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Challenge AS2

Development of new 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 AS2

Development of new 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.

Sellafield is looking to improve analytical delivery and resilience by using improved and novel techniques e.g. NDA (Non Destructive Analysis), in-situ analysis and rapid screening to facilitate future analytical delivery.

THE CHALLENGE

The challenge is to explore and develop new techniques and provide fit for purpose instruments capable of supporting both current and future analytical requirements. These instruments ideally meet the following criteria:

- They occupy a smaller footprint (miniaturisation) and can therefore be situated in a containment enclosure without further modification. They may be small enough to be sited with another instrument in the same space.
- More analysis can be done from a single instrument (multi-analytical equipment).
- Instruments are modular so separation of components allows improved utilisation of space. Certain parts of the instrument could be treated as consumable.
- Minimal installation, commissioning, training, maintenance and waste disposal requirements.
- Produce little or no orphan wastes, i.e. any waste generated should have a disposal route.
- Utilise technologies from other industries e.g. medical, pharmaceutical, construction, manufacturing, space, oil and gas. Operations in hostile environments are of particular interest.

THE CONSTRAINTS

- Instruments and analytical techniques must be evaluated as part of the overall process. For example, an in-situ instrument measuring a single specific analyte may not deliver any overall benefit if sampling and laboratory analysis is still required for other analytes.
- Capital costs must be balanced with operational and lifetime costs to provide an overall benefit.
- Combinations of techniques must be compatible – i.e. not cause interference.
- Radiological contamination of instrument internal parts can make maintenance difficult.
- Deterioration of some instrumentation, typically electronics, may be expected in higher activity environments (>5 mSv). Engineering modifications could extend the operational lifetime.
- Extensively modified Instruments often need operate beyond their expected operational lifetime.
- Techniques must be compatible with the containment environment, e.g. a flame spectrophotometer would not work in an argon inerted glovebox.

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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EXAMPLES

- In-situ Sr^{90} analysis
- Dipsticks or portable analytical techniques
- Newer semi-conductor crystals for use in gamma spectrometry
- In-situ rheology
- Robotics

SPECIFIC AS2 CHALLENGES

CHALLENGE AS2.1

Radiation dose and radioactive contamination are invisible hazard that have the potential to cause harm to individuals.

DESIRED SOLUTION

If a coating was developed that changed colour in the presence of beta/gamma radiation or alpha contamination it could be applied to lab coats, fumehood ledges, glove, floors etc. A colour change would then precipitate mitigating action to remove radiation hazards and halt the spread of dangerous alpha contamination.

CHALLENGE AS2.2

Performing analysis in-situ can deliver significant cost savings whilst also improving quality. To enable the future processing and mobilisation of radioactive sludge waste it is vital that the rheological properties are understood. Sampling and sub-sampling of sludge can change the fundamental physical properties of the material prior to analysis.

DESIRED SOLUTION

In-situ measurements should be more reproducible than the measurements obtained via sampling and subsequent analysis and there could be significant cost savings. Effective rheological measurements could be delivered at variable depth and real time monitoring of rheological changes is possible. Future developments could give indicative information on particle size and shape.

CHALLENGE AS2.3

A furnace system in a Medium Active cell is to be used to volatise samples (up to approx. 1000°C) and bubblers will be used to capture tritium and Carbon14. These bubblers will then be removed from the cell prior to liquid scintillation counting.

DESIRED SOLUTION

There is a proposal that both tritium and Carbon14 could be measured by photo-acoustic detection following laser excitation. This would eliminate the use of bubblers (traps) and reduce the number of sample movements.

There is potential to integrate Carbon14 measurement with temperature to provide indication of chemical stability.

This technology could also be used for detection for of other gaseous species associated with furnace/pyrolysis methods. This could be utilised in a variety of containment solutions.

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THE TEAM

This challenge has been authored and commissioned by the Analytical Services Technical Team.

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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