Sellafield Ltd

GAMECHANGERS
DELIVERING NUCLEAR INNOVATION



CHALLENGE:

Better equipping nuclear decommissioning personnel working in demanding environments

Sellafield Ltd is seeking product-based innovations that can be used alongside existing protective equipment to better support nuclear decommissioning operators working in contaminated environments. Restrictive PPE, demanding manual tasks and difficult operating conditions can make this work physically challenging and limit the time operators can work effectively. Improvements could enhance operator safety and comfort, increase productive working time, and support faster, more efficient decommissioning.

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Figure 1: Operators wearing air-fed PVC suits



Figure 2: Operator protection: then and now

Introduction

Many nuclear decommissioning tasks at Sellafield take place within complex legacy facilities where remote methods are not always practicable. Some activities therefore require operators to enter contaminated areas and undertake manual, tactile work, demanding high levels of dexterity.

During these entries, operators must wear restrictive personal protective equipment (PPE), selected according to the task and operating environment. Depending on the level of contamination, this may include respirators, hoods, double gloves, PVC garments and air-fed suits, sometimes with additional protective layers. These arrangements are essential to protect the operator, but they can also make work hot, tiring and physically awkward. Tasks may be manually intensive and require high levels of dexterity, yet many of the supporting tools, accessories and suit interfaces have changed little over several decades.

The aim of this challenge is not to replace the operator or to seek a completely new protective suit. It is to identify products that can be used with current arrangements to better support the person doing the work.

Challenges for the Nuclear Decommissioning Operator

The protective equipment and operating conditions associated with human-entry decommissioning create a number of challenges for operators:

- **Heat stress:** The combination of restrictive garments, physical activity, reduced ability to lose heat and high temperatures reduces the time an operator can work effectively. Current suited working periods are typically around 1 to 1.5 hours, although this varies by task and conditions. During periods of hot weather, temperatures within the work area may rise to levels at which suited work must be suspended.
- **Communication:** Speech and hearing are affected by respirators, suit airflow, background noise and the physical separation between the operator and supporting personnel, making communication difficult. This can slow tasks, increase repetition and make it harder to provide timely support or confirm the operator's condition.

- **Decontamination and the safe removal of PPE:** The outer surfaces of protective garments may carry radioactive contamination, creating a risk of transfer to the operator, assisting personnel or the surrounding area during removal. Bulky, multi-layered PPE must therefore be handled carefully while maintaining separation between contaminated and clean surfaces, making this a complex and safety-critical stage of each entry.
- **Operator functionality:** Double gloves, bulky garments and restricted movement can reduce dexterity and make tools, controls and other equipment difficult to use, particularly during precise or tactile work.
- **Monitoring:** Supporting personnel may have limited real-time information about the operator's physical condition or the conditions within the work area. This can make it more difficult to identify developing issues and assess whether the operator can continue safely.

Whilst the major themes are covered above, the challenge is not limited to these areas and solutions which focus on other areas of the operator experience are welcomed.



Figure 3: Operator wearing PVC suit and full-face respirator

Current Practice

For work in the most contaminated environments, operators typically wear one of two types of protective suit: an airline-fed PVC suit, supplied through a dedicated line connected to an external compressor, or a powered air-purifying PVC suit, which uses an integrated fan-and-filter unit to draw in and filter air from the surrounding environment. Both types of suits are worn with a protective hood. In areas with lower levels of contamination, operators may instead wear a protective suit with a full-face respirator. Other task-specific PPE, including gloves, footwear and lead vests are selected according to the operating environment. Entry duration is limited, primarily to manage heat stress and the physical burden of working in restrictive PPE, while radiological and other environmental conditions may impose further limits.

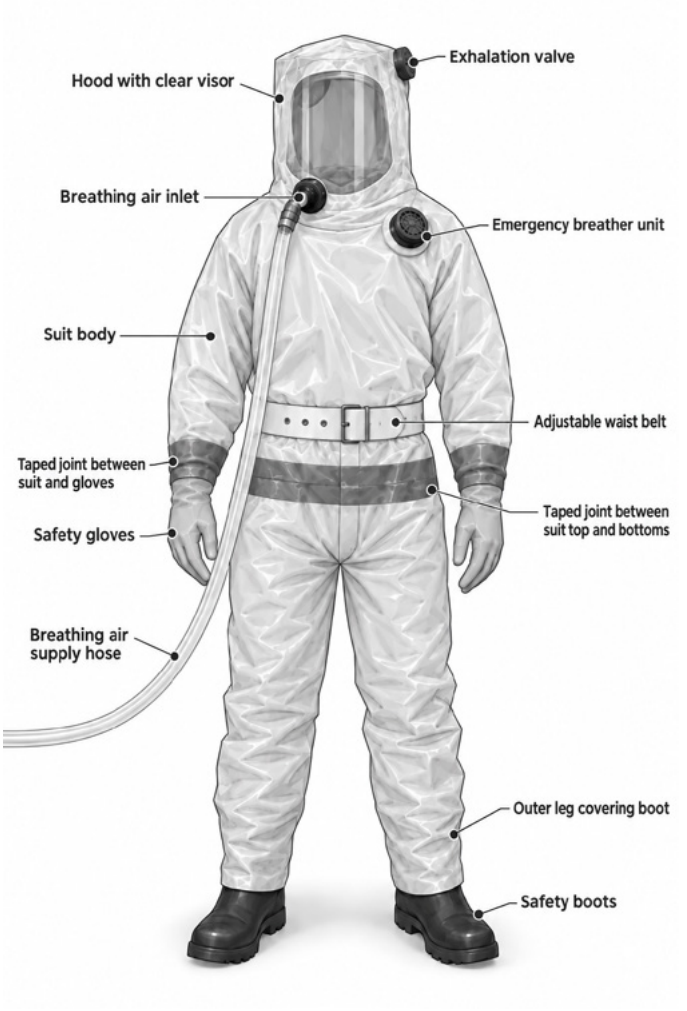


Figure 4: Air-fed PVC suit configuration

On leaving a contaminated area, an operator's protective suit may carry radioactive contamination. Therefore, the suit needs to be decontaminated before removal to reduce the risk of transferring contamination to the operator, the assisting operator or the surrounding area. Current methods include showering or wipe-down with cleaning agents. Operators decontaminate one another and assist each other out of the suits and other PPE.



Figure 5: Suit cleaning by assistant operator

A number of related technologies have already been, or are currently being, explored. Spray-on fixatives are being trialled to help contain contamination on protective suits during exit and removal of PPE. A separate project is considering augmented-reality headsets for communication. Therefore, proposals focused solely on augmented-reality headsets or spray-on fixatives are not the focus of this challenge. However, other approaches that could improve communication, decontamination and the safe removal of PPE remain in scope.

Temperature sensing has also been investigated as a means of providing earlier warning of potential heat stress. Further solutions in this area, as well as other forms of operator and environment monitoring, are welcomed, particularly where information or alerts can be viewed in real time by an external operator or supervisor.

A previous challenge considered the full operator journey and sought integrated improvements across pre-entry, in-task and post-exit activities. It generated useful learning, but many of the resulting outputs were process-led, including training, planning and consultancy. This challenge therefore has a different emphasis. The primary output must be a tangible product, device or product-led system that can be tested and demonstrated. Supporting changes to procedures may be necessary to deploy a product safely, but a standalone process review, training package, planning exercise or consultancy output will not meet the intent of the challenge.

Products that address one part of the problem are welcome. Applicants are not expected to produce a single integrated system covering every theme.

Challenge Aims

The aim of the challenge is to make operator-led decommissioning safer, more comfortable and more effective. Solutions may improve the operator's working experience, reduce fatigue, extend effective working time, improve task performance, provide better information, simplify decontamination or reduce the number of entries required.

The outcomes below are not exhaustive; proposals may address one or more of them, or another clearly evidenced operator need:

- Reducing thermal burden, heat stress, moisture or discomfort.
- Improving communication and reliable information exchange between the operator and supporting personnel.
- Making decontamination and changeover safer, quicker and easier.
- Improving ergonomics, movement, visibility, dexterity, strength or the usability of task-specific tools and controls.
- Monitoring the operator or local environment and providing clear, timely warnings or status information.
- Reducing the amount of single-use equipment and secondary waste or enabling safe reuse where appropriate.

Any proposed product will need to fit around existing protective arrangements and operating practices. Any hazards introduced by the product must be identified and capable of being managed. The product must not impair the performance of the suit or air supply, or make the operator's task more difficult.

Ready-to-deploy or modified commercial off-the-shelf products are of particular interest because earlier implementation would be beneficial. However, Sellafield Ltd is willing to support promising products that need further development or adaptation for nuclear use. An implementation route within approximately one to two years would be advantageous.

Partial solutions that address a single issue are welcome. Applicants are not expected to produce a single integrated system covering every theme.

Benefits to Sellafield

Solutions could enhance operator safety and comfort, increase productive task time, reduce work stoppages during periods of hot weather, and improve the quality and consistency of task delivery. Better communications and monitoring could allow faster intervention when an operator needs assistance. Easier-to-use tools or accessories could reduce fatigue, errors and repeated actions.

More efficient work could also reduce the number or duration of entries, lowering consumption of disposable PPE and the volume of secondary waste. This would support quicker decommissioning and hazard reduction.

Each entry is currently estimated at approximately £10,000 when PPE and associated processing overheads are included. Typically, two entries are carried out per day over approximately 250 days of the year. This indicates a substantial cost-saving opportunity should the benefits noted above be realised.

The opportunity is likely to extend across the wider Nuclear Decommissioning Authority estate and to other industries where people carry out manual work in restrictive PPE or contaminated environments.

Constraints

Proposed solutions must be suitable for use within nuclear decommissioning environments and take account of the practical, safety and operational constraints set out below. The relevance of individual constraints will depend on the nature of the solution and its intended use.

PPE compatibility and operator experience

- The product must be compatible with existing suits, hoods, respirators, gloves and air-supply arrangements and must not reduce their protective performance.
- It must be safe and straightforward to use while suited, including where the operator has limited dexterity, vision, hearing or freedom of movement.
- Minimal training or familiarisation is preferred.
- The product must not meaningfully reduce vision or hearing, prevent site alarms being heard, or interfere with other safety-critical warnings.
- Displays, controls and alarms should be easy to understand while the operator is carrying out a demanding task and should not create unnecessary cognitive load.
- Wearable products should be comfortable, lightweight and arranged to avoid snagging, restricted movement or interference with the air supply.
- Wearable products worn outside the suit may become contaminated and could become single-use waste, therefore they should be able to be worn under the suit where practicable.

Operating environment and power

- Products may need to operate in hot, humid and contaminated environments up to 50°C.
- Where used on the operator, power should normally be portable and self-contained, with no trailing mains supply. Battery runtime must support a minimum of 2 hours entry.

Materials and decontamination

- Any chemicals or materials introduced should not be corrosive, toxic or flammable. Aerosols would require specific justification and approval.

- Applicants should consider relevant cleaning, decontamination, reuse and maintenance; however, fully developed nuclear-specific approvals are not required at application stage.

Communication and data

- Communication products may need to operate around suit airflow and noise, plant noise, thick walls, metal structures and other sources of interference.
- For any device that generates, processes or stores data, on-site data handling should be prioritised. The preferred methods of data transfer, from most to least preferred, are wired connections, local-only Wi-Fi, cloud-based transfer and Bluetooth. Cloud-based transfer and Bluetooth-enabled devices will require additional scrutiny.

Functional Requirements

The challenge is broad, so not every requirement below will apply in the same way to every product. Applicants should explain which requirements are relevant and provide evidence that their product can meet them.

Essential

- The primary output is a tangible product, device or product-led system, rather than a standalone process, training package, planning exercise or consultancy study.
- The product augments and supports the operator and existing protective arrangements; it does not replace the operator or require a completely new protective suit.
- The product provides a credible and measurable benefit to safety, comfort, communication, functionality, monitoring, decontamination or another evidenced operator need.
- The product is compatible with the intended PPE and working environment and does not compromise the suit, respirator, air supply or other safety controls.
- The product can be operated or used effectively while the operator is suited, including when wearing double gloves and working with restricted movement or visibility.
- The design manages power, materials, failure modes and conventional hazards safely.
- The product can be tested and demonstrated in a representative inactive environment, with a credible route to deployment in an active environment following the required approvals.

Desirable

- Based on an existing COTS product, or capable of adaptation and implementation within approximately 1 to 2 years.
- Produces evidence of benefit, such as improved safe working time, reduced task duration, fewer repeated actions, fewer entries, reduced downtime or less secondary waste.
- Low in weight and bulk, easy to inspect and maintain, and suitable for repeated use where practical.
- Provides clear real-time information, alarms or feedback to the operator and/or supervisor where relevant.

Out of scope

- A completely new protective suit (products that safely augment or interface with existing suits remain in scope).
- Robotic or remote systems whose primary purpose is to remove the need for the operator.
- Standalone process reviews, planning tools, training or virtual-reality training packages, consultancy studies or organisational change programmes.
- Products focused solely on augmented-reality headsets or spray-on fixatives, as these are being considered through separate work.

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.

The deadline for applications for this challenge is 3pm on Wednesday 25th November 2026.

Designed and delivered by:

FIS 360
INNOVATION DELIVERED

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