



CHALLENGE:

Autonomous Transportation of Nuclear Materials

Sellafield Ltd is seeking to automate the transportation process of packages housing nuclear materials from legacy stores into new purpose-built facilities for long-term storage, improving efficiency, and maintaining absolute safety and security of carriage.

Introduction

Sellafield Ltd is building new long-term facilities to safely and securely store nuclear inventory. Once operational, the new storage facilities will receive packages that are being transferred from a number of legacy stores in locations across the Sellafield site. This will significantly increase the number of journeys waste packages are currently making across the site, from monthly to daily. It is essential that packages can be moved reliably and predictably and this increase in waste package journeys will become a challenge for the current transportation process. The availability of transport at the right place and the right time is key for efficient operations. This may not be possible if Sellafield Ltd continues to use the current process and existing fleet of vehicles. Simply increasing the number of journeys and placing additional demands on current drivers may contribute to a higher attrition rate of suitably qualified and experienced staff.

Current Practice

When waste packages are transported across site, they are currently loaded into wagons that are then driven under armed Civil Nuclear Constabulary (CNC) escort on the Sellafield site road network. Due to the complexity of site operations, it can take 7 or 8 weeks of planning to move a package. This is due to the logistics and work management planning requirements within Sellafield Ltd to ensure work is assigned and agreed weeks in advance.

As the requirements for regular movements across the Sellafield site increase, a strain on the current practices will have the potential to cause bottle necks and cause significant delays in the transfers between plants.

Challenge Aims

Sellafield Ltd is planning to bring the new storage facility into active commission within 5 years. A solution to fully automate package transfers without the reliance on manual methods is desirable within this timeframe. Sellafield Ltd is looking for a prototype or high-level concept (or combination thereof) in the first instance,

with the opportunity for further development to Proof of Concept (PoC) through the Game Changers programme, completing before April 2025. The concept must be able to cope with the increased frequency of journeys. Successful operation is paramount, and any solution must provide constant communications with a base (and ensure communications with CNC). If the solution were to break down, then the solution must be capable of flagging a change in its status to base. Safeguarding of the transfers must be manageable and an eye on approach through the use of technology such as cameras must be available continuously to ensure compliance with regulatory requirements (at all times).

Additionally, it is an aspiration to have an intelligent transport system that can understand the overall layout of the Sellafield site in order to service various plants and stores and have the capability to understand obstacles and road closures, as well as navigating and abiding with unmarked crossroads and pedestrian crossings. The Sellafield site is unique in its layout and much of the typical road signage you would commonly see on highways is not always present in some less populated areas of the site.

Sellafield Ltd is interested in receiving applications from organisations capable of delivering a full system. Applications outlining how sub-systems of an intelligent delivery system could be implemented are also of interest; for example, the provision of video analytics that could help to identify pedestrians.

Benefits to Sellafield

Investing in automated processes to transport waste and product packages across the Sellafield site will reduce the reliance on driver and vehicle availability. Automating the transfers will improve overall capability to increase Sellafield's transfer activities in the coming years.

There is a potential cost benefit in the range of £1m to £5m per year from simplifying operations, maintaining throughput of transfer activities, and reducing risk of downtime on downstream plant.

By reducing the potential risks associated with delivery, an integrated approach could result in improved efficiency of operations from facilities on site.

Downstream plant: Reduce downtime of equipment ensuring other operations are not waiting for packages.

Safety: Reduce the time packages are at risk, maintain radiological containment.

Security: Removing humans from the transfer processes will reduce the security challenge.

Constraints

- The solution must be capable of intelligent autonomous transit from various locations on the Sellafield site, which will involve navigating a standard UK road network, including other vehicles, pedestrians, zebra crossings, pelican crossings, junctions etc. The solution must also be capable of navigating temporary obstacles and road closures
- Operation on the site will mostly be on flat ground. There is a possibility that a vehicle may encounter some small debris
- The route is assumed to be on roads, not involving the use of pavements and not crossing over kerbs
- The deployed solution must use adequate cyber security protocols. These would be developed throughout the stages of development and with the cyber security team at Sellafield Ltd. An outline is given below. More information can be shared with those who are awarded feasibility funding
 - o The security protocols should align with the Sellafield Ltd/Nuclear Decommissioning Authority security risk framework. The basis of choice is risk informed; however, the protocols should be based on secure transports such as HTTPS, SSH etc., and the connection level between facility and other systems should be based on the Sellafield Ltd Connecting Domains standards
 - o The baseline security standard for any deployed piece of OT should be bounded by the current Sellafield Ltd Engineering Standard 248 (these will be provided to applicants if they are successfully awarded feasibility funding)
- o The encryption mechanism should conform with the latest NCSCa guidance; these currently cover symmetric key lengths (currently AES256), asymmetric key lengths, TLS 1.2+, Public Key Infrastructure requirements etc. It is anticipated that an entry-level e.g. new development of a robotic platform would require Cyber Essentials, bespoke entry-level coding for PoC would require Cyber Essentials Plus and a full development would require a CS&IA security case. Design in line with a class 2 IPES and hand 2487 to comply (these will be provided to applicants if they are successfully awarded feasibility funding)
- The solution must be capable of operation within a GPS-denied environment
- It should be noted that the maximum speed on the road network is 5mph
- The system must observe other safety systems including criticality safety
- The solution must satisfy Civil Nuclear Constabulary (CNC) monitoring and safety requirements (more information can be shared with those who are awarded feasibility funding)
- The solution cannot rely on the installation of significant infrastructure on the Sellafield site; for example, the installation of rail networks. The use of some additional features to support the operation of the solution would be considered; for example, the installation of beacons or use of painted lines
- The communication system on which the solution relies must be absolutely secure. The tolerance for loss of connection must be zero, although the solution must be able to cope with limited losses/drop-outs and gaps in cover

Functional Requirements

- The solution must be able to transport packages (e.g. SAFKEGs) which may vary in mass
 - o Some will be in excess of 62 kg and may be in a stillage containing four SAFKEGs



Figure 1 – Transport package.

	Outer Container	Inner Container
External Diameter (mm)	425	150
External Height (mm)	541	229
Internal Diameter (mm)	247	116
Internal Height (mm)	342	200
Weight (kg)	46	7.3
Weight of Cork Packing (kg)		0.3
Maximum Weight of Contents (kg)		11.5
Maximum Weight of Package Design including Contents (kg)		65.1

The transport unit should:

- Be parked safely and securely when not in use
- Be operable in all weathers for up to 24 hours per day
- Be robust and not compromise the quality of the packages being transported
- Be physically secure, lockable and potentially sealable
- Maintain perfect continuity of communications
- Be self-powered – Sellafield Ltd has not constrained the choice of power source, but consideration to safety, reliability, clean and environmentally-friendly operation should be given
- Be an intelligent system capable of operation in a multi-use environment with external factors relating to route planning taken into consideration
- Be fully autonomous, from point A to point B, stopping when arriving at the destination. The start point should be triggered by a manual ‘go’ button or similar

The solution should:

- Consider building in redundancy to avoid system failure of any critical part of the system or the system as a whole
- Ideally give some consideration to providing additional containment and shielding of the cargo during transit
- Incorporate collision avoidance
- Be capable of navigation along a pre-planned route, but will need to include obstacle/hazard detection. The system may have to course-correct or flag a warning should it be unable to complete its journey
- Be capable of transporting packages of variable size and shape
- Be one single unit – not making use of a trailer for example
- Not involve the use of operators
- Provide real-time live feed; live communications with zero fail is desired
- Provide a health/status check heartbeat
- Flag when something is not working properly
- Be operable in all weathers
- Be fail-safe

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 \(gamechangers.technology\)](http://gamechangers.technology)

The deadline for applications for this challenge is 6pm on Thursday 30th November 2023.



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