In 2005 OC Robotics supplied snake-arm robots to Uddcomb Engineering (Areva) to replace a section of safety critical pipe immediately below the Ringhals 1 pressure vessel.

**Objectives**

To replace a section of a thick wall stainless steel SCRAM pipe by providing remote handling capability to operate within a highly inaccessible network of pipes – nicknamed ‘The Jungle’ - using only pre-existing access routes (Fig 1).

To provide a generic method to access all 157 SCRAM pipe nozzles.

**Environment**

The Common Insulation Room, ‘the Jungle’, contains 157, 205mm diameter control rod drive mechanism (CRDM) tubes. Each CRDM tube has a dedicated SCRAM pipe which forms part of the emergency shutdown system. Access between the CRDM tubes is via 80mm wide corridors which are up to 6m long. The Jungle is accessed via a temporary ladder and peripheral crawl-space (Fig 2).

**Process development**

The project was completed in under 9 months from notification of the urgent requirement to completion of site acceptance tests and trial deployment. This included design of two snake-arm systems and development of a multi-stage process involving four tools. Partners included Uddcomb Engineering and Climax Precision Machine Tools.

**Two snake-arms**

The first snake-arm was a compliant 800mm long, 40mm diameter, 23 degree-of-freedom snake-arm. The snake-arm entered the Jungle through pre-existing 60mm diameter holes in the floor and snaked around obstructing pipes to gain the ideal view of the work site (Fig 3).

The second snake-arm was 600mm long, 60mm diameter, with 13 degrees-of-freedom (Fig 4). This snake-arm used a wrist and gripper to deliver: fixtures and jigs to secure the pipe; cutters for the ‘inside-to-out’ cutting tool; a tack welding head; a gas shield and an x-ray film holder. Point to point, computer controlled motion resolution was better than 20 microns.

**Operation**

The actual pipe repair was completed manually in 3 days, using the processes developed for the robots, as it was just within reach. Subsequently the robots replicated the manual process in less than 24 hours with no manual intervention and demonstrated the generic solution.

**Conclusion**

The pipe repair at Ringhals was a world first. The snake-arm solution showed that all 157 SCRAM pipes could be accessed using the same equipment and procedures. This successful demonstration was a key requirement of the safety case, allowing the plant to come back online. The snake-arms delivered and positioned a wide range of tools with precision and flexibility, within hazardous, confined spaces.
OC Robotics

OC Robotics are world leaders in confined space automation - our snake-arm robots are designed specifically for remote handling operations within confined or hazardous spaces.

The Explorer catalogue

The Explorer range of snake-arm robots are general purpose tools which occupy the mid-range for diameter, reach, payload, curvature and precision.

The catalogue shows all of the available configurations and can be downloaded from our website.

Bespoke solutions

Confined spaces are nearly all different. The work to be completed may involve a wide range of tools.

OC Robotics delivers bespoke solutions to clients across a wide range of industries. Our engineers focus on solving customer problems, with solutions including snake-arm robots as well as other engineering and robotics.

Snake-Arm Simulator

Download the free version of Snake-Arm Simulator from our website to test drive a snake-arm and experience the intuitive nose-following control first hand.

We offer consultancy services to analyse your requirements using our proprietary tools.