Robotic Bioshield Repair - A Diakont Success Story

Introduction

The Bilibino Nuclear Power Plant experienced a critical failure on a biological shield (bio-shield) surrounding one of the plant's EGP-6 reactor channels. The bio-shield is a cylindrical metal tank full of water that completely surrounds the reactor, eliminating neutron dose in the adjacent work areas. When the failing bio-shield created unsafe working conditions, the reactor had to be shut down. Instead of completely dismantling the reactor for repair, the plant owners commissioned Diakont to diagnose the situation and repair the damaged bio-shield.

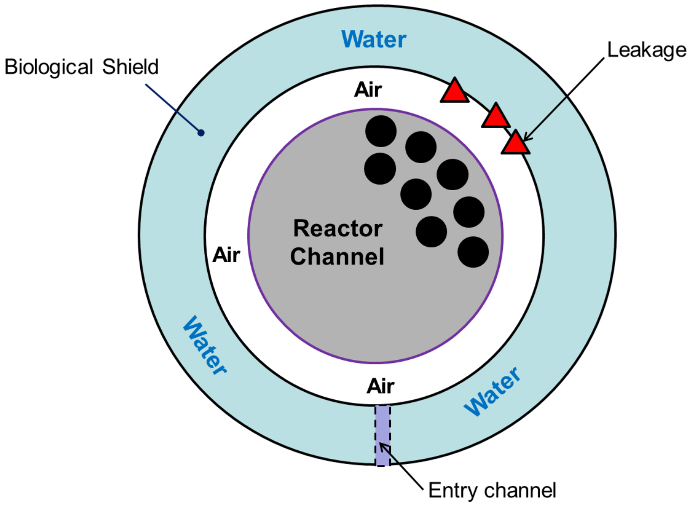
Challenge

After an exterior examination of the bio-shield wall showed no damage, it was determined that the interior wall (reactor side) of the bio-shield was leaking. An inspection had to be conducted within this extremely high dose area to determine the location and severity of the leakage. To complicate matters, the only access point was a 2" diameter opening.

Remote Grinding Robot

Diakont Solution

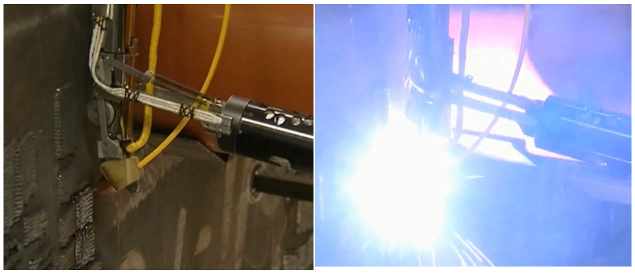
Diakont designed and manufactured a remote, self-propelled robotic system to diagnose the damage and repair the bio-shield. The advanced system is based on a "snake-like" form factor and has a magnetic chassis to adhere to the metallic wall and traverse the entire surface area of the bio-shield. This robot was outfitted with three modular payloads to perform distinct, role-specific tasks: inspection, surface preparation grinding, and welding.



Results

Diakont's custom robotic solution was deployed through the narrow 2" opening in the bio-shield wall and successfully located the damaged areas using high-resolution video and ultrasonic testing (UT) probes. Next, Diakont dispatched the robot with the grinding tool to prep the surface for a weld repair. Finally, the robot was sent into the bio-shield with the weld head, where it successfully repaired the damage.

Diakont successfully completed the entire project within three months. The bio-shield was repaired at a fraction of the cost of full replacement, the personnel dose exposure was minimal, and the reactor was brought back online well ahead of schedule.



Remote Welding Robot

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Fuel Guide Tube Repair - A Diakont Success Story

Introduction

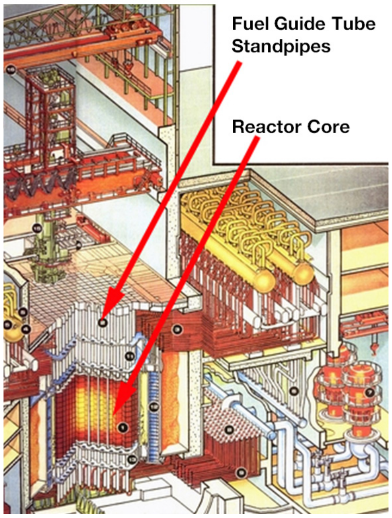
Diakont was commissioned to repair the fuel guide tube standpipes for a nuclear utility with aging RBMK-1000 reactors. RBMK reactors have several hundred standpipes above the core which are used to contain and move fuel and control rod assemblies. These standpipes have telescoping expansion joints which thermally expand and contract during normal plant operations. However, due to structural changes in the reactor core graphite moderator blocks over time, the lower portions of the guide tube standpipes had begun to sag. This resulted in a scenario where the telescopic joints could completely disengage, leading to reactor internals and/or core damage.

Challenge

These fuel guide tubes are an integral component of the reactor core design, and are completely inaccessible by personnel due to high radiation levels, even when all fuel is offloaded. This first-of-a-kind problem had never been encountered by the industry, so it was unknown whether a solution could be developed.

Diakont Solution

Diakont worked with the chief designer of the RBMK reactor to develop specialized mechanical collars for installation around the guide tube telescopic joints. These collars provided a crucial vertical extension, such that the telescoping travel range of motion was extended. To install these mechanical extension collars, Diakont developed a complex system comprised of three remotely-controlled robots: one for loading, one for delivery, and another for installation. The system was a "dual marsupial" design, meaning that the operators first deployed a loading robot from the refueling hall, which entered the reactor and deployed the delivery robot, which then transited to the appropriate reactor position and deployed the installation robot. Working together, this three-robot system performed the delivery, alignment, and installation of the specialized mechanical collars inside the reactor.



Results

This Diakont robotic system was developed, manufactured, and delivered in a very short period of time so that the reactor could be repaired and returned to service. Diakont first utilized this robotic system to complete repair operations at this plant's Unit 1 reactor between August and November 2011, installing extension collars on 209 guide tubes. Compared with the alternative standpipe replacement option evaluated by the utility, the use of the Diakont robotic system drastically reduced the quantity of rad waste produced, as well as reducing personnel dose exposure by a factor of 200 and the repair duration by a factor of 3.

Robotic Delivery System

Mechanical Collar installation

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