This scheme is funded and supported by

Sellafield Ltd

GAME CHANGERS .technology

CHALLENGE: Characterisation of landfill and disposal areas

Sellafield Ltd are seeking ideas, innovations and technologies that will deliver game changing improvements over the current techniques used for characterisation of landfill, land-raise, trenches and disposal areas across the Sellafield site.

Current characterisation regimes produce satisfactory information for permit compliance monitoring. However, to meet a defined remediation end state, more detailed information is required about the contents of the landfill and trenches. In particular, Sellafield would like to determine whether the disposal sites contain any discrete objects and whether actinides and their daughters are present.

This call for innovation is open to applicants from any sector including industries such as oil and gas, mineral mining, chemicals, pharmaceuticals, and water.

Sellafield are seeking a proof of concept capable of deployment in a real environment as soon as practicably possible.

Introduction

The Sellafield site has a number of legacy waste disposal facilities such as landfill, land-raise, tips and trenches which typically contain rubble, excavation works and demolition materials. To achieve the desired end state, Sellafield needs to demonstrate that these areas do not pose a radioactive hazard, can remain undisturbed and don't have to be re-sentenced for alternative disposal.

Sellafield would like to characterise and map these legacy disposal areas to confirm there is no radioactive material present. If the characterisation and mapping activities do detect the presence of radioactive material it will enable Sellafield to determine a suitable waste retrieval, repackaging and resentencing route for the contents of the disposal facilities.

The land-raise areas may be up to 200m in length, 50 to 100m wide and up to 10m high. They may also contain material around 2m below ground level. These areas are likely to be covered by soil, textile covers or clay cap and, in some cases, may have vegetation and trees growing on the surface.

One of the trenches is approximately 100m long, 50 to 100m wide and 5m deep (below ground). Trenches are covered over by concrete or tarmac which may be up to 1m in thickness.

Current Practice

To meet current environmental monitoring requirements, Sellafield carry out monitoring that gives a broad indication of environmental impact by sampling gas, groundwater and leachates. Discrete gas samples are taken in some areas and 10 to 15 boreholes are drilled at locations close to the perimeter of these areas, periodically measuring and monitoring subsurface groundwater. This monitoring provides information about what is migrating from the landfill but doesn't measure what it is in the landfill itself.

Boreholes need to be carefully positioned to take into account of restrictions on site such as access, the need to avoid buried services and the presence of vegetation. The Land Quality team carry out ongoing conceptual model updates, including a great deal of interpolation and scenario mapping to build a picture of ground conditions from the known information taken at borehole locations.

This regime produces satisfactory information for general condition monitoring. However, to meet the end state, more specific information is required about the contents of the landfill and trenches as historical practices in inventory record keeping for waste disposal (both at Sellafield and wider industries) do no match today's standards. The perimeter monitoring of environmental conditions described above is not likely to provide the correct resolution to determine whether there are any discrete objects within the waste disposal facilities. Estimation of conditions between the bore holes (inference made between measurements in a number of locations) could potentially miss discrete objects. Furthermore, this analysis regime does not detect actinides and their daughters which could be present inside the disposal areas. Additional characterisation is therefore required to enable Sellafield to confirm that no radioactive material is present to meet future end state requirements. Sellafield is therefore interested in sensing the totality of the disposal areas.

Challenge Aims

Sellafield are seeking ideas, innovations and technologies that will deliver game changing improvements over the current techniques used to **characterise the contents of the landfill and disposal areas** across the Sellafield site.

Applications are invited for technological solutions to meet part or all of the challenge, which may be considered as:

1. **Deployment** of the equipment to gather data
    a. What can be achieved, at scale, minimising or eliminating groundworks where possible? e.g. the use of novel geophysics, drone surveys, satellite imagery, gas emission monitoring, drone surveys, instrumentation of drilling rigs etc.
    b. How can data point collection and data spatial resolution be increased?

2. **Gathering and analysing data**, for example, improving the quality of data through sensing/measuring/recording/analysis below the surface. The following are of specific interest:
    a. Measuring the radiological inventory (alpha, beta, gamma)
    b. Identifying specific nuclides of long-term radiological significance (for example carbon 14)
    c. Understanding the presence of material that is reactive. It is desirable that proposed solutions should confirm the material through characterisation
    d. Identifying materials that might create leachates that increase the mobility of radiological materials

Options for discrete or continuous (preferred) monitoring will be considered.

Solutions which allow for the interrogation of existing datasets are of interest.

Opportunity:

1. Sellafield acknowledge that solutions for the trenches may differ from solutions for land-raise areas.
2. Applications for all or part of the solution will be considered.
3. Scanning the waste areas will not be a one-off activity and will be repeated as necessary:
    a. properties of buried waste materials may change over time
    b. changes in atmospheric conditions may affect buried waste materials
    c. the frequency of scanning may change depending on what materials are identified
    d. characterisation of all media phases (e.g. solid, liquid, gas) will be considered

Benefits to Sellafield

Solutions to this challenge will directly support the remediation of the Sellafield site. A better understanding of the ground condition and contents of disposal sites removes any uncertainty and will enable planning to achieve a desired end-state.

It is anticipated that solutions will:

- Remove or reduce the need for human intervention
- Minimise groundworks
- Reduce risk to people by understanding sub-surface conditions
- Enable more strategic deployment of resources where risk is higher
- Allow better scenario modelling leading to a more predictable end-state and removing uncertainty about the sub-surface conditions
- Enable the identification of objects or materials which will be retrieved, repackaged and put into alternative appropriate disposal
- Give Sellafield the confidence to leave land undisturbed if the solution confirms that no radioactive materials are present
- Have the potential for use in other parts of the Nuclear Decommissioning Authority estate
- Allow for more effective remediation, potentially saving many billions of pounds

Constraints

Challenges to deployment will include, amongst others:

Access:

- Waste disposal areas might be covered or capped with different barrier materials, including tarmac, clay and / or concrete
- Challenging topography
    - Soft ground may make it difficult to move across, particularly with heavy vehicles (the maximum land-based vehicle size which may be feasible to use could be similar to a quadbike)
    - Steep slopes of land-raise areas may be difficult to climb
- Disposal areas may have mature vegetation growing on them
- Airspace above the survey area may be subject to restrictions
- Additional access controls and arrangements will be required for work in radiologically controlled areas

Reliability:

- Due to the cost, time and disturbance created in drilling activities, it is desirable that solutions once deployed, can operate and communicate reliably for as long as possible without intervention.

Data interrogation

- Proposed solutions which involve access to legacy datasets, may necessitate applicants holding the Cyber Essentials Plus certificate issued by the National Cyber Security Centre before any information is shared with any organisation

https://www.ncsc.gov.uk/cyberessentials/overview

Functional Requirements

Data collection

- It would be desirable to continuously monitor in-situ in preference to undertaking periodic sampling
- Solutions must be capable of characterising actinides and their daughters
- Wireless communications are preferred, subject to achieving acceptable data security and reliability and taking into account available signal
- Output data should be compatible with INSPIRE metadata standards and specifically with the Sellafield land quality database (LDQMS) SQL server, for example flat data files such as .dat, .csv, .xls. Sellafield can supply an example data sheet if required.
- The solution must operate in an entirely consistent and predicable manner to build stakeholder confidence.

If you consider that you are strong in only one aspect of the challenge, we would still like you to put your application forward for consideration.

What next

Game Changers are hosting an online briefing webinar for this challenge. Details of the webinar will be 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 www.gamechangers.technology/our-process.

The deadline for applications for this challenge is 12pm, Friday 25th September 2020.

This scheme is funded and supported by

Sellafield Ltd

GAME CHANGERS .technology

Twitter @GC_Innovators Vimeo.com/GCinnovators
LinkedIn - Game Changers Innovation Programme

Delivered by

NATIONAL NUCLEAR LABORATORY

FIS360 innovation to revenue