Sellafield Ltd

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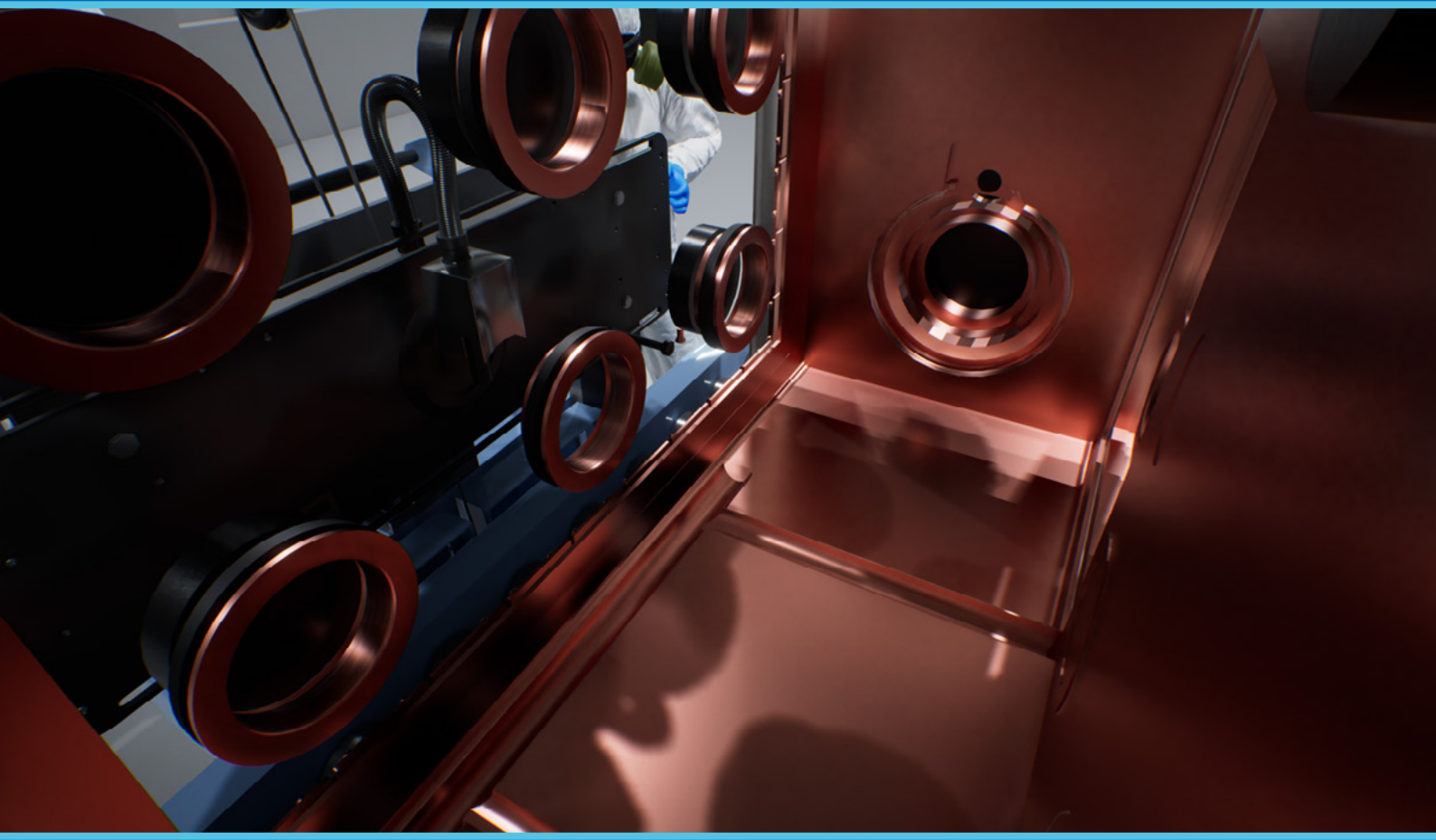

CHALLENGE:

Fixatives for containment of alpha contamination in gloveboxes

Sellafield Ltd would like to explore options for effective, strong and durable fixatives that would provide containment of alpha contaminated material within gloveboxes selected for decommissioning, preventing the radioactive contamination from becoming airborne during preparation and transfer of the gloveboxes for processing.

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Introduction

There are approximately 800 gloveboxes in total across the Sellafield site that have been used to handle radioactive material and are now due to be decommissioned. These gloveboxes are made up of a variety of materials such as steel, plastics and elastomers, and contain radioactive material including alpha particles, which range in size but can typically be described as finely milled powders. Due to the advanced age of many of the gloveboxes, they may fail within the next few years, leading to a breach of containment. This creates an immediate need to prevent the radioactive contamination from becoming airborne, thereby reducing the radiological risk associated with the decommissioning operation. Sellafield Ltd is keen to explore the use of fixatives that would provide containment of alpha contaminated materials by preventing them from becoming airborne.

As part of Sellafield Ltd's alpha remediation strategy, gloveboxes will need to be transported to processing facilities. The options for processing are either a thermal treatment plant, known as the Large Box Thermal Plant or a compaction plant. Currently the Large Box Thermal Plant is the preferred way forward to deal with alpha contaminated waste. Gloveboxes containing waste and contaminated material would be loaded into glass reinforced plastic (GRP) crates, which would then be placed into boxes to be transferred to the facility for thermal treatment. The Large Box Thermal Plant is currently under design and development and is planned to be operational from 2047 to 2097.

The Large Box Thermal Plant is an evolving facility and if it is not operational by the need-by date, then the strategy will switch to a compaction plant facility. A key enabler for both options will be the use of effective, strong and durable fixatives to allow the transfer of alpha contaminated waste to the processing facility.

Some gloveboxes onsite are large and would have to be dismantled prior to being transported. In this scenario, fixatives would provide protection to operatives during the dismantling process where containment is inevitably breached. If fixatives can be implemented in advance of the Large Box Thermal Plant development, this would improve regulator confidence in the facility, further justifying this as the preferred way forward.

The implementation of fixatives could render the decommissioned glovebox materials safe enough to allow interim storage, pending the future availability of a suitable waste treatment capability.

Current Practice

Sellafield Ltd employs fixatives over the short to medium term, typically up to 2 years, and does not use any fixatives for long-term alpha containment in gloveboxes; available fixatives and application technologies have not been assessed for this purpose.

Without suitable long-term fixatives, areas containing ageing alpha contaminated gloveboxes can become designated as restricted access zones, resulting in time and cost implications.

Challenge Aims

Sellafield Ltd would like to identify a fixative that securely fixes airborne alpha particles in place, along with an application method that can be deployed through a 150mm diameter glove port. The fixative solution must be chemically compatible with the glovebox materials, stable under ambient conditions and be as long-lasting as possible. Further details can be found in the "Functional Requirements" section below.

Due to the risks of a breach of containment posed by ageing gloveboxes, a solution is desired as soon as practicable. As operations at the Analytical Services Laboratory at Sellafield, which contains many alpha contaminated gloveboxes, are being phased out, this further exacerbates the need for a fixative solution. Other methodologies have been trialled; however, Sellafield Ltd is looking to improve upon these.

The ideal scenario would be the capability to coat a glovebox sufficiently for it to be transported without an outer box or crate. Treatment that enables an empty glovebox to act as a container for waste would be an added benefit. Due to the complex states of gloveboxes across site, and the resulting requirements on fixative technology, Sellafield Ltd understands this will be a challenge.

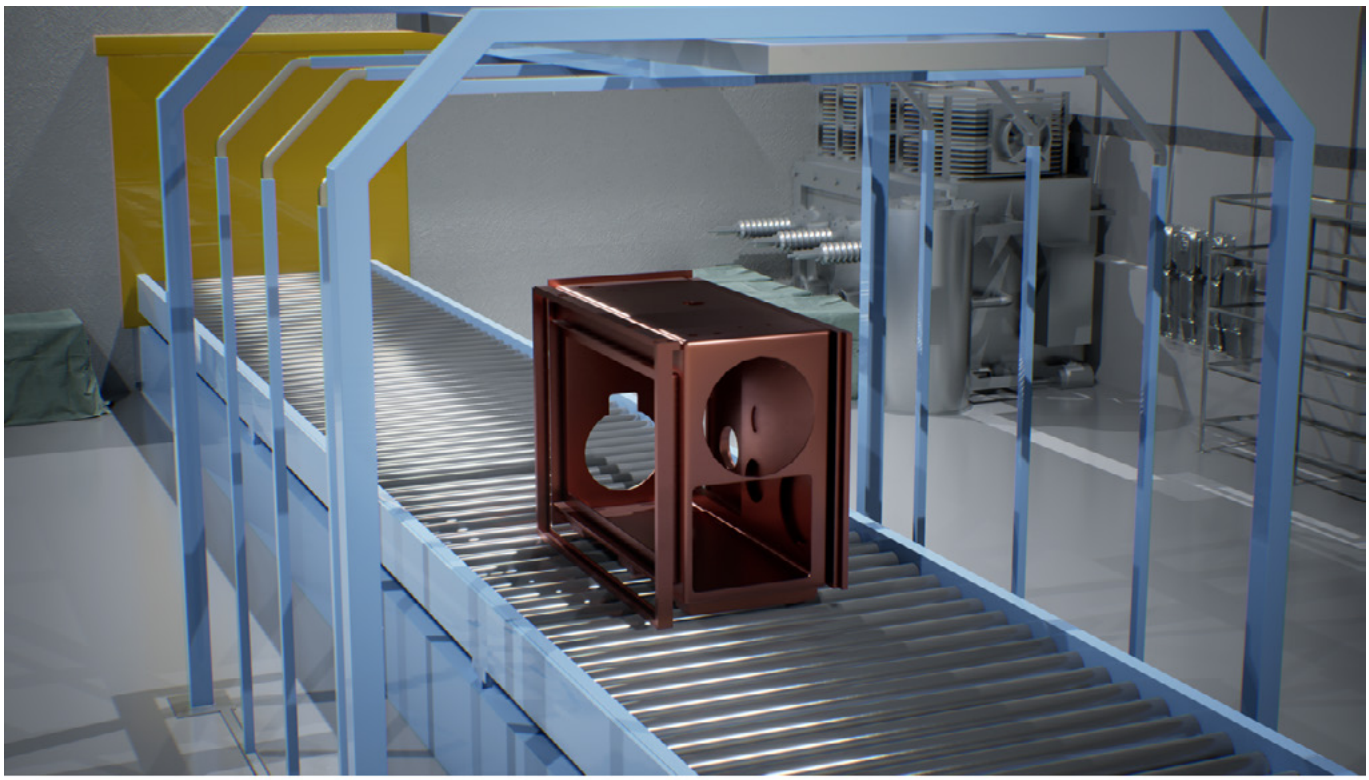

Figure 1: Ideal scenario – glovebox coated for transport

Benefits to Sellafield

The capability to either fully or partially prevent alpha contaminated particles from becoming airborne would provide huge benefits. Reducing the release of contamination within gloveboxes, thereby lessening the effects of a potential containment breach, would provide protection to workers during the transfer of gloveboxes to and from a GRP crate. This would also enable the alpha contaminated gloveboxes to be stored in a safer state, allowing for the reduction of restricted access areas.

Any solution developed in response to this challenge is likely to be applicable to other nuclear facilities. For example, the Atomic Weapons Establishment (AWE) has a number of alpha contaminated gloveboxes due to commence GRP crating operations within the next 3-4 years.

Constraints

Any proposed solutions to this challenge need to be able to work within the following constraints:

- Some gloveboxes are located in restricted access areas.
- Some gloveboxes are located in confined spaces.
- Some gloveboxes are in poorly lit areas.
- Gloveboxes are stored under ambient conditions, normally in very low radiation level areas.
- The availability of power sources where gloveboxes are located cannot be guaranteed.
- Application method must be suitable for deployment through a glove port, which typically have a diameter of 150mm, unless sealing the entire glovebox completely from the outside is achievable.

Figure 2 & 3: Gloveboxes – differing materials

Functional Requirements

Any proposed solutions should have the following features:

Essential

- Effectively contains and fixes alpha contamination in place with a high adhesion and coating quality. The alpha contaminated particles range in size but can typically be described as finely milled powders.
- Chemically compatible with alpha contamination and glovebox materials and does not cause potential safety concerns due to its chemical composition; e.g. potential criticality risk from chelating agents, or the process generates hydrogen.
- Stable throughout expected storage conditions; gloveboxes are stored indoors under ambient temperature and humidity conditions, with very low radiation levels expected.
- Life expectancy and quality of coating to be as long-lasting as possible, with the ability to be remediated or reapplied until disposal.
- Satisfy site or local regulations such as fire safety where required.
- Does not create an airborne radiation risk during application; e.g. through agitation of surface contamination.
- Application method is suitable for use through a glove port (150mm) or can be applied to the outside of the box to create a seal.
- The fixative and application method does not pose a risk to glovebox integrity where containment must be maintained; e.g. increased weight from the fixative causing failure of the glovebox.

Desirable

- Suitable for use on a variety of surfaces (grease, dust, loose debris) and materials (steel, elastomers, polymethyl methacrylate and polycarbonate, sealant, plasticiser, paint) as surface preparation might not be possible.
- Meets Waste Acceptance Criteria for disposal via low level waste or plutonium contaminated material waste routes, and/or via the Large Box Thermal Plant, i.e. can be thermally processed or compaction processed.
- Can be applied to surfaces that have complex geometry.
- Ability to handle gloveboxes without damaging the integrity of the fixative.
- Reduces risk to operators cutting up gloveboxes for disposal into GRP crates. Be compatible with and not cause damage to cutting equipment.
- Does not create further complications to decommissioning operations.
- Ideally fixatives will maintain their containment function for approximately 80 years.

Figure 4: Fixative applied via 150mm glove port

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 Thursday 15th August 2024.

Assessment questions for this challenge can be found on the challenge webpage.

Sellafield Ltd

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