Sellafield Ltd

GAMECHANGERS
DELIVERING NUCLEAR INNOVATION

CHALLENGE: Unmanned Aerial Vehicles in confined spaces

Sellafield Ltd would like to support the development of an Unmanned Aerial Vehicle (UAV) platform capable of carrying equipment to capture visualisation data, that can be deployed in confined spaces.

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Introduction

There are hundreds of nuclear and non-nuclear facilities which need to be cleaned up on the Sellafield site. Manual decommissioning of Sellafield's facilities is hazardous for operators and extremely time consuming. Opportunities to undertake decommissioning activities faster, more safely and at a reduced cost are constantly being explored.

Sellafield would like to make use of an Unmanned Aerial Vehicle (UAV) that can access hazardous facilities whilst carrying a range of sensors and other analytical tools, to facilitate safer and cheaper decommissioning. The aim of this challenge is to develop a UAV modular toolkit that can be easily tailored for deployment in a wide variety of decommissioning scenarios.

Current Practice

The characterisation of difficult to access areas on the Sellafield site such as storage cells, culverts, voids and ullages is typically achieved in one of two ways:

i) by positioning a ground-based remotely operated vehicle (ROV) into the target area. The ROV will be equipped with an onboard camera and lighting arrangement that will be directed upwards within the target area

ii) by manually deploying long reach carbon poles into target areas. The poles are up to 16m in length and are fitted with camera and lighting arrangements. The cameras deployed to undertake these operations are equipped with a pan, tilt and zoom function. The use of poles is limited by reach and dexterity.

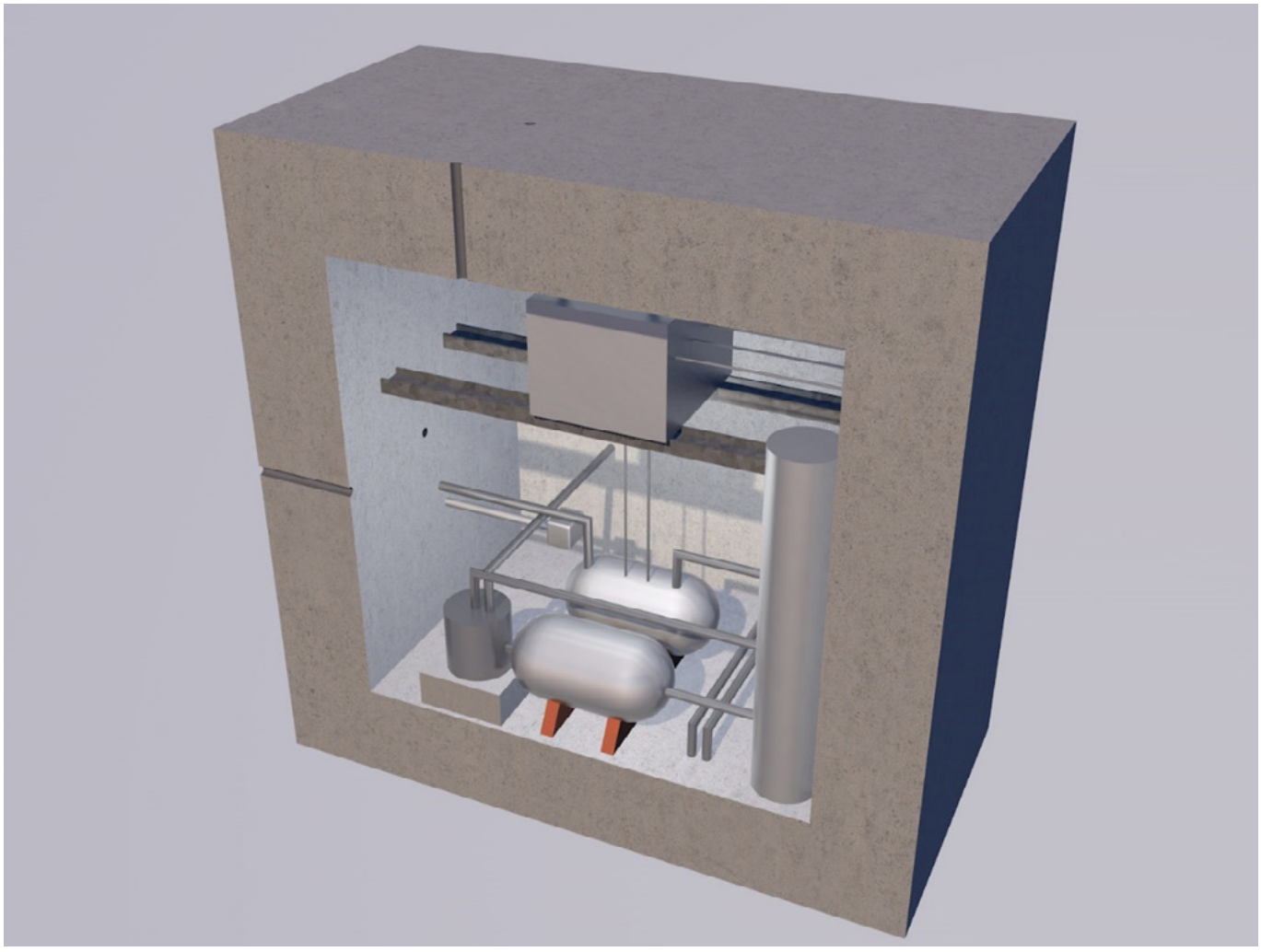

Figure 1: Illustration of a cross section of a typical cell on the Sellafield site which requires decommissioning

Challenge Aims

As decommissioning activity on the Sellafield site accelerates, the aspiration is to develop a UAV deployment toolkit that could be tailored to meet the needs of specific challenges as and when they arise.

Sellafield are seeking a UAV platform that is capable of:

- Carrying visualisation equipment
- Deployment through vertical or horizontal inspection ports without the requirement for significant reconfiguration (see Figure 2). Ports are typically 140mm in diameter, through concrete up to 1.5m thick
- Providing the operator with its position in real time
- Operating in an entirely consistent and predicable manner in order to build stakeholder confidence

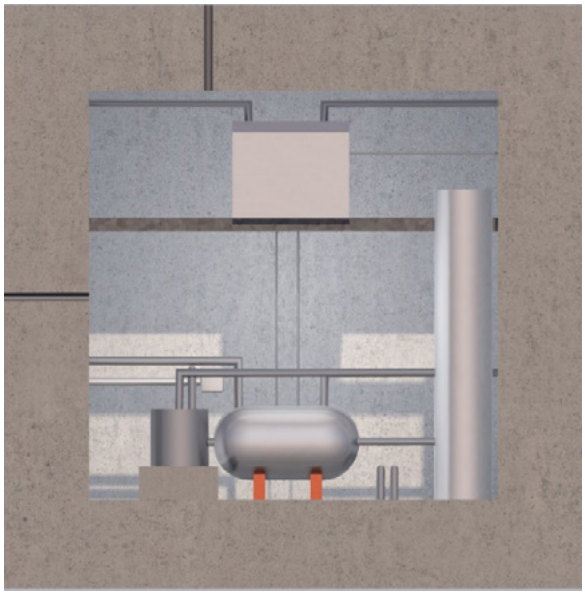

Figure 2 Examples of vertical and horizontal entry ports

Sellafield are seeking a solution that provides proof of concept within 12 to 18 months and full deployment reasonably soon after. UKCA marking of the equipment is required for the commercial solution, although this is not necessary for a prototype active deployment demonstrator.

Benefits to Sellafield

It is expected that a UAV capable of characterising difficult to access areas on the Sellafield site will bring the following benefits:

- Increased operator and equipment productivity, resulting in a reduction of the decommissioning timescale and overall cost
- Improved efficiencies and cost savings through extended working periods
- Increased safety of operations through reduced human intervention, leading to a reduction in operator exposure to radiation
- Reduction in the time required for deployment due to the re-use of the core technology toolkit
- Reduction in costs due to the elimination of the need for development of one-off bespoke solutions
- Reduction in the maintenance down-time required due to increased reliability

It is anticipated that the ability to obtain a better understanding of the nature of contamination within structures will lead to a reduction in secondary waste generation.

Constraints

Any proposed solutions to this challenge need to take account of the following constraining factors:

Operational environment for the modular UAV

- Often dark, with little or no lighting
- High humidity, up to 35% relative humidity
- Temperature gradient ranges from 10°C to 40°C
- The areas of interest are GPS denied
- Cell ventilation speeds need to be considered

Access to the operational environment

- Access is commonly via inspection ports of typically 140mm diameter through concrete up to 1.5m thick
- Navigation of a complex network of pipes and vessels is often required
- In order to avoid operators being directly exposed to hazardous radiation, deployment must be from outside the area under inspection

Retrieval from the operational environment

- The solution should not lead to the generation of significant amounts of secondary waste
- The solution and any debris should be retrievable via the inspection port or other relevant point of entry

Functional Requirements

Solutions to this challenge should meet the following functional requirements as a minimum:

- Capable of operation for as long as possible in the environment under inspection. If the UAV necessitates the use of lithium batteries, they must be detachable once the UAV is recovered from the operational environment
- Able to carry a camera with tilt functionality. If the camera can pan and zoom this would be beneficial. An ability to adjust camera exposure would also be beneficial
- Able to carry lighting equipment to the areas of interest
- The UAV must be fully deployable and should be retrievable through a 140mm diameter inspection port
- A good level of positional accuracy is required
- Be operable beyond the line of sight available through the inspection port
- An onboard vision system may be required due to the lack of light in some areas which require inspection
- Capable of providing transmission of live view images, in real time, to the operator
- Able to transfer captured visualisation data to the operator
- The overall system needs to make use of closed communications. 256 bit encryption is ideally required, although a shorter flight time may negate the need for this
- The use of a repeater system that bridges the 1.5m concrete shielding is an option
- Designed to minimise or eliminate contamination traps that increase the risk of spreading radioactive contamination
- All equipment, including communication devices, should in the majority of cases be fully retrievable from the environment under inspection. The use of sacrificial UAVs is also of interest though this would necessitate that the devices are of minimal cost
- The inspection ports, walls and any other structures in the area under investigation must not be damaged by the deployment of the UAV
- The use of guarding and or rotor protection should be considered
- Collision avoidance technology should be considered
- The operator interface should include a full control system for the UAV as well as functionality to control the analytical capability and capture of data
- Autonomous operation of the UAV is not necessarily required
- An ability to leave the UAV in-situ for the period of monitoring, with the point of entry sealed, may be beneficial
- Any proposed solutions should not require extensive maintenance and may include integration of proven technology
- The UAV should be untethered (preferred)
- The IP rating of the technology may need to be taken into consideration

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 **12:00 noon on Friday 18th November 2022**.

Sellafield Ltd

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