Sharing Lessons Learned "Across the Pond" on Two Major Construction Projects: Evaporator D and SWPF - 16050

Mark Bailey and Graham Jonsson, (UK Nuclear Decommissioning Authority),
Andrew North, Ian McGarry and Jennifer Carruthers (Sellafield Ltd),
Pam Marks, Shayne Farrell (US Dept of Energy, Savannah River Site),
Tom Burns (Parsons)
Laurie Judd (Longenecker & Associates)

Abstract

This paper compares and contrasts two projects, the Salt Waste Processing Facility at Savannah River in the US and Evaporator D at Sellafield in the UK, to highlight the similar challenges that each project has experienced since contract award and how these challenges have been addressed.

The paper compares the lifecycles of the projects, project strategy, design, construction, and regulatory issues, along with cost and schedule performance. There is also some discussion about the anticipated challenges in the future as the projects move into the startup and commissioning phase.

Overall, the paper identifies some of the common areas that have affected these projects and how these similarities have been the subject of sharing and collaborating lessons learned on a broader scale, even though the delivery organizations operate in different countries under different regulatory and Government frameworks.

INTRODUCTION

The US Department of Energy (DOE) and the UK Nuclear Decommissioning Authority (UK NDA) signed a Statement of Intent in 2007 which allows for exchange of information, lessons learned and personnel exchange in areas including, but not limited to, cleanup technologies and approaches. This agreement has been extremely beneficial to both organizations and has addressed multiple topic areas including plutonium management, sludge retrieval, contracting approaches and D&D technologies.

One of the most recent initiatives is focused on startup and commissioning of new nuclear plant; an area of great interest and importance to both organizations. In mid 2015, it was agreed to share retrospective lessons learned on both the UK's Evaporator D project and the DOE's Salt Waste Processing Facility (SWPF) and to develop a collaborative path forward so that there can be an ongoing dialogue to help both plants begin active operations as quickly and effectively as possible.

The intention of the exchanges is to move away from the more typical information exchange/lessons learned exercise and move towards a more detailed, intensive and "tacit" exchange of know-how and information. For example, does the project have a risk and opportunities register and/or does it have a risk and opportunity management culture that engenders learning and offsets risk by the development and acceptance of alternative approaches.

It is also well accepted that major projects tend to focus on retrospective lessons

learned at the end of a project and that continuous learning from experience (LFE) opportunities on the project tend to get consumed within the maelstrom of project completion. The approach being adopted in this instance has been aimed at developing relationships at a much earlier stage of the projects, which makes the detailed and tacit exchange of information that much easier.

Over the past few months, a number of discussions and videoconferences have been held and a path forward has been agreed to ensure that the projects move forward together as they move from construction completion, through inactive commissioning and, eventually into active operations.

Overview of Evaporator D and SWPF

Evaporator D

Evaporators have been used at the Sellafield site for many years to support ongoing reprocessing activities, by reducing the volume of the Highly Active Liquor (HAL) prior to vitrification into a form suitable for long term storage. The technology is therefore proven and well understood. However, the existing evaporators are aging and have suffered from failures in recent years and, although recent inspections and changes to the way of operation have improved the confidence in the ability of the existing fleet to support operations for another few years, it was decided to design and build a new evaporator (Evaporator Delta).

Initially Evaporator D was only intended to be used on the HAL and an additional evaporator (Evaporator E) was planned to deal with Post Operational Clean-up Operations (POCO) wastes which have a much higher solids loading. However, following a detailed assessment by NDA it was decided that use of a modified Evaporator D in place of construction of a new Evaporator E could save the UK taxpayer close to $1bn and so the design of Evaporator D was modified to meet the new requirements.

Evaporator D was designed, constructed and delivered through a series of large-scale (hundreds of tonnes each) modules fabricated offsite and transported to the site by sea and then installed using a gantry system. This was the first time that such an approach had been used at the Sellafield site.

Salt Waste Processing Facility (SWPF)

The Salt Waste Processing Facility (SWPF), located at the Savannah River Site (SRS) in Aiken, South Carolina, is a multi-billion dollar Liquid Radioactive Waste (LRW) processing facility that represents the keystone for the U.S. Department of Energy (DOE)-EM clean-up mission at SRS. SWPF is a first of kind facility in the US and makes use of a number of new technologies and approaches. It facilitates DOE-EM clean-up at SRS by decontaminating the salt waste, which is the dominant volumetric component in the LRW tanks, thereby allowing the cleaned salt waste to be removed from the tanks and stabilized into an approved grout-based final waste form. The small volume of removed radionuclides is sent to the Defense Waste Processing Facility (DWPF) for vitrification. Emptied LRW storage tanks are then grouted into an approved configuration for final closure.

Project Organization

At the working level, both projects have an organization hierarchy where there is a prime contractor responsible for overall delivery, with a series of subcontractors responsible for delivering specific elements within the overall scope of work as shown below

Evaporator D

End Customer	UK Nuclear Decommissioning Authority
Operational customer	Sellafield Ltd (the Site Licensed Company)
Prime Contractor	Costain

The Evap D contract is let on an EPCC (Engineering, Procurement, Construction and Commissioning) basis. Once the facility is inactively commissioned it is handed over to the Site Licence Company (SLC) to operate.

SWPF

End Customer	US Department of Energy
Operational customer	Parsons
Prime Contractor	Parsons

The SWPF contract is let on an EPCCO (Engineering, Procurement, Construction, Commissioning and Operate1) basis. The prime contractor is therefore responsible for a period of operations following construction, testing and commissioning activities.

The prime contract is held directly between the Department of Energy who retains design authority and the prime contractor

Project History

Figures 1 and 2 below demonstrate the major milestones of both projects from their initial inception through to their planned operation.

Evaporator D

Evaporator D was originally planned to be completed by 2010 to replace the three existing evaporators at Sellafield. However, in May 2012, it was announced that the original schedule for completing the Evaporator D project was going to slip to 2016 and that the project was going to need additional funding to complete construction. The project was resanctioned and a revised budget and timeline agreed. This is illustrated in Figure 1 where the critical May 2012 date is identified as RS12.

[1] Operate for 12 months

SWPF

The SWPF contract was awarded to Parsons in 2002 for designing, building, starting up and operating the SWPF for one year. Construction was originally scheduled for completion by 2009 but is now projected for mid/late 2016. While the SWPF Project has incurred substantial delays associated with over 115 contract modifications including changes in design and quality requirements, a significant delay on the SWPF project was related to the manufacturing and delivery of 10 large American Society of Mechanical Engineers (ASME) processing vessels. After initially awarding a subcontract to a small business contractor, it eventually became apparent the vendor could not provide the quality necessary for the large vessels. That contract was terminated and a second subcontractor was incentivized to deliver the vessels by July 2011. However, the 10 large ASME vessels were not delivered to SWPF until June and July 2012 leading to significant project delays and a renegotiation of project milestones.

Some of the detailed issues behind both project issues are discussed in Table 1

Current Project Status

Evaporator D

The construction phase on Evaporator D is essentially complete and the project is currently undergoing inactive commissioning. The timeline of critical events moving forward includes;

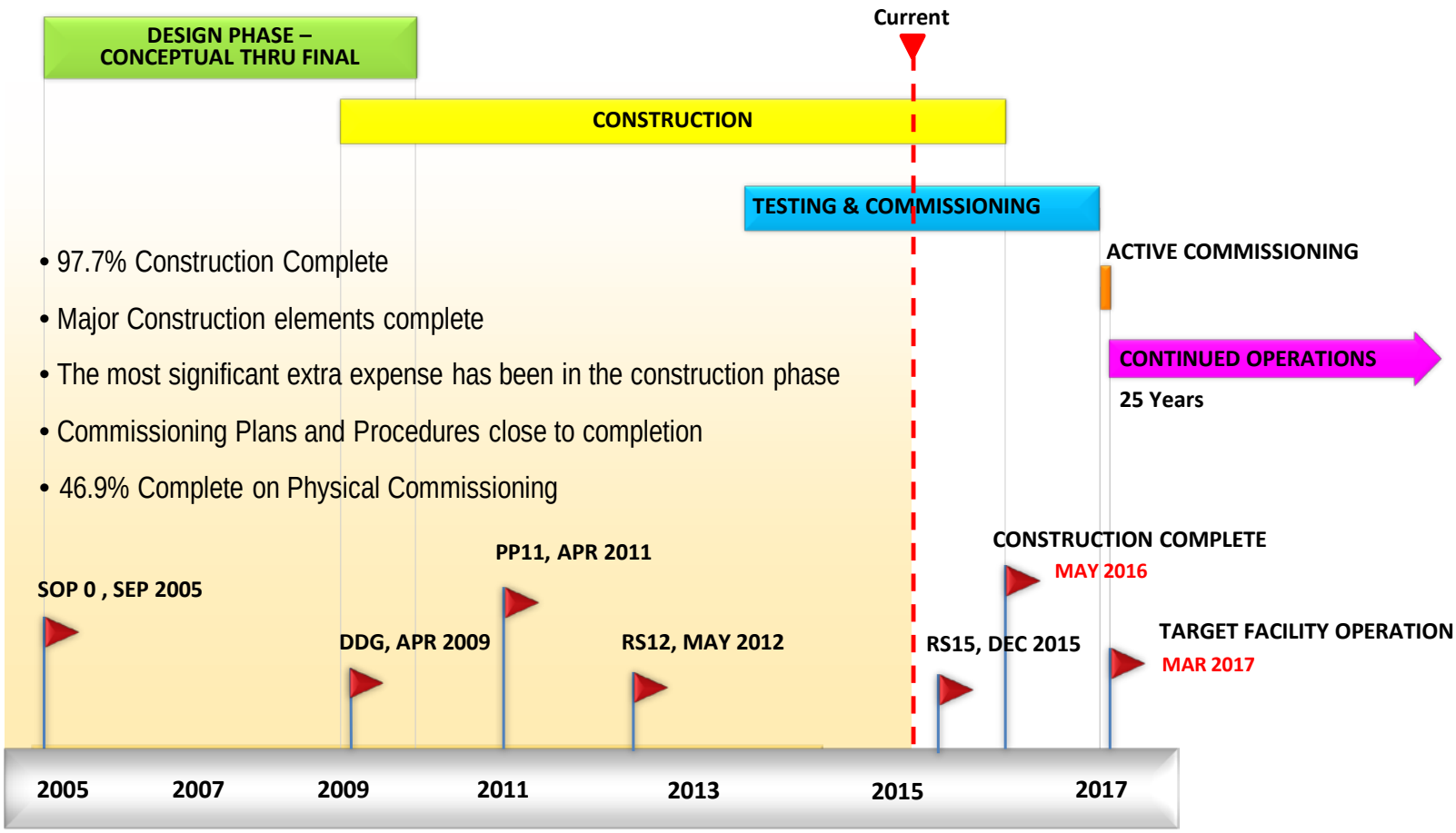
- Successful system commissioning — January 2016
- Integrated plant testing — June 2016
- Full plant water trials — August 2016
- Inactive safety commissioning — October 2016
- Endorsement of active commissioning — November 2016
- Active tie ins — November 2016
- Active commissioning — February 2017

SWPF

SWPF is currently in the last stages of construction and is 12-18 months behind Evaporator D in its evolution. The timeline of critical events going forward includes;

- Completion of construction (projected) — April 2016
- System operational testing — August 2017
- Integrated system operational testing — September 2017
- Cold commissioning — September 2018
- Hot commissioning — November 2018
- Start of Operations — December 2018

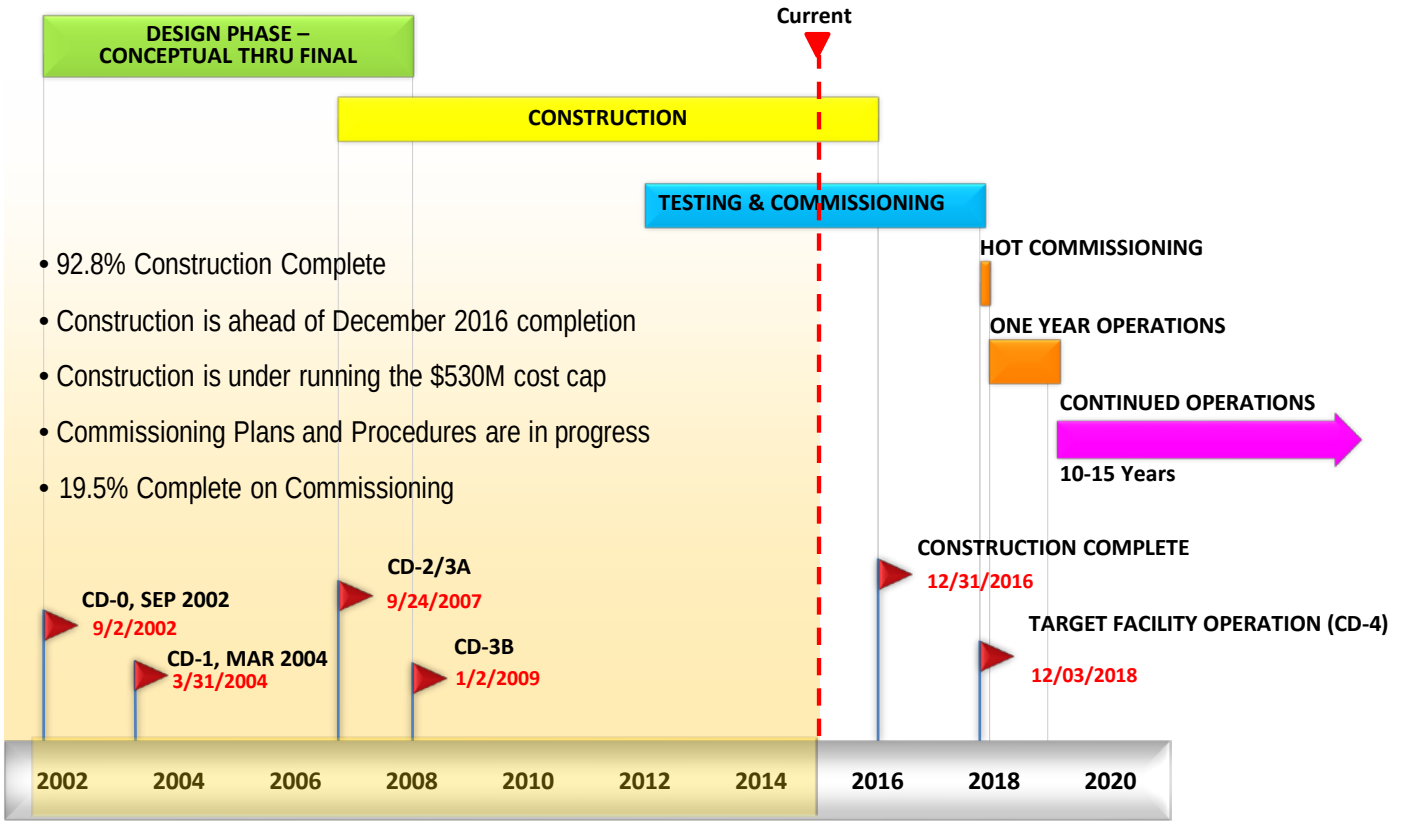
EVAP D Project Level Milestones



SOP 0, Sales & Operations Planning, Project need formally sanctioned, project initiation.
DDG, Detail Design Gate, Approve project delivery strategies, initial early procurement to start footprint construction in advance of final design
PP11, Performance Plan 2011, Approve Performance Baseline, holding DDG costs, but with accelerated delivery
RS12, Re-sanction 2012, Required following issues with performance issues in Engineering, Procurement and Construction
RS15, Re-sanction 2015, Required following an inability of the contractors to improve performance, also to account for various quality issues.

Figure 1: Major Milestones on Evaporator D Project

SWPF Project Level Milestones



CD-0, Critical Decision 0, Approve Mission Need
CD -1, Critical Decision 1, Approve Alternative Selection and Cost Range
CD-2/3A, Critical Decision 2, Approve Performance Baseline and Critical Decision 3A, Approve Limited Construction/Long Lead Procurements
CD-3B, Approve Start of Construction
CD-4, Approve Start of Operations/Project Completion

Figure 2: Major Milestones on Salt Waste Processing Facility

Challenges and Lessons Learned

During the past 3-4 months a number of meetings and videoconferences have been held between the Federal and contractor teams to share lessons learned and to discuss potential challenges that will present themselves in the next 12-18 months. These discussions will continue through 2016 as each project progresses and discussions will expand to include how these lessons can be transferred and applied to other projects in the DOE complex and on the NDA Estate.

Some of the retrospective lessons learned are included in the table below and have been aggregated together into 4 main themes that were common to both projects.

On review of the common issues there is nothing that is really unique however project still seems to consistently be delayed by similar types of issues. The reason for this paper is to highlight that common issues arise wherever a project exists and this comparison highlights similar issues in two different continents.

Following the table this paper then identifies how these issues can be addressed going forward.

Table 1: Summary of retrospective Lessons Learned on Evaporator D and SWPF from Project Inception through mid-2015

Issue	Evaporator D	SWPF	Observation / resolution /recommendation
Supply Chain Capability	- Competitive tender process resulted in only two bidders - There was a desire to broaden the supply base and therefore the bidders were encouraged to engage with known nuclear suppliers to enhance their technical capability. - After award, the selected consortium lost their key technical partner, but the customer elected to backfill with a number of small suppliers which, ultimately, made the project more complex and expensive - The selected suppliers did not have the strength in depth to make up for the 'lost' technical partner	- Critical path fabrication item was awarded to lowest cost, technically acceptable bidder who, ultimately, was unable to perform to the contract quality assurance requirements and was eventually abandoned. - A new contract was awarded to a different vendor via a sole source procurement based on the highest demonstrated technical capability.	- Politics and finance always plays a part in procurement – but do not let them overshadow the technical requirements - Recognise the limitations of the supply chain - Pay more attention to evaluating suppliers upfront and plan within their limitations. - Question if a lower standard is acceptable and, if it is, ensure that its introduction is managed carefully and effectively

Issue	Evaporator D	SWPF	Observation / resolution /recommendation
Seismic design	- Programme (schedule) and commercial considerations led to over conservative seismic model and pipe stress analysis.	- Changes in seismic requirements occurred early in the design phase	- Ensure design requirements are clear, agreed and well-defined and adhered to throughout the project.
Design Changes and Preconceptions	- The Evaporator D design was changed after contract award to accommodate management of POCO wastes - The plant footprint was defined early in the project with a drive to prepare the site prior to the full design. Subsequently, no-one questioned whether this could be amended even given a 7 fold increase in the number of process vessels resulting from the change in evaporator requirements.	- Parsons implemented a large scale testing program on new technologies which drove a number of design changes on the plant including; - processing pipe diameter increases to reduce flow upsets - increased amounts of coalesce media for improved solvent recovery - improved operational methodologies for acceptable operation - complete redesign of the Barium Decay Tank	- Ensure design requirements are clear, agreed and well-defined and adhered to throughout the project. - Be willing to challenge previous decisions.

Issue	Evaporator D	SWPF	Observation / resolution /recommendation
Fire Protection	- The design called for an Intumescent (Fire Resistant & Fire Retardant) paint system to be used. - The selected product required a relatively short cure time, after which the top coat could be applied. - After installation there was evidence the paint was delaminating and therefore not effective as a fire protection system. - The project then had to investigate alternatives to resolve the issue , especially for those areas with access restrictions where the paint could not be reapplied.	- SWPF had very similar issues with the application of intumescent paint, although the cure time appears to have been significantly longer, delamination occurred as well. As SWPF does not have the same access and space constraints, they were able to apply fire boarding to all areas.	- Use Fire Boarding not Intumescent paint, especially in areas where failure of the system would be difficult to resolve.

Issue	Evaporator D	SWPF	Observation / resolution /recommendation
Quality Issues / Release of incomplete products	- Significant issues with both the quality of fabrication and delivery of associated paperwork. - Quality of construction delayed a number of modules, resulting in some modules being delivered to site incomplete. - It was not clear who had the responsibility to complete the modules on site and the EVM system on the project was unable to account for the handover which led to delays and increased costs	- The original construction plan was to build the facility around the vessels, however, due to late delivery the plan was changed and the facility was built and the vessels eventually slotted in. - Paperwork was delivered 15 months after the vessels arrived on site. - A formal Buyers Shipping Release procedure was established to ensure effective handover roles, responsibilities and EV management	- Ensure that the supply chain qualifications are as good as they say they are ("don't believe the vendor hype") from both a delivery and a paperwork perspective. - Ensure that the quality and workmanship standards are clearly defined - Ensure that the supply chain produces paperwork concurrently with delivery of the product - Implement a Buyers Shipping Release procedure to ensure that when incomplete items are delivered, a full inventory of remaining scope is identified and is acceptable at site and fully recognised in the site schedule and EVM system

The Path Forward

Discussions to date have focused on retrospective lessons learned but both projects are now entering into the critical startup and commissioning phase over the next 12-24 months. Whilst both projects have a well-defined pathway to startup, there is recognition that there are still likely some currently unanticipated areas which will need to be addressed and so the collaboration will be maintained as first, Evaporator D, and then SWPF move through component testing, integrated plant testing, inactive commissioning and, finally, active commissioning. This collaboration will include sharing of respective risk registers to identify common issues, quarterly update videoconferences and participation by UK staff in critical SWPF project review meetings to ensure that the most recent and pertinent lessons learned from Evaporator D can be integrated into SWPF commissioning.

More broadly, there is a general realization that there are a number of other projects that will be entering the startup and commissioning phase in the relatively near future and so the Evaporator D and SWPF teams will also explore ways in which the lessons learned from this activity can be shared with other projects within the UK and US through, for example, workshops.

Conclusion

Information exchange and sharing of lessons learned will continue between the projects over the next 12-24 months as both plants move towards active operations. A review of retrospective lessons learned identified by both projects to date can be summarised into 4 areas;

Capability of the supply chain to deliver quality products and services

Both projects have suffered from the inability of their respective supply chains to deliver nuclear grade products on time, on budget and to the required quality. LFE from both projects has suggested that more effort needs to be devoted to ensuring that the selected suppliers are truly able to deliver on the promises they make in their proposals from both a technical and a paperwork perspective. However, in an industry where projects are often first of a kind, supply chain capability cannot be proven without significant trials being conducted. The ideal situation would be to ensure continuity of complex nuclear projects and therefore a continued capability. If this is not possible then the prime contractor needs to adopt a more collaborative approach with their suppliers throughout the bid, qualification, award and delivery process.

Control of design

Both projects have experienced design changes created from additional functional requirements. They have also both suffered from issues with seismic design. SWPF had the seismic requirements modified during the design and construction phases,

whereas Evap D lacked internal expertise to qualify or challenge the resultant over-engineered seismic design. The key learning from this is to both have the capability and be willing to challenge design requirements.

Pay close attention to Interface issues

The Evaporator D project had a situation develop whereby contractor A delivered partially completed modules to site and contractor B was expected to complete the modules and integrate them into the rest of the plant. However, this interface had not been documented or well managed and the EVMS arrangements had not been amended in line with the scope changes. The formal US Buyers Shipping Release procedure developed and adopted by Parsons and DOE SR is a formal approach to managing this situation.

Question Restrictive Design Assumptions

The Evaporator D footprint had been set and constructed before the final design was completed. However, even after the change of evaporator requirements were implemented, no-one questioned the footprint restrictions. This resulted in a highly congested plant design which could have been simplified through an expansion of the footprint.