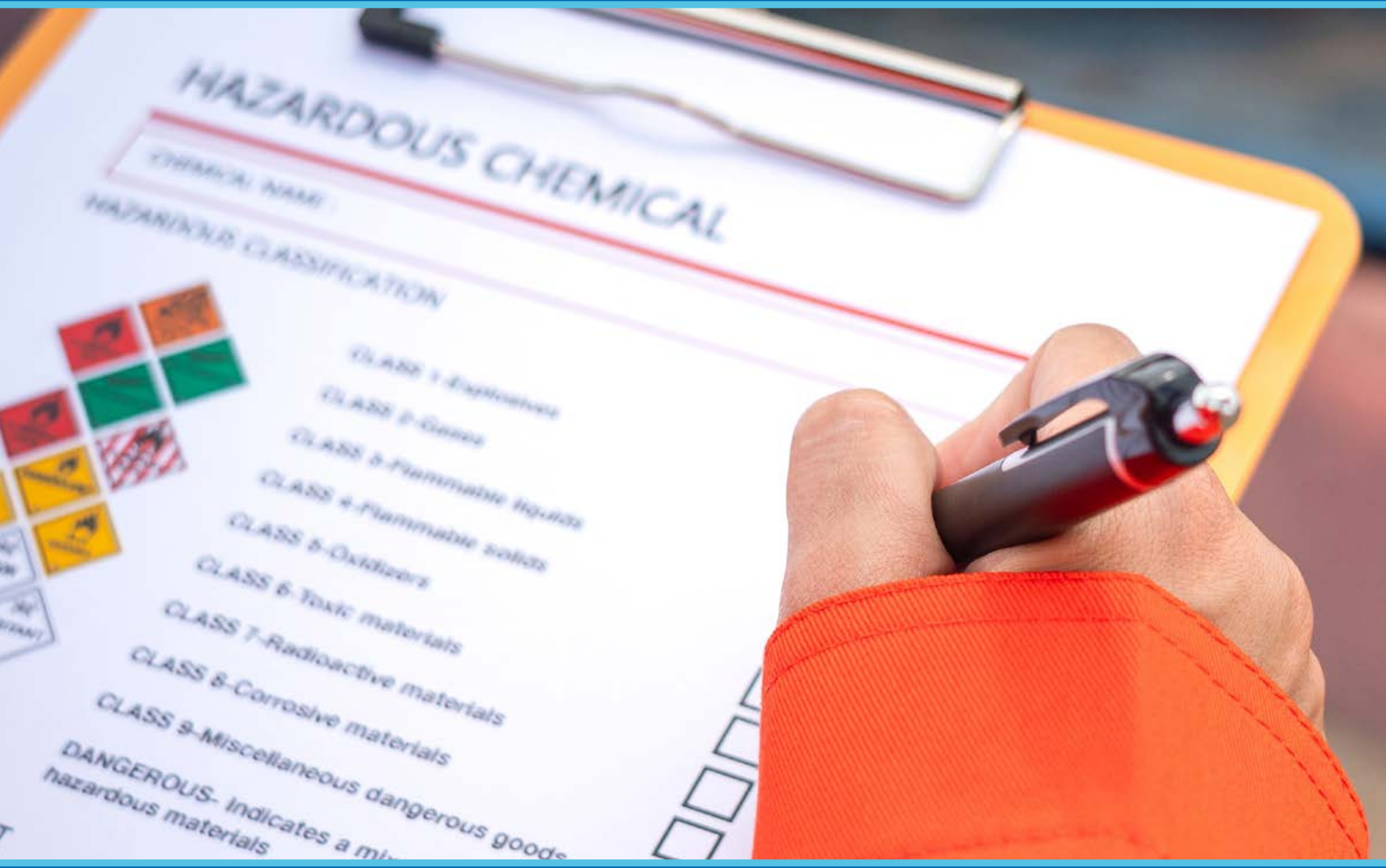
Sellafield Ltd

GAMECHANGERS
DELIVERING NUCLEAR INNOVATION



CHALLENGE:

In-situ real-time characterisation and measurement of materials for effective nuclear waste management

Sellafield Ltd is pursuing innovative solutions to accelerate the characterisation and measurement of materials through in-field testing capabilities. The objective is to shift from traditional lab-based methods to in-situ analysis capable of detecting a wide range of radiological and chemical characteristics (quantitatively and qualitatively) across various site environments, aiming to drastically shorten the current 12-week data collection and analysis timeframe.

FIS 360
INNOVATION I TECHNOLOGY I BUSINESS

NATIONAL NUCLEAR LABORATORY

Introduction

This challenge focuses on characterising and measuring data, whether in situ or remotely, of various materials to support strategic business decisions in managing waste at Sellafield.

Waste must be classified and any hazardous properties identified before being handled, packaged, disposed of, or recovered. This classification will determine the controls applied to the waste's disposition. Additionally, the classification, quantification and hazard assessment must be documented in waste records.

Conducting measurements in situ enables faster, real-time data gathering and analysis, facilitating immediate decision-making regarding the treatment, storage or disposal of waste. This measurement data can also help determine the packaging and storage requirements.

Waste Management at Sellafield needs to consider both the potential radiological (e.g. very low-level waste (VLLW), low-level waste (LLW), …) as well as chemical (hazardous/non-hazardous/inert) classification. With Sellafield's history as a large nuclear industrial site since the 1940s, there is an extensive range of potentially hazardous substances which can be present in different waste matrices. Some of the more common hazardous contaminants are listed below:

- Total petroleum hydrocarbons (TPH)
- Polychlorinated biphenyl (PCBs)
- Polycyclic aromatic hydrocarbons (PAHs)
- Semi-volatile organic compounds (SVOCs) and volatile organic compounds (VOCs)
- Heavy metals (As, Ba, B, Cd, Cr, Cu, Pb, Hg, Mo, Ni, Sb, Se, Sn, V, Zn)
- Anions (F^-, Cl^-, total cyanide, nitrate, sulphate, sulphide)
- Asbestos (identification and quantification)
- pH

The Sellafield site covers an area of approximately 6 km^2, containing almost 2000 buildings, while also being a site of significant decommissioning works as well as multiple construction sites (to support the decommissioning mission). As a result, the waste materials and environments can be equally as varied:

- Construction materials (such as bricks and concrete), from both above and below ground
- Metal objects (e.g. pipes, vessels, tanks, support structures), typically mild and stainless steels
- Wood
- Glass, Perspex
- 'Soft waste' such as PVC, and Personal Protective Equipment (e.g. gloves, boots)
- Roofing materials (e.g. felt, insulation)
- Painted materials, both indoors and outdoors
- Soil

With such a complex and varied requirement, it is recognised that a single technological solution is unlikely to be feasible and instead a 'toolbox' approach may be necessary, with different technologies required for different applications. However, a system which could work over a wide range of environments, providing a large suite of data/analysis would be preferable.

It should be noted that not all analysis necessarily requires a numerical value to be beneficial; for example, if a technology can determine an analyte to be below the relevant hazardous waste threshold, there may not be a requirement for a definitive quantitative result (so long as the robustness of the technique can be demonstrated).

Current Practice

Currently, samples are collected in-field and sent for either offsite or onsite laboratory analysis. This can expose individuals to hazardous environments and materials and can be very time-consuming, with data collection and analysis taking up to 12 weeks. Samples are taken from various material forms, including oils, gases, wood, concrete, liquids, and powders. This process provides Sellafield Ltd with the quantitative and qualitative data needed to make informed decisions about waste materials.

While there have been advancements in recent years with radiometric technologies for in-situ data gathering and analysis, there has not been an equivalent improvement in non-radiological technologies. Sellafield Ltd is currently exploring the value of X-ray fluorescence instruments, and also uses a non-destructive chemical test for detecting the presence of coal tar in historic tarmac surfaces.

Challenge Aims

The aim of this challenge is to enhance the characterisation toolkit at Sellafield – identifying technologies that can assess a wide range of waste material characteristics, including radiological, non-radiological, chemical, and physical properties.

The solution(s) should be able to remotely identify and determine both the type and quantity of the following components in situ in any given waste material:

- Total petroleum hydrocarbons
- Polychlorinated biphenyls (PCBs)
- Polycyclic aromatic hydrocarbons (PAHs)
- Semi-volatile organic compounds (SVOCs) and volatile organic compounds (VOCs)
- Heavy metals
- Anions
- Asbestos
- Persistent organic pollutants (POPs)
- Chlorofluorocarbons (CFCs)
- Waste Acceptance Criteria (WAC) testing
- pH

Sellafield Ltd is seeking solutions that can address all or part of the challenge and help reduce the current 12-week timeframe for data gathering and analysis of samples.

Benefits to Sellafield

Addressing this challenge could enable an in-situ analysis of what is currently done via sampling and laboratory analysis at Sellafield. This would lead to faster, real-time decision-making, significantly reducing the current 12-week turnaround time, which in turn would provide the following benefits:

- Improved safety through reduced requirement for intrusive sampling in challenging environments (decreased exposure to hazardous materials and environments)
- Faster decision-making reduces the risk of waste management becoming a bottleneck for achieving the site's decommissioning mission
- Lower commercial risk
- Releasing laboratory capacity (a limited resource) to provide support for other projects and business needs
- Reduced resource requirements, allowing staff to focus on other tasks
- Cost savings through accurate waste classification, which helps determine the appropriate waste disposal route using a risk-based approach
- Provision of tools and processes to support informed business decisions at Sellafield
- Addressing current gaps in laboratory capability

Constraints

The solution should:

- Ideally be hand-held or portable and comply with any manual handling regulations
- Be deployable in situ or remotely, removing people from harm
- Be deployable in a radioactive environment
- Provide data analysis in a time frame shorter than 12 weeks
- Potentially be left in situ for reuse on other campaigns
- Have the potential to be implemented across the site and in various environments, including but not limited to cells, glove boxes, buildings and ponds etc.

Note, the availability of power sources cannot be guaranteed.

Where relevant some additional factors should be considered:

- Comply with regulations for asbestos management in terms of who can analyse and who can sample
- If the technology collects/transmits data, there may be additional information security challenges

Functional Requirements

Any proposed solutions should have the following:

- The solution should ideally be a 'plug-and-play' technology, requiring minimal setup and integration to be operational
- The solution must support in-situ analysis of waste materials to enable real-time data collection and decision-making
- The solution must be capable of identifying and quantifying a wide range of materials (or selection of), including but not limited to heavy metals, anions, asbestos, total petroleum hydrocarbons, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs), and pH levels. A solution which can characterise multiple or all of the contaminants of interest is preferred
- The solution must minimise the need for individuals to handle hazardous materials and reduce exposure to dangerous environments, thereby enhancing overall safety
- The solution should significantly reduce the current 12-week timeframe for data gathering and analysis

Dependencies

Commonly requested chemical species for analysis include, but are not limited to:

Metals (Sb, As, Ba, Be, B, Cd, Cu, Pb, Mn, Hg, Mo, Ni, Se, Sn, V, Zn)
Anions (bromide, chloride, cyanide, fluoride, nitrate, sulphate, sulphide)
Oil (GRO/PRO [C6-C10], fuel oils [inc. DRO, C10-C25], non-fuel oils/lubricating oils [>C25])
Polycyclic aromatic hydrocarbons (PAHs)
Volatile organic compounds (VOCs)
Semi VOCs
Polychlorinated biphenyls (individual breakdown)
Asbestos screen
Asbestos quantification
pH
WAC Leachate (Sb, As, Ba, Cd, Cu, Hg, Mo, Ni, Pb, Se, Cr, Zn, chloride, fluoride, sulphate, phenol index, dissolved organic carbon, total dissolved solids, moisture, pH)
VOC organics (total organic carbon, total BTEX compound (benzene, toluene, ethyl benzene, and xylenes))
Hazardous suite (H1, H2, H3, H4, H5, H6, H7, H8)
WAC suite (H10, H11, H12)
Metals in oil
Anions in oil
Density by pycnometer
Density (m/V)
Total carbon
Ammoniacal nitrogen
Conductivity
Cr (III) and Cr (VI) speciation
Flash point
Magnesium
Sulphate (water soluble)
Glycol (screen)
Glycol (screen) as %
Glycol (total)
Glycol (total) as %
Loss on ignition
Total inorganic carbon (TIC)
Total organic carbon (TOC)

Find Out More

Game Changers are hosting a workshop for this challenge where delegates will have the opportunity to meet challenge owners. Details are available on the Game Changers website www.gamechangers.technology.

If you have new ideas or innovations which can be applied to address this challenge, we invite you to join us. If you'd like more information about the funding available through the Game Changers programme, please visit Our Funding Process (gamechangers.technology).

The deadline for applications for this challenge is 3pm on Tuesday 26th November 2024.

Sellafield Ltd

Delivered by

FIS 360
INNOVATION I TECHNOLOGY I BUSINESS

NATIONAL NUCLEAR LABORATORY

Email: apply@gamechangers.technology