Fit For Purpose Design for Remote Operations - Handling the Hot Potatoes

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Remote handling must be employed in a wide range of situations where more convenient methods of operation are unsuitable due to the need for biological shielding. Working remotely can readily be achieved by various means, however they typically require concessions to productivity, versatility and user operability. Solutions are available which mitigate these drawbacks but they can be costly and complicated to implement, particularly when considering existing facilities or limited/single use campaigns. How do you balance these conflicts to find a fit for purpose solution?

Aquila Nuclear Engineering are an engineering design company providing bespoke solutions for the nuclear industry specialising in remote handling, shielded facilities, containment and radioactive material packaging and transport. In delivering these projects, the engineering team frequently develop remotely operated equipment tailored to the needs of the user and limitations of the facility.

This paper will consider three case studies, looking at what fit for purpose design means for very different applications.

Case Studies

PIE Cave Re-Configuration – National Nuclear Laboratory, Sellafield. The National Nuclear Laboratory (NNL) Windscale Laboratory at Sellafield offers shielded cell facilities to clients for non-destructive and destructive examination of reactor fuel and irradiated materials. The high activity caves are fitted with remote handling equipment and services and may be decontaminated, emptied and refitted as required to suit the requirements of the client.

In 2018, Aquila delivered a number of size reduction machines concerning the refit of one of these caves to support a research project analysing fuel pins. Once commissioned, Master Slave Manipulators (MSM) will be used exclusively to operate and maintain the equipment in a labour intensive campaign expected to last 10 years.

A modular approach was used with standardised components and features where possible minimising installation, operation and maintenance effort. Equipment had to be robust, efficient to use and minimise day to day operator effort with commercial off the shelf (COTS) items used for reliability but adapted for remote operation and maintenance. All interfaces had to be MSM compatible and especially simple for those in daily use. While machine maintenance must also be possible, the difficulty of the procedure could be considered against the likelihood or frequency of occurrence.

Active Waste Vault Retrieval and Export – Magnox, Berkeley. Magnox Berkeley nuclear power plant generated power from 1962 through to 1989 and is leading the rest of the fleet in terms of decommissioning. The reactors have been sealed and are now in long term ‘safestore’ until 2074 but a number of challenges regarding Intermediate Level Waste (ILW) remain on site.

The Active Waste Vaults (AWV) are a series of underground concrete vaults that are currently storing a variety of waste accumulated during the lifetime of the two reactors and the adjoining research laboratory. Emptying one of these required the creation of a temporary hot cell to safely package retrieved waste into shielded flasks for interim storage. Due to the limited quantity of waste and therefore short lifespan (the equipment was ultimately used for 9 months to fill 11 containers), only occasional operator intervention was needed and therefore the purpose designed equipment needed to be simple but safe.

The hotcell is of basic construction in cost effective materials with shielding only provided where required and a fit and finish appropriate to the limited usage. Simple mechanical actions are used to import, open and position the 9,000kg shielded flask in preparation for receiving a waste basket, primarily with only human effort. The system relied on position stops, alignment markers and operator feedback to allow blind operation, although cameras were provided for additional confirmation. Operation under robust procedural controls and a reduction in electrical parts reduced the complexity of the control system resulting in a lightweight Electrical, Controls and Instrumentation (EC&I) package.

Legacy Facility Decontamination and Decommissioning – GE Healthcare, Amersham. The Senior Caves facility in Amersham was constructed in 1957 on what was then a UKAEA site manufacturing radioactive materials for peacetime uses in medicine, scientific research and industry. Originally intended to purify fission products in support of site processes, an accident in 1962 resulted in widespread Cs-137 contamination preventing purification. The plant was used to produce Cs-137 sources until 1964 and in 1966 an attempt to decommission one of the cells resulted in another leak and further spread of contamination.

Returning to the facility in 2010 to begin decontamination and decommissioning, GE Healthcare started with no lights, service or remote handling equipment and solid shielding in front of leaking ZnBr shield windows meaning no internal view. Over the course of the last 6 years, Aquila have supported GE Healthcare with a variety of novel remotely operated equipment, reacting to the unique problems as they have been uncovered.

After initial work to establish a safe route into and out of the complex, work began on decontamination. Tools range from basic components like a 3D printed MSM tool holder allowing operators to quickly make custom tools, to miniaturised grit blasting and vacuuming equipment allowing removal of surface contamination. Due to the single use nature of much of the equipment, trials and close collaboration with the plant operators was vital to minimise delivery time and secondary waste.