experience.
- Engage redundant staff for key expertise – to promote synergies and increase probability of knowledge retention. But do remain nimble.

III.B. Communication

To maximize efficiency and quality with regards to project communication, the following approaches are recommended for consideration:

- Create opportunities for staff to connect and share experiences – beyond traditional, formal project meetings. The increased connectivity this creates will enhance the ability to cope with change – both at the individual and group level.
- Enable face-to-face meetings with staff members of organizations that are associated with interfacing facilities and projects.
- Foster a climate of mutual respect and collaboration; that is, projects for developing and maintaining safety cases are very much a 'team sport' and need to be managed as such.
- Encourage oral traditions, such as the sharing of stories on the history of key decisions and on lessons learned (both dos and don'ts).

III.C. Documentation

Safety case development generally entails production of very large volumes of documentation. As such, risks associated with documentation are not that there would be a lack thereof – but rather that there may be too much, which can lead to situations of 'not seeing the forest for the trees.' Considerations for minimizing risks associated with documentation therefore include:

- Encourage staff and contractors to be brief and to the point in their writing. Avoid repeating information within a report – or across reports – and question the relevance of very large documents. (What are the pertinent points? What is needed as evidence for making those points? Can the rest be discarded?)
- Maintain a log of major decisions and changes (to note the what, when, why and by whom) and keep it in a format that is easy and inviting to read – in order to facilitate knowledge transfer over decades. Only include information that a project member many years later may find of interest and value, and resist the urge to document 'everything'; one year's entries should fill no more than a couple of pages in the log.

III.D. Learning

Given the amount and wide range of information normally associated with safety cases, the promotion of learning among project staff is essential in order for the project to be adaptive. Recommendations with regards to learning include:

- Create working teams that comprise members with complementary expertise, as well as has breadth in terms of age distribution.
- Promote circulation of staff (of all ages) to enable project members to learn from – and to teach – as many as possible. This also achieves the benefit of minimizing risk that the types of groups that keep others left out are formed. Staff circulation should be promoted both within and between interfacing projects/facilities – and if possible, also with external organizations.
- Encourage staff to broaden their expertise, but be mindful of maintaining an appropriate balance between generalists and specialists.

III.E. Planning

With regards to planning, it is recognized that most implementing organizations will require their project managers to apply a certain degree of 'conventional' project planning in order to retain the sense of control. But given the likelihood of significant delays, the reality is that the work that goes into creating and recreating detailed project plans may not only prove to be unnecessary but could in fact hinder rather than benefit the project; that is, when the major milestones continue to be postponed – and the project plan consequently needs to be revised at regular intervals – momentum will be lost and a sense of failure within the project team is bound to surface eventually – even if the reasons for the recurring delays may be purely due to external factors.

Recommendations with regards to planning of projects that wish to apply an adaptive approach therefore include:

- Make it explicit to the project team that the plan is a working assumption only and that it likely will change many times over the coming years.
- Create detailed plans only for the short term (in the range of months to a year) – but beyond that, maintain only high-level project plans.
- Use tools and formats that are quick and easy to update, as well as conducive for communication (both with project members and company management).
- Embrace that the project needs to 'plan for the unplanned.' That is: 1) embed in the project plan margins for the unforeseen; 2) encourage project members not to be discouraged by changes and delays; and 3) view – and communicate – the major changes once they emerge as anticipated and not as issues – and recognize that they entail windows of opportunity for renewal, innovation and staff development.

IV. CONCLUSIONS

When initiating and managing projects that are more likely than not to experience significant delays – such as projects associated with developing and maintaining safety cases for nuclear waste management facilities – the application of an adaptive approach would be beneficial. Compared to traditional project management, an adaptive approach has the potential to: 1) increase job satisfaction (and consequently staff retention); 2) minimize lead time for project reorganizations (since it by definition is designed to accommodate major changes); 3) maximize creation and retention of core project knowledge (through promotion of knowledge sharing and learning); and 4) increase probability of overall success of implementation (since connectivity with interfacing projects and facilities is enhanced).

Given that each of the four potential benefits above would have a direct – and possibly considerable – impact on project costs it can furthermore be argued that an adaptive approach to project management may prove beneficial also from an overall financial standpoint.

As such, by managing long-term projects with an aim to increase resilience – not only will the project itself become more sustainable but benefits are bound to overflow to the implementing organization as a whole. Acknowledging these types of cross-scale effects is another key feature of resilience theory[4] – which further supports the claim that applying an adaptive approach to projects that are tasked with developing and maintaining a safety case for licensing would be wise.

REFERENCES

1. K. GILLIN, "Encapsulation of Spent Nuclear Fuel in Copper Canisters," *Proceedings of the Eight International Conference – High-level Radioactive Waste Management,* Las Vegas, Nevada, May 11-14, 1998, p. 689, American Nuclear Society (1998).
2. SKB, *RD&D Programme 98, Treatment and final disposal of nuclear waste. Programme for research, development and demonstration of encapsulation and geological disposal*, Swedish Nuclear Fuel and Waste Management Co (SKB), Stockholm, Sweden (1998).
3. R. BIGGS, M. SCHLÜTER and M. SCHOON, *Principles for Building Resilience: Sustaining Ecosystem Services in Social-Ecological Systems*, Cambridge University Press (2014).
4. B. WALKER and D. SALT, *Resilience Thinking – Sustaining Ecosystems and People in a Changing World*, Island Press (2006).