Chute Silo ILW Project Berkeley-16649

Author: Chris Thomson, Aquila Nuclear Engineering
(cthomson@aquilaeurope.eu)

INTRODUCTION

Magnox, a Tier 1 Site Licensed Company (SLC), is the management and operations contractor responsible for the decommissioning of twelve of the Nuclear Decommissioning Authority's (NDA) nuclear sites in the UK.

Aquila Nuclear Engineering is a specialist Tier 3, turnkey engineering company based in the UK, delivering mission critical engineering solutions to Europe's nuclear and nuclear medicine industries.

Berkeley Nuclear Power Station, Berkeley, England started generating electricity in 1962, ceasing operation 27 years later in 1989. The Chute Silo ILW Project at this Reactor Site had been set up to retrieve irradiated control rods and charge chutes disposed of within a subterranean vault (silo). The project involved in-silo size reduction of waste in to 30-35 waste baskets.

The waste basket was then to be retrieved via a pintle grab and hoist mechanism in to a Transfer Flask (through a silo and a Transfer Flask gamma gate).

The Transfer Flask was then to transit along existing crane rails, out of the silo building and over the top of an Import/Export Facility.

A Ductile Cast Iron Container (DCIC) was to be imported into Import/Export Facility and inspected/prepared to receipt the waste basket from the Transfer Flask. Once filled, the DCIC was then to be sealed and exported to an on-site storage facility.

Figure 1: 3D CAD Model of Chute Silo ILW Project, illustrates Aquila's implemented design.

Due to an issue with the Magnox Tier 2 Framework holder in delivering a cost effective and viable solution for their Chute Silo ILW Retrieval Project, Magnox took the ground breaking decision to 'self-perform'.

This involved dividing the larger project into several smaller packages. Two of these packages – for the shielded Transfer Flask and the Import/Export facility – were put out for competitive tendering directly to the Tier 3 Supply Chain.

The work completed by the Tier 2 Company was shared with the Tier 3's, but Magnox expressly requested the Tier 2 proposals were scrutinised and that far more cost effective, robust and simpler solutions were provided for within the Tier 3 Tenders.

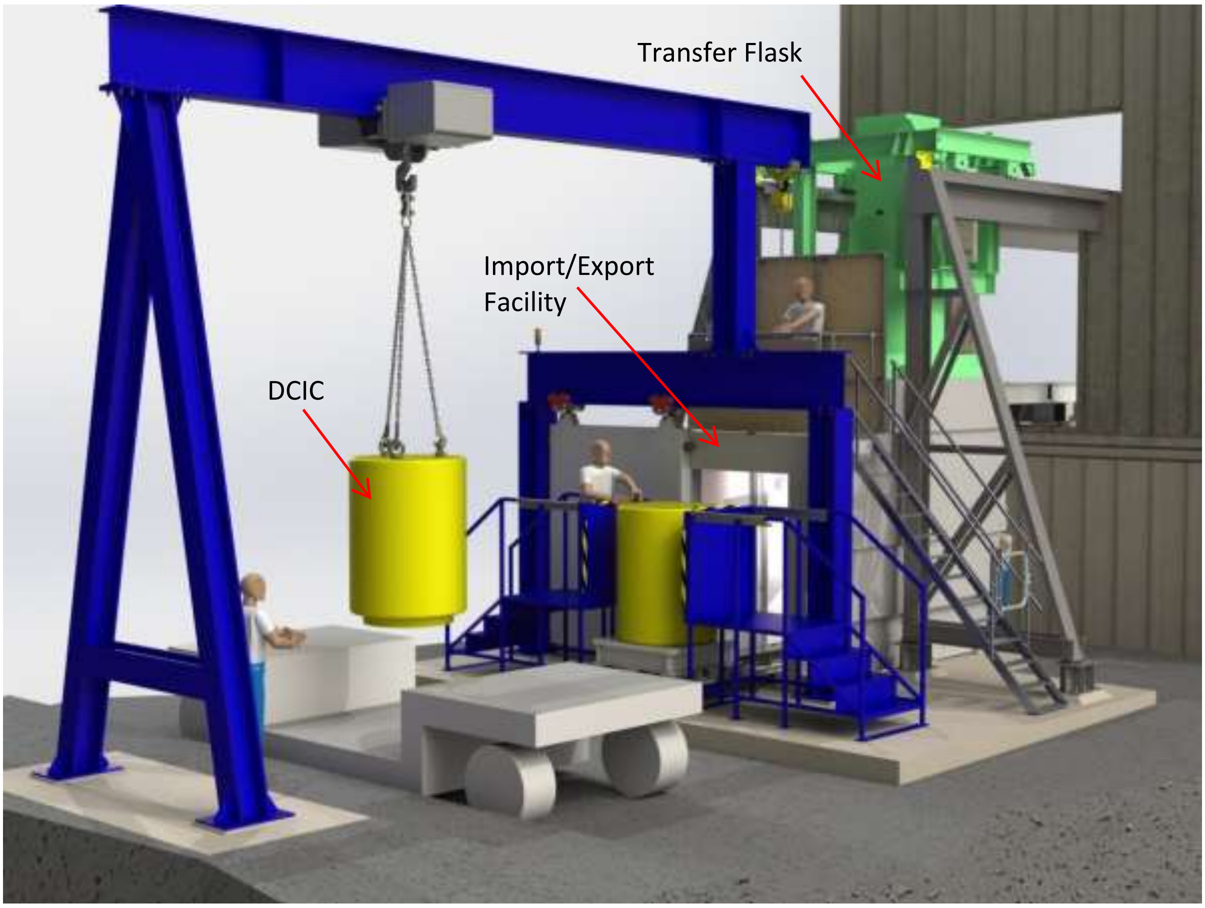

Figure 1: 3D CAD Model of Chute Silo ILW Project

Aquila won both work packages and delivered them with significant and demonstrable cost savings, on time and under budget.

This was achieved by the collaborative arrangements between Aquila and Magnox, the methodologies of both company's project teams and the innovation and 'fitness for purpose' of Aquila's design pragmatism.

COLLABORATIVE WORKING

Collaborative working is defined here as two organisations engaged in a Client/Supplier relationship, working together to successfully achieve a particular project in a consultative, supportive and consistent manner.

The success of the Magnox/Aquila Nuclear Engineering collaboration was due to 4 pivotal ingredients;-

1. A Common Goal
2. Big Picture Approach
3. Mutual Respect
4. Listening

Common Goal

In order for both parties to be aligned they both needed to share the same vision and the same understanding of what the end result was to be.

Magnox needed to create, and unambiguously define, the common goal and then both parties had to identify and agree the items of significance and their priority relative to each other.

Project leaders in both Magnox and Aquila had to show strong leadership in ensuring that the goal and direction remained clear and that focus was maintained. In parallel to this, the project leaders had to demonstrate 'soft' leadership skills in the delegation of activities, empowerment, supporting and trust of the respective delivery teams.

Big Picture Approach

This approach not only involved maintaining sight of the common goal of delivering a safe, fully functional system, but also to understand the function and interrelationships between the sub-systems and discreet disciplines, e.g. mechanical engineering, nuclear safety case, human factors etc. It also involved each company (project team) understanding the other and developing intercompany relationships to best support each other's project activities and objectives.

Open and honest lines of clear and timely two-way communication were always maintained. This approach ensured that, not only was there no 'silo mentality' in each company's project team, but there was no inter-company silo mentality either. Maintaining the 'Big Picture Approach' supported the aim of the 'Common Goal'.

Mutual Respect

Respect, as ever, has to be a two way process. Magnox had to respect the experience and capabilities of the Aquila team and their ability to deliver robust, fit for purpose solutions in a timely manner for the key items identified in the common goal. Aquila had to respect that Magnox's perception and perspective of the common goal and big picture (as the end user) were the best informed.

The mutual respect also extended to each party being able to interrogate the other and propose alternatives and, as importantly, for neither party to feel 'embarrassed' in adopting the ideas of the other.

Listening

On tendering for this project, the greatest differentiator between Aquila and its competition was that, at Magnox's pre Invitation to Tender (ITT) meeting, Aquila listened to the request by Magnox to dramatically simplify, where possible, the existing concept designs for the project.

Throughout the project, listening to Magnox was a prerequisite to understanding their functional requirement and the process they envisaged employing to achieve this. Without this understanding design, manufacturing, assembly, testing and installation could never have been fully optimised.

Equally important was for Aquila to constantly view the project aim from Magnox's perspective. As the end user Magnox had insight into operational considerations that Aquila could not know and also Magnox held the unique knowledge of how to best steer potential issues through the requirements of their own organisation.

METHODOLOGY

Both Magnox and Aquila independently operated a 'cellular' project management methodology which promoted concurrent engineering and lean management principles, achieving better performance throughout the project.

Magnox

When Magnox took the unprecedented decision to 'self-perform', it utilised a small and motivated delivery team who were heavily invested in the project.

Aquila, as mentioned earlier in Collaborative Working, carefully listened to Magnox's objectives and requirement at the pre ITT meeting and proposed a well-developed concept design which was fully costed within the Tender.

In addition to incorporating all of Magnox's requests, the simplicity, quality, pragmatism and cost effectiveness of the Aquila proposals meant that Aquila were awarded both packages of work to a target price on an NEC3 Contract.

Aquila

The project delivery methodology at Aquila has always been to set up a small dedicated project cell with the requisite, suitably qualified and experienced (SQEP) engineers.

Aquila has always had a listening culture and the desire to engage its clients as early and as fully as possible.

In the execution of this project, Magnox engineers were invited to embed themselves into the Aquila design team through the attendance of design reviews and design risk assessments.

This had the additional benefits of ensuring Aquila had correctly interpreted Magnox's requirements and constraints and to inform Aquila of additional requirements, such as those to satisfy the nuclear safety case at a very early stage. Equally, this integration informed Magnox of any issues that Magnox would need to take back to resolve within their own organisation.

The Delivery Dream Team

With both Magnox and Aquila utilising small, motivated and professional project cells/delivery teams, collaborative working became as much intuitive as a methodology implemented by management.

The small teams permitted the fast tracking of inter-company relationship development, making communicating and sharing the same vision of the common goal simpler and quicker.

Equally, looking outside each's own organisation at the other's and understanding the bigger picture became easier.

Mutual respect and the willingness to listen, whilst championed by management, were probably achieved to a greater extend by the personality, quality and character of the individuals themselves. Doubtless though, this was greatly facilitated by the clarity and focus of the common goal.

The small teams also encouraged accountability and the empowering of individuals, in addition to promoting collaborative support and inclusiveness at the same time as eliminating blame and politics.

DESIGN FEATURES

Aquila Nuclear Engineering applies a rigorous approach to reducing costs within its designs, without compromising quality, following a proven 7-step value engineering methodology;-

1. **Information Phase** – The gathering of information about the requirement/plant and process and the main functionality required.
2. **Function Analysis Phase** – Analysis of the project to clarify the required functions. Identification of what functions are important and which performance characteristics are required for these functions. The output from this phase is the Functional Specification agreed by the Client. This process is based exclusively on "function", i.e. what something "does" as opposed to what it "is" and is an open discussion of further improvements rather than a quality evaluation of the design.
3. **Creative Phase** – The generation of ideas on all possible ways to achieve the required functions. This phase looks for various alternative solutions to achieve the identified requirements.
4. **Evaluation Phase** – The assessment of ideas and concepts from the Creative Phase. Verification that these meet the required functions and the selection of the most promising, feasible options.

5. **Development Phase** – The development of the best ideas selected at the Evaluation Phase with particular focus on their impact with regard to the costs and performance that can be expected.
6. **Presentation Phase** – Presentation of the identified and developed alternative solutions and the provision of all pros and cons of the alternative solutions.
7. **Implementation Phase** – The development and optimisation through Design Review, Design Risk Assessment and Design for Manufacture of the chosen solution(s)/concept(s) into full 3D scheme designs ready for the production of 2D detailed design for manufacture.

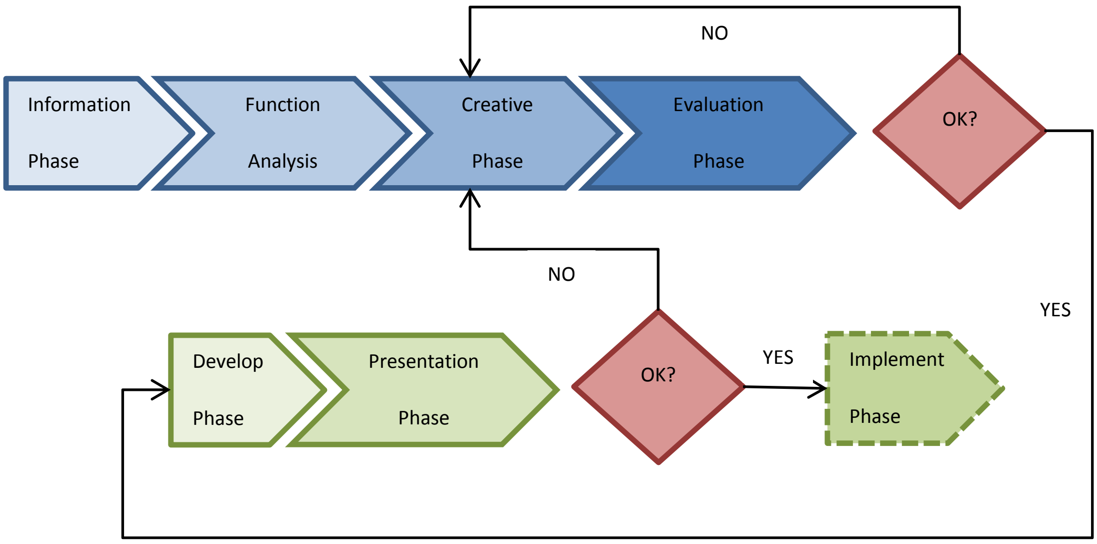

FIGURE 2: Value Engineering Workflow

All seven steps of this process were performed on the information available pre tender submission, to produce a revised and mature concept design incorporating Magnox's requests and Aquila's initial value engineering.

As part of Aquila's tender submission, this developed concept allowed accurate estimating and demonstrated to Magnox that, not only had their requests been correctly understood and incorporated, but that Aquila could add another level of pragmatism and simplification along with the associated cost and program savings.

Transfer Flask

The Transfer Flask body required a 200mm wall thickness to satisfy the requirements of the Safety Case. At tender stage it was determined that the most cost effective method of manufacture would be from a steel forging. This 8,000kg forging was costed and a lead time confirmed at tender submission.

FIGURE 3: Transfer Flask

Aquila's program reflected defining the forging as the first design activity thereby permitting order placement very early on in the project, negating the extended lead time for the forging and saving programme time.

Pintle Grab

The Pintle Grab had been defined as the single, biggest risk item on the project by both Magnox and Aquila.

Magnox's original concept incorporated a design for a Pintle Grab that had never actually been manufactured and proven, Figure 4: Original Pintle Grab.

The Grab was complex, the landing area on the claws minimal - a loaded waste basket could weigh up to 1250kg – and it was solenoid/electrically operated. The solenoid necessitated a cable reeling system to manage the cable. Couple this to the knowledge that the Pintle Grab would be deployed some 12 to 13m down in to the silo and expected to latch on to a 100mm diameter pintle with the cable reel exerting its own force on the Pintle Grab and the risks against success were apparent.

Aquila was confident that they could develop and scale down a proven design that was purely mechanical. This they did early in the project with multiple trials successfully completed at Magnox's Berkeley Engineering Hall.

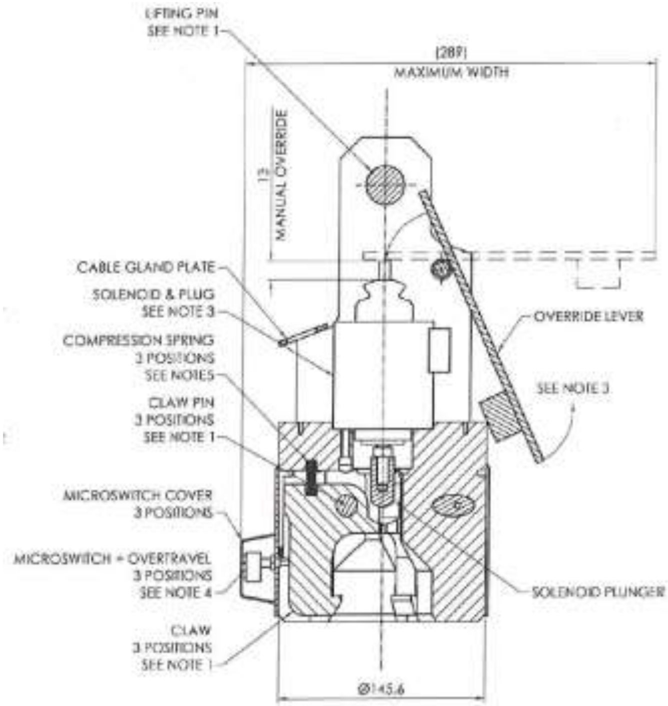

FIGURE 4: Original Pintle Grab

Aquila’s design was based on the principle of an indexing (retracting/extending) ball point pen, Figure 5: Aquila Pintle Grab. This system latched from locked closed to locked open (and vice versa) via the self-weight of the Pintle Grab. The Grab also incorporated a simple visual aid (to be viewed by cameras already required by the system) as to its open/closed condition.

FIGURE 4: Aquila Pintle Grab

Import/Export Facility

The original concept proposed an on-site, fully welded, carbon steel structure. Aquila made considerable manufacturing, testing and installation savings by designing the 40,000kg shielded facility from carbon steel, laminated plate supported on a carbon steel frame (the concept for this appearing in Aquila's tender). This negated a considerable welding and non-destructive testing (NDT) requirement in addition to specialist lifting equipment.

DCIC Bogie and Rail Transfer System

The original concept contained a complex, motorised bogie, a sophisticated positioning system and an unnecessarily expensive recovery mechanism. Aquila introduced positional compliance in the design, negating the need for very high positional accuracy. This permitted the use of a simple, manually operated, linear chain drive and a robust and cost effective positioning system. The recovery mechanism was replaced with a commercial of-the-shelf (COTS) wire rope hoist.

FIGURE 5: Import/Export Facility Trial Build/Testing at Aquila

DCIC Lid Removal

Again, an extremely complex and expensive semi-automated system was outlined in the original concept. Aquila, having introduced the positional compliance mentioned above, was able to adopt a manual system employing a simple COTS chain block. Additionally, Aquila utilised the shielding afforded by the DCIC lid to make up part of the Import/Export Facility ceiling shielding.

FIGURE 6: DCIC Lid Removal

DCIC Hoist

Two discrete hoist rail systems were proposed in the original concept, one to lift the DCIC and one to remove the DCIC lid. Aquila integrated these in to one assembly and, further, utilised this frame to support the Import/Export Facility shield door.

FIGURE 7: DCIC Hoist, Import/Export Facility Structural Steelwork and Bogie Transfer System

Import/Export Facility Shield Door

The Import/Export Facility was originally intended to be housed within a building canopy that was also to afford structural support for the 6,500kg facility shield door. By incorporating the support for the door within the DCIC Hoist and Lid Removal rail system, considerable savings were made in the requirement for supporting structures and the sophistication of the canopy.

Aquila did away with the original powered drive and associated control system for the shield door and instead utilised a simple COTS, manually operated, geared beam trolley

Access Platforms

Where feasible, Aquila replaced the proposed bespoke, fabricated access ladders and platforms with inexpensive COTS alternatives.

CONCLUSION

The original Tier 2 Framework holder's price to Magnox for the Chute Silo ILW Project was between £2-3M.

Aquila delivered the equivalent scope for under £1M.

Aquila's original programme was maintained despite the award of additional scope and (Magnox) delays on site.

Aquila came under the original target price for each discrete phase of the project.

The above was achieved because of:-

- the collaborative arrangements between Aquila and Magnox
- the methodologies of both company's project teams
- the design features put forward by Aquila (welcomed and adopted by Magnox)

In 2014 Aquila Nuclear Engineering received formal recognition of its achievements on this project by winning an NDA Supply Chain Award for *"Best example of supplier 'going the extra mile'"*.

Points highlighted in the award were:-

- improved customer focus, leading to stronger relationships
- encouraging challenge and innovation
- continuous suggestions for improvement
- £1 million savings and three months programme reduction