Innovate UK

Results of Competition: SBRI - Nuclear Decommissioning: Integrated System Demonstrator

Competition Code: 1701_SBRI_NDA_PH1

Total available funding is up to £900,000 for Phase 1 of this competition

Note: These proposals have succeeded in the assessment stage of this competition. All are subject to grant offer and conditions being met.

Participant organisation names	Project title	Proposed project costs	Proposed project grant
Create Technologies Limited	Elephants to Ants: Innovation in Integration	£49,921	£49,921
Project description - provided by applicants			
Innovative integration is about more that just integrating innovations. Developments in robotic systems integration in the R&D space over the last 10 years have made profound changes to the way such systems are developed by making robotics open, modular and re-usable. This has resulted in big speed-ups and cost reductions for those developing new robots. The agility that these robotics developments systems enable is perfectly suited to nuclear decommissioning, where flexibility and the adaptability in the presence of both known and unknown technical risks is the key to success. In this project we will demonstrate that this flexibility not only enables improved performance in and of itself, but that it also has a fundamental impact on the form of both the solution and the way it is deployed and operated. These new solutions will: maximise re-use (saving cost), reduce initial acquisition cost, reduce overall technical risk, reduce waste arising and accelerated decommissioning.			

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James Fisher Nuclear Limited	Hot Hatch Cell Recovery	£49,592	£49,592
Project description - provided by applicants			
The collaborative team, spearheaded by James Fisher Nuclear are pleased to offer our innovative, yet transferable solution to the Technical Specification supplied. We believe that we have identified an end-to-end solution utilising several emerging technologies and SME's to deliver a step change to the decommissioning approach. A blend of new technology and novel applications of existing technology form the basis of our submission which we believe can be developed and fully integrated within the boundaries of the contract. The combination of our facilities and collaborative partners enables us to deliver this project to phase 2 and beyond. Existing facilities, site locations and experience of personnel enable us to offer value for money from the collaborative team. Utilising existing NDA assets and hiring equipment for development and demonstration will minimise our upfront capital equipment costs, allowing the project budget to be spent primarily on valuable labour activities.			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Westinghouse Electric Company UK Limited	Integrated Innovation for Nuclear Decommissioning	£50,000	£50,000

Project description - provided by applicants
The Innovation for Decommissioning (I4D) team of Westinghouse Electric Company UK Limited, Cammell Laird, REACT Engineering, Forth Engineering, Fraser Nash Consultancy, Nuclear AMRC, BROKK, OC Robotics, SPEX, TWI and the universities of Lancaster, Sheffield, Manchester, and Liverpool have come together to provide an integrated platform to safely deliver the most cost effective decommissioning programmes for our clients. The complementary skill sets of the I4D team bring a solid platform of proven systems interwoven with innovative technologies and advanced modelling developments that will challenge the current decommissioning methods to drive lifecycle cost reductions. As a UK centric team with a worldwide reach, the individual members are actively engaged in the development and integration of new technologies into the nuclear decommissioning market. With vast experience in nuclear activities and technology research and development I4D can draw upon 1000's of skilled UK personnel to design, manufacture, test and operate our systems. Further by linking universities, catapult centres and industrial partners our programme will continue to draw upon cutting edge technology to drive improvements in decommissioning cost reduction. Importantly the I4D methodology will focus on elevating the capabilities of the UK supply base to the forefront of worldwide decommissioning innovation. An offsite demonstrator representing the legacy cells will be constructed to confirm the performance of the decommissioning machines and processes. The process identified by I4D will focus primarily on developing a highly skilled workforce; reducing dose to operators; increasing productivity through additional working time; appropriate and innovative use of technologies (both existing & new) and better waste recycling. The development of virtual reality (VR) as a proven method of working will allow the operator access to facilities in a safe environment to prove the deconstruction techniques can be delivered. Decontamination techniques available through the team will allow metallic waste to be recycled away from costly storage; this approach will be deployable at other UK sites and round the world. This document will need final approval from Westinghouse and the I4D team before being made public

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Barrnon Ltd	Barrnon Integrated Decommissioning System	£59,988	£59,988

Project description - provided by applicants
The tasks addressed by the Barrnon Integrated Decommissioning System include characterisation, planning, visualisation, size reduction, chemical & sludge removal, contamination management, decontamination, control and mitigation of airbone contamination, waste handling, waste segregation and storage. All is achieved through the design and development of an integrated system for the decontamination and decommissioning of contaminated materials bringing existing and new technology to the workface enabling a substantial reduction in cost whilst giving an additional reduction in operator risk and a reduction in decommissioning timescales. This will be achieved through the use of new and innovative sensor technology, innovative robotic manipulation equipment combining a wide range of end effectors. A Novel liquid nitrogen decontamination process reduces contamination without producing any secondary waste enabling the user to down grade the waste classification, reducing the cost of waste storage. The package will seamlessly intergrate the advances of VR technology both for characterisation and planning but also for direct operator interface, all in conjunction with existing visulisation machine control. We create a user friendly system which allows characterisation pre, during and post operation reducing the risk, speeding up the process, reducing the cost of operations. Our equipment will offer a step change approach; each of the partners are at the forefront of their given area of expertise. Each partner is working currently on major projects globally and in instances already collaborating to deliver work. This global approach takes learning from the likes of Japan (Fukushima), Hanford (US) as well the European markets to give our product reliable deployment, in turn allowing us to create new markets swiftly for our innovation. The technologies of the main project partners Oxford Technologies Ltd, Createc Ltd and Barrnon will combine to offer a suite of decomissioning tools readily deployable with advanced decomissioning tequniques making the process of decomissionning faster, cheaper safer.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Oliver Crispin Robotics Limited	LaserSnake++	£50,000	£50,000
Project description - provided by applicants			
With the current nuclear liability of £117billion with -20%/+100% errors bars, the Nuclear Decommissioning Authority needs a generic safer, faster, cheaper decommissioning toolkit for high hazard facilities. Remote decommissioning tools of the past have typically been expensive, bespoke and unreliable systems that have been quickly abandoned. With a focus on significantly reducing time and cost without compromising safety, demonstrable, reliable, and transferable technology is needed to tackle decommissioning challenges now and in the future. LaserSnake++ seeks to address this need by building on the '2016 NDA Innovation of Year' award winning LaserSnake2 project which delivered a modular, flexible, size reduction tool '“ 'LaserSnake' and demonstrated size reduction of a 5 tonne, double skinned vessel in Sellafield's First Generation Reprocessing Plant. LaserSnake++ adds Createc, RACE and Masters of Pie to the core of the LaserSnake team, OC Robotics and TWI. The consortium has extensive, combined expertise in nuclear operations, robotics, size-reduction, nuclear characterisation and virtual and augmented reality tools which will be combined in LaserSnake++. LaserSnake++ will enhance existing visual and radiation mapping tools to construct a detailed augmented reality model of the cell. This will be used to to generate cutting and waste storage strategies based on time and cost optimisation within the constraints of acceptable risk. LaserSnake++ will deliver a scalable solution for faster, cheaper and safer decommissioning; developing an expandable toolkit, with a digital platform, to provide full end-to-end service which can be re-used and re-applied across multiple environments. These tools will enable continuous improvement in training, operations and management of complex decommissioning tasks.			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
MDA Space and Robotics Limited	DecomSmart	£45,000	£45,000

Project description - provided by applicants
MDA Space & Robotics Ltd., has partnered with innovative and experienced UK SME companies and a renowned UK international organisation to demonstrate the expertise to perform and deliver characterisation, decontamination and dismantling of complex nuclear chemical facilities. The team of 10 UK Companies, each a technology specialist in its own field, contribute to this highly skilled Consortium that is ideally placed to deliver a unique integrated solution that can be applied across the national and international nuclear decommissioning markets. Using sophisticated communications expertise coupled with robotics engineering developed and deployed for the most hazardous and challenging environments including those of space, medical and nuclear industries, the solution offered by the MDA led consortium brings together cost effective but proven cutting edge technologies with a pragmatic 'fit-for-purpose' delivery approach. An essential element of the characterisation process is the management and understanding of primary and secondary waste and to ensure its sorting and packaging in accordance with statutory legislation. The use of innovative decontamination and waste collection techniques shall ensure the cost and environmental consequences are known and minimised whilst maintaining compliance with safety standards. Integrating and building upon current technologies and innovative concepts this 'end-to-end' solution enable full and complete facility characterisation, including establishing a physical, chemical and nuclear environment inventory providing with confidence a detailed map of the building complex to be dismantled. This provides a stable platform to achieve safer, cost effective, and quicker completion. The complete dismantling process will generate technical records that will be vital component in the long-term management of waste as well as ensuring compliance with nuclear waste disposal legislation. Traceability of each item removed, its subsequent monitoring and treatment, followed by the sorting and segregation decision shall be uniquely documented and recorded.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Nuvia Limited	Nu-Decom	£49,584	£49,584

Project description - provided by applicants
Nuvia Limited, a UK based, international nuclear engineering, project management and services contractor has teamed up with a number of the UK's top innovative technology providers in response to Innovate UK's SBRI IIND funding competition. The title of the project is "Nu-Decom" and that reflects the aim of the project which is to demonstrate a range of new decommissioning technologies that will deliver the safer, cheaper and quicker decommissioning of the UK's nuclear legacy. Nuvia have assembled a comprehensive team suited for the complex and wide ranging challenges associated with the decommissioning of the active process plants on the Sellafield site. The team includes expertise from both industry and academia, and the fields of expertise include: (1) Teleoperable systems, advanced robotics & semi-autonomous systems for challenging environments. (2) Remote radiometrics and geometric characterisation. (3) The post processing of geometric data into 3D modelling and visualisation software packages. (4) The use of games technology, virtual (VR) and augmented reality (AR) technologies to provide immersive environments for training and communications purposes. (5) The application of Artificial Intelligence (AI) to provide a knowledge base and expert systems that can be used to support and guide remote operations across the UK's decommissioning program. (6) Application of Human Factors principles. These innovative new technologies and techniques will be integrated with Nuvia's own tried and tested nuclear decommissioning expertise and knowhow which has been successfully deployed throughout the UK and on the global decommissioning market thus providing an established route to a global market for UK Technologies. The Project Team's industrial partners include:- Nuvia (Project Lead), Clicks & Links (C&L), Hu-Tech, MOOG, PaR Systems, Tacit-Connections (TC), UKAEA RACE and Imitec. The Project Team's academic partners include: University of Manchester (UoM) and the University of Bristol (UoB). As part of Phase 1 the project team will assess each step in a typical decommissioning process including:- initial characterisation, decontamination, the design & manufacture process, operator training, HAZOP and safety case processes, site preparation, installation & commissioning, Safe Systems of Work (SSoW), the Human Machine Interface (HMI), remote operations, size reduction, consumable management, materials handling, routine maintenance, remote intervention & repair, waste export routes, ex-situ size reduction, assay monitoring, waste sorting, waste sentencing & segregation, waste packaging, waste container handling and finally export from the facility. Phase 1 will investigate the feasibility of applying the range of innovative technology platforms to each of the above steps and rank and rate each of the applications and potential benefits against the required criteria i.e. improved productivity, minimising human intervention, transferability, scalability and optimising waste treatment packing and routing into the most cost efficient waste streams. The project will also consider the Technology Readiness Levels (TRL) and the cost to develop technologies to a level suitable for (a) Inactive Demonstration (Phase 2) and (b) active demonstration. The project will prioritise and make recommendations for which platforms go forward to the Phase 2 inactive demonstration.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Amec Foster Wheeler Nuclear UK Limited	Integrated Innovation for Nuclear Decommissioning	£50,000	£50,000

Project description - provided by applicants
Our aim is to develop a modular integrated platform that will combine state-of-the-art technology with tried and tested decommissioning 'know-how'. We will use experience from the conventional decommissioning sectors, combined with cutting-edge space, defence, medical and industrial technologies, to produce a streamlined, safety orientated solution. The project will be developed using our experience of the pragmatic integration of complex technology to generate a step-change in decommissioning performance, that will be Cheaper, Faster and Safer as follows: '¢ An innovative modular control and automation strategy that can be proven and validated within the nuclear environment (Cheaper, Faster) '¢ Draw on cross-sector innovations and a pioneering approach to reliability and fault recovery: our approach removes the need for manned entry to cells (Safer, Faster, Cheaper) '¢ A philosophy of minimal in-situ characterisation (Cheaper, Faster) '¢ A planning approach that enables simulation within a virtual environment, optimising sequence, process and waste management (Safer, Faster) '¢ A remote de-planting process that reduces operations at height, and removes the need for temporary platforms, scaffolds and man entry (Safer, Faster, Cheaper) '¢ A suite of innovative modular waste handling and processing tools that characterise, size-reduce, sort and decontaminate waste, using a repeatable and scalable process (Faster, Cheaper) '¢ Optimised waste characterisation by moving analysis to the waste (Safer, Faster, Cheaper) Our team (Amec Foster Wheeler [Lead Partner], Airbus Defence and Space Ltd., Clicks and Links Ltd., Damavan Imaging SAS, Digital Concepts Engineering Ltd., IS-Instruments Ltd., Lancaster University, Salford University, and TWI) builds on existing relationships, creates new ones, and comprises nuclear and out-of-sector expertise, innovative SMEs and applied academic innovation; we will collaborate to bring true innovation in thought and technology to this decommissioning challenge. Amec Foster Wheeler's world-class track record in delivering and integrating complex, multi-partner projects gives us confidence that we can deliver the project successfully within tight constraints. Our strong position in the nuclear decommissioning market provides a platform to commercialise any technology developed both in the UK and overseas.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Eadon Consulting Limited	Versatile Decommissioning System (VDS)	£47,400	£47,400

Project description - provided by applicants
The project will develop a Versatile Decommissioning System (VDS), which brings together proven technologies to provide a powerful visualisation and planning process, coupled with a range of access equipment and tools specifically suited to the challenges of nuclear decommissioning. The VDS will consist of five elements: (IMPP) The Integrated Model Planning Process is a CAD based planning system, taking LIDAR and Gamma imaging point cloud data to produce a BIM style 3D model of a cell. The Model will define section properties, contamination mapping, and structural characteristics. The IMPP will also include a live 'œplanning database' allowing rapid identification of suitable tools or techniques for a range of decommissioning tasks. (NDAS) The Nuclear Decommissioning Access System will provide a toolkit of access components to enable top-down decommissioning of large cells. A working platform will be supported from proprietary lifting modules at the roof. Hydraulically operated camming feet will brace the platform against the walls to provide redundancy, stability, and a completely independent load path. Remotely operated equipment can be mounted onto the platform and the entire platform can be raised or lowered to enable a top-down "salami-slicing" approach to decommissioning. (INDT) The Integrated Nuclear Decommissioning Toolkit will provide a modular system of components configured to provide decommissioning capability, planning data for defined tools will be tabulated in the planning IMPP database. (SBPH) The Small-Bore Pipe Harvester is a new tool based on the concept of a forestry felling machine. The SBPH will scan, hold, and crush small bore pipes into uniform length flat sections, for efficient packing at source. The SBPH will be compatible with COTS robotic arms. (LWRS) The Local Waste Retrieval System is a new lightweight container, grab and hoist system enabling highly efficient packing of waste at source. The LWRS containers will tessellate within nuclear flasks to minimise handling and ensure efficient packing. The VDS will enable detailed and accurate planning of decommissioning operations, minimising operator/material interfaces, optimising the categorisation and packing of waste, and increasing productivity. The SBPH provides a step-change in the removal of small bore pipes, offering reduction of up to 81% in waste volume. The elements are not interdependent, and each can be integrated into ongoing decommissioning work, thereby offering rapid bennefits and a viable route to commercialisation.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Rovtech Solutions Limited	Integrated Keyhole Remote Decommissioning System	£44,000	£44,000
Project description - provided by applicants			
A fully integrated , remote decommissioning system designed to minimise direct human interface in the decommissioning of irradiated nuclear cells. The system will incorporate innovative radiological characterisation techniques, laser and video imaging, semi autonomous tools and end effectors for the mechanical dismantling, size reduction, sorting, decontamination and removal of low to high level radioactive plant and equipment. The Keyhole Remote Decommissioning System integrates existing technologies and innovative solutions into a ground-breaking new deployment concept. Once implemented this system will have the capability to be operated remotely from un-connected buildings via remote link. Successful deployment of the system will result in a process which is safer than all current decommissioning methods, removing all direct human intervention. The system will be faster than any other system available by opening up the ability to run multiple working zones and carry out different tasks concurrently. Keyhole Remote Decommissioning will provide a cost affective, modular solution to one of the biggest challenges in nuclear decommissioning; providing cost savings during the decommissioning process and downstream with dramatically reduced waste disposal costs.			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Cavendish Nuclear Ltd	Sellafield In-Cell Decommissioning System (SIDS)	£49,976	£49,976
Project description - provided by applicants			
Our project will combine three existing technologies to create a system which will be make it safer and more efficient for operators to see exactly what is inside cells before they begin the task of removing and packaging the items. We will integrate Cavendish Nuclear's 3D gamma dose rate scanning equipment - Radscan with robotic deployment snake arm laser cutting technology This will enable operators to efficiently identify what is Intermediate Level Waste (ILW) and what is Low Level Waste (LLW) and allow them to target which type of waste they should remove first from each cell. It will enable operators to plan and synchronise the type of waste being removed at any point in time to match the capacity of the ILW and LLW waste routes that are currently available on Sellafield site. In addition to Radscan and snake arm laser cutting technology, our project will also integrate Virtual Reality (VR) technology. Based on the scanned 3D data, VR will be used to programme the motions for the robotic deployment system, so that operator can monitor operations rather than manually controlling the operations of the equipment. Our project will also explore the feasibility of deploying remotely positionable explosive cutting devices. The innovation in our approach is the combination of these existing technologies into one platform that integrates the benefits of all of the technologies into a single user interface. Cavendish Nuclear has an established track record of combining different systems and technologies into integrated systems to provide solutions to decommissioning challenges across nuclear sites.			

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DavyMarkham Limited	Integrated & Transferable Decommissioning Toolkit	£49,750	£49,750
Project description - provided by applicants			
DavyMarkham Limited (DML) is collaborating with Siempelkamp NIS Ingenieurgesellschaft mbH (NIS) in the development of a range of decommissioning tooling for Sellafield Process Cells that are TRANSFERABLE, SCALABLE and INTEGRATED based around the successful "toolbag" of tools used globally for the dismantiling of reactor pressure vessels and their internal structures. NIS are the leading company for reactor pressure vessel and internals dismantling having successfully completed over 24 such projects worldwide. Both DML & Siempelkamp have leading nuclear sector design and manufacturing capabilities and both DavyMarkham and Siempelkamp design and manufacture storage, transport and disposal containers for the nuclear waste therefore offering a fully integrated solution for the dismantling of cell internals through to the safe containerisation of the wasste. The DavyMarkham and Siempelkamp NIS Ingenieurgesellschaft mbH would like to thank Innovate UK and Sellafield Limited who have recognised the need for an integrated toolkit based on proven decommissioning tooling optimised for Sellafield process cell decommissioning but having sufficient flexibity so that the same or similar tooling can be used in other extereme envoronment deconstruction projects at Sellafield and further afield.			

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Costain Oil, Gas & Process Limited	Stabilisation, Excavation and Segregation	£49,309	£49,309
Project description - provided by applicants			
Dismantling process equipment and supporting steel in nuclear cells is made complex by the requirement to carry out multiple steps in a hazardous environment where working times are limited. Eliminating as many of these steps from the dismantling process as is practical has the effect of accelerating dismantling, leading to improvements in productivity and reduction in cost and dose. The proposed approach is to fill a cell under decommissioning with low density loadbearing grout and void fillers which has the effect of stabilising and passivating the facility. Next to excavate the grout in layers, each layer exposing a manageable portion of pipe, vessel and steel for size reduction using tracked vehicles deploying standard cold-cutting tools. Materials are thebn removed from the cell into a purpose built access facility for categorisation using radiometric instruments before being packaged for disposal. This simplification of the process excludes the operator from the cell and renders avoidable several of the functional steps in the dismantling process such as characterisation, planning, decontamination and holding. The proposed approach is an end to end solution, starting with a cell under decommissioning and ending with a cell completely empty of process equipment and structural steel and ready for demolition, with all the waste arising			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
University of the West of England	Integrated robotic system for characterisation and decommissioning	£49,991	£49,991

Project description - provided by applicants

This project will deliver an advanced mobile manipulator robot for nuclear decommissioning, based on a customised combination of proven industrial robotics hardware, state-of-the-art control algorithms, and advanced interfaces. The robot will comprise a ruggedised mobile platform, carrying advanced manipulator arms, and a variety of tooling (hands/grippers, cutting tools, pressure hose). State-of-the-art AI and machine vision algorithms will be informed by a diverse sensor suite (vision, radiological, thermal), to provide 3D characterisation, and semi-autonomous control. Prior to decommissioning, characterisation is needed. Our team has demonstrated how state-of-the-art machine learning and computer vision (UoB - all partners defined in later sections) can provide real-time 3D reconstruction of scenes, while simultaneously recognising and labelling materials (concrete, metal, wood, ceramics) and waste-like objects (rubber gloves, cans, pipe-work, hoses). We have also (lead partner BRL) demonstrated how this information can then be used for efficient navigation amongst the characterised materials and objects in those scenes. This will be augmented by combining vision sensors with radiation, contaminant, thermal and other sensors, to automatically annotate 3D models of scenes with rich characterisation data to inform decommissioning planning, and real-time monitoring during remote operations. These will be combined with advanced finite element analysis models (partner NNL), enabling planning and risk analysis (e.g. cutting of a component could have wider structural implications). Following characterisation, decommissioning interventions will require grasping, cutting, and manipulating parts of legacy plant, as well as decontamination (scabbling, grinding or pressure spraying). Our team is at the forefront of research in advanced control of remote robots for performing such actions. While conventional direct teleoperation must always be available to the human operator, our research has shown that incorporating elements of advanced autonomous robot control via an advanced Human-Machine Interface (HMI), so as to provide variable autonomy as an operator-assistance technology, can improve safety, speed, and efficiency whilst greatly reducing stress and workload. Our team has already demonstrated AI and vision-guided robot arms in UK nuclear industry sites: 1) human-supervised autonomous robot grasping of (inactive) waste-simulant objects (@Workington) '“ NNL & UoB; 2) human-supervised autonomous laser-cutting of radioactive metal (Preston active cave) '“ NNL & partner ARM. This project will extend these methods from large, fixed manipulators, to versatile mobile-manipulators (robotic arms mounted on robot vehicles). We will integrate advanced manipulation methods with our state-of-the-art vehicle navigation system, which allows a human operator to dynamically select between different levels of autonomy (LOA), ranging from direct joystick control to fully autonomous navigation. Phase 1 will involve demos at BRL using existing robots drawn from our team's equipment resources. In Phase 2, NNL will supervise design and build of an inactive plant-representative testing arena, within one of the new 200sqm. spaces being specially dedicated for this purpose at BRL, which will be used to demo, evaluate and benchmark the Phase 2 robot.

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A.N. Technology Limited	A Flexible Measurement and Waste Led, Robotics-Based Decommissioning Project	£48,890	£48,890
Project description - provided by applicants			
The project is based on several interconnected and innovative processes including 'in cell' survey measurements to establish the geometry of the cell and the distribution of activity, dismantling the cell in a planned manner, removing the components to an adjacent Waste Segregation Area (WSA) for processing and finally assaying, characterising and segregating the waste components and placing them in appropriate waste containers. The process is implemented, in keeping with the ALARP principle, through the extensive use of a flexible 'œtoolbox' of proven robotic technology, which is applicable to a wide variety of different decommissioning situations and scenarios. The principle objectives are to reduce or eliminate both man entry into the cell and the manual handling of radioactive waste items while processing the waste. The waste is processed only once and characterised approved waste packages are produced as the process output.			

Note: you can see all Innovate UK-funded projects here
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