1. Executive Summary

This paper examines the factors that must be addressed in being able to deliver a cost effective solution for designing and building special equipment for use in remote environments and our chosen case study is a cutting machine for use at the European Spallation Source (ESS) in Lund, Sweden.

Our paper will cover the operational and maintenance constraints, design solutions, and the Aquila methodology for “fit for purpose” solutions in a commercial environment.

2. Context

The ESS will be one of the world’s largest scientific and technology infrastructure projects delivered to date. It is funded by a European Research Infrastructure Consortium (ERIC) to fulfil the international requirement for high-energy neutron source research.

The ESS will be located to the north east of Lund, in Sweden and will include a particle accelerator, target station, experimental halls and office facilities. It will also include a waste processing plant known as the “ESS Active Cells”.

The United Kingdom Atomic Energy Authority (UKAEA) has been engaged by the UK’s Science and Technology Funding Council (STFC) to design and supply significant parts of the ESS Active Cells, as part of the UK’s in-kind contribution to ERIC.

The objective of the ESS Active Cells is to size reduce, store and enable subsequent shipping of radioactive material that will be produced as a byproduct of the ESS research operations.

Human access to the ESS Active Cells is highly restricted and almost all operations and maintenance activities will be undertaken remotely using a robotic handling system and size reduction equipment.

A critical component to be operated within the ESS Active Cells is the ESS Shaft Cutting Station, which is used to size reduce large irradiated Target Components.

In 2018, UKAEA issued an Invitation to Negotiate for the design, build, test, install and commissioning of the ESS Shaft Cutting Station. After a successful tendering process, UKAEA engaged Aquila to deliver the ESS Shaft Cutting Station, employing remotely operated diamond wire technology in an active environment.

Delivering this work package is heavily informed by the innovative and collaborative approach adopted by UKAEA, Aquila and its supply chain.

We discuss below the success factors in tackling an unmet requirement and delivering a workable solution while maintaining a competitive edge.
3. **Setting success factors**

UKAEA is an executive non-departmental public body, entrusted with UK tax payer’s money for the purpose of developing and researching nuclear fusion power. It therefore has a duty and a need to drive value for money in designing and procuring engineered solutions.

As with all ESS Active Cell projects, the ESS Shaft Cutting Station has several critical success factors: value for money, zero-harm safety performance and getting the solution right, first-time.

Our solution echoes years of experience in pragmatic engineering and delivering quality systems while maintaining safety through project delivery and operation.

To properly achieve value for money and engineering a solution that is workable, we considered UKAEA’s requirements against all constraints and parameters within the Active Cells.

4. **Defining requirements and constraints**

The ESS Shaft Cutting Station will be installed and operated within the ESS Active Cells. When the Active Cells are commissioned, no human access will be permitted, and all operations will be carried out remotely using in-cell camera viewing systems and remote handling equipment. Any equipment installed within the Active Cells must therefore be capable of remote maintenance or replacement.

Although these constraints increase scope for innovation and creativity, they equally minimise the scope for achieving success factors, such as getting it right, first-time. We therefore had to understand each requirement and assess readily available solutions against the need to modify and validate alternative solutions.
We did this by mapping out solutions to fulfil the requirements and systematically assessing those solutions, identifying the benefits and acknowledging any disadvantages.

Throughout our assessment and review, we were driven by the requirements and constraints, as well as being influenced by the success factors. These considerations, when combined, provided an informed framework from which our innovation and pragmatism could flourish.

5. **Developing the concept to provide assurance**

Having defined the requirements and constraints, we set about identifying workable solutions which were readily available but perhaps not yet proven in similar circumstances. We engaged like-minded subcontractors with demonstrable experience in size reduction using diamond wire technology.

This engagement was a first of its kind for Aquila and required close collaboration and buy-in from all parties. Diamond wire technology has been proven in highly regulated and challenging environments, however use within active environments where no human access is permitted, is somewhat unproven.

During the tendering stages of the ESS Shaft Cutting Station, we set about validating how diamond wire could not only make the required cuts on irradiated components, but also how it the wire itself was capable of remote replacement using in-cell manipulators.