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Challenge AS1

Development of existing techniques to further implement, underpin and deliver the analytical hierarchy.

The end of re-processing operations at the Sellafield Site will initiate an increase in remediation and de-commissioning activities, presenting new challenges to the Analytical Services teams.

Operations in the current laboratory are being phased out and the majority of the future work will be performed in a new purpose-built facility, the National Nuclear Laboratory Central Lab (NNLCL).

A review of current, historical and future anticipated activities has been performed.

It is recognised that there is an opportunity for operations in the new NNLCL to exploit the latest developments and so improve the efficiency, safety and quality of analytical work.

From this review, a series of challenge statements have been produced to illustrate the requirements and help interested organisations engage with Sellafield Ltd:

- Development of existing technologies and techniques.
- Deployment of new technologies and techniques.
- Use of emerging computer-based technologies.
- Utilisation of new engineering materials and design philosophy.

These challenge statements are designed to stimulate innovative thinking. Sellafield Ltd is keen that as many ideas as possible are heard and discussed, with the potential for their development and deployment in the nuclear decommissioning arena.

Sellafield want Game Changers.

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CHALLENGE AS1

Development of existing techniques to further implement, underpin and deliver the analytical hierarchy.

THE SITUATION

Many of the analytical technologies used in the current analytical facility are based on processes developed in the 1970's and 80's. Although much of the technology is old, Analytical Services still delivers a diverse range of analytical methods to support site missions.

Customers often demand a high level of confidence in the analytical data (high degree of accuracy and precision) in order to maintain safe operations of plant processes.

The equipment employed to provide this work is often modified to fit the containment (fume-hood, glove-box or hot cell). This is to manage the radiation and contamination risks from the materials undergoing analysis. In some instances, the containment does not meet modern engineering standards or regulatory requirements.

The majority of these analytical methods are manually operated and produce significant amounts of wastes (both solid and liquid) that result in increased operator time and large disposal costs.

The failure to adapt instrumentation and techniques into the new analytical facility could be very costly as the opportunity to reduce waste and operational costs would not be realised.

Sellafield's Analytical Services Teams are looking for opportunities to improve on the existing technologies in order to meet future demands.

THE CHALLENGE

The adoption of these techniques must demonstrate a clear benefit for Analytical Services. The challenge is to provide tools, instruments and techniques that fulfil the criteria that set out below.

- Automation and miniaturisation of techniques and equipment to fit into hot cell and alpha containment units without impairing the capability.
- Techniques that use less sample.
- Techniques that improve operability and maintainability.
- Improved accuracy, precision, limit of detection, resolution and robustness.
- Clear benefit measured in terms of cost, time (of analysis or handling) and risk reduction.
- Automated sample preparation.

There might be a need for accreditation of some analytical methods to ISO17025.

The adoption of new techniques and technologies must demonstrate a clear benefit for Analytical Services.

The current Analytical Services facility at Sellafield consists of 96 laboratories containing instrumentation and enclosures.

There is additional space for offices, storage and supporting infrastructure.

It is the size of four football pitches and sits within the controlled area at the Sellafield site (readily accessible to plants).

A large variety of analyses in terms of sample types and chemical species are measured:

>50,000 samples analysed per year

>200,000 analyses performed on these samples

The analytical techniques used in the department encompass a wide range of routinely used analytical techniques, including:

- *Mass Spectrometry*
- *Optical Emission Spectrometry*
- *Gamma Spectrometry*
- *Radiochemistry*
- *Ion Chromatography*
- *Titrimetric techniques*
- *XRF*
- *Physical analysis*

It is intended that the new NNLCL facility should provide the bulk of the site's analytical service until at least 2035.

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THE CONSTRAINTS

- Techniques should not be prohibitively expensive
- Techniques must be resistant to contamination i.e. can be simply decontaminated
- Techniques and equipment must be small in size and be easily replaced
- A holistic overview is required e.g. improvements in quality may not actually deliver any benefit in terms of cost, schedule or safety.

EXAMPLES

- Automated radiochemical separation.
- Smaller Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) to fit in a standard fumehood.
- Delivering multiple capabilities with a single device (e.g. combined furnace) to save space.

SPECIFIC AS1 CHALLENGES

CHALLENGE AS1.1

The construction and operation of Highly Active (HA) cells is very expensive, as is the disposal cost of associated Intermediate Level Waste.

DESIRED SOLUTION

Combining techniques into a single instrument can save valuable cell space and also reduce the amount of waste produced. Sellafield Ltd and the National Nuclear Laboratory are pursuing an option to deliver a combined furnace system in a HA cell to provide analysis that would previously have required a number of furnaces.

HA cell size is approximately 2.5m x 2.5m x 2.5m. This principle applies to gloveboxes and fumehoods also.

Other examples of combined techniques could be:

- A combined ICP-OES and ICP-MS with integrated software delivering improved interference correction whilst saving space.
- An integrated heating and weighing capability for monitoring changes in mass at very high temperatures (up to 1000°C).

CHALLENGE AS1.2

Gamma spectrometry detection of gamma emitting species is affected by background interference.

DESIRED SOLUTION

This situation could be greatly improved. For instance, improved electronics and software could discriminate Compton scatter from “real” counts. Genuine background could be reduced by employing directional discrimination of gamma photons.

CHALLENGE AS1.3

Radiochemical separation techniques are often very time consuming and produce significant radioactive waste.

DESIRED SOLUTION

Advances in Inductively Coupled Plasma - Mass Spectrometry (ICP-MS) instrumentation in terms of removal of interferences and reduced Limits of Detection (LoD) mean that ICP-MS is an increasingly viable option for radionuclide analysis.

Further advances are likely to negate the need for pre-chemical separation and the achievement of lower LoDs.

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THE TEAM

This challenge has been authored and commissioned by the Sellafield Integrated Innovation Teams.

Should you have any questions about this specific challenge, please email **gamechangers@nnl.co.uk** and your enquiry will be responded to by the appropriate member of the team.

Any further information which is deemed to be of potential use to other applicants may be published into the public domain.

Individual applicant’s intellectual property shall be upheld.

Further enquiries and applications should be made via the Game Changers website at:

www.gamechangers.technology

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Get involved.

Should any or all of these challenge statements be of interest to you and your organisation, and you feel that you have the innovative technologies or techniques to help deliver the desired solution, then we'd like to hear from you.

Visit **www.gamechangers.technology** to download or complete an application form online, or you can request an application form by email at **gamechangers@nnl.com**

The decommissioning of the Sellafield site is anticipated to take over 100 years, cost in excess of £50bn and creates challenges never encountered before. These challenges require investment in innovative technologies, concepts and methods.

Sellafield Ltd actively seek to engage with Game Changers - businesses, academia and individuals who can bring their innovations into the nuclear arena and help achieve the goals of accelerating the decommissioning programme whilst also reducing costs and upholding Sellafield's commitment to human and environmental safety.

Game Changers could also be technologies and methods which are already used in other industries which could be developed for use in the nuclear sector.

Funding for proposals is available to support development of these technologies: we invite proposals which clearly articulate the innovative technology development needed to meet Sellafield's decommissioning challenges.

Successful applicants are eligible for an initial £5,000 of funding and commercialisation support to present their innovations to Sellafield Ltd.

Further proof of concept and prototype development funding will be made available to any innovations identified by review panels to have significant commercial and operational potential.

Information about this initiative is available on the Game Changers website at **www.gamechangers.technology** or you can contact us by email at **gamechangers@nnl.co.uk**

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