



Robotic Underwater Decontamination and Robotic Inspection Services

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Agenda

- Background
- Refueling cavity decon
- Established methods
- Robotic decon tooling
- FENOC decon project
- Robotic decon procedure
- Results
- Robotic Inspection Services







Core Competencies

















Decon to Reduce Dose

- BWR and PWR plant operators reduce dose by decontaminating surfaces
 - Refueling cavity
 - Drywell heads and other curved surfaces
 - Equipment pools and pits
 - Spent fuel pool
 - Fuel transfer canals
 - Coated and non-coated surfaces





Industry challenge to improve methods and tooling





Established Methods

- Manual scrubbing
- Strippable coatings
- High-pressure washing
- Hydrolasing
- Legacy automated tooling





Effective, but can cause increased dose, radiological waste, and Outage schedule





Robotic Decon Solution

- Hybrid ROV-crawler platform
- ROV mode vectored and vertical thrusters provide maneuverability and positioning
- Flow-less vortex generator for adhering to all surfaces:
 - Flat
 - Curved
 - Horizontal / vertical
 - Interferences and seams
- Integrated cleaning system
- Interfaces with filtration system





Scrubber brush

Tri-nuke vacuum suction



Decon Tool Operation

- Transitions freely between "flying" and "crawling" modes
- Flow-less vortex generator creates up to 60 lb. of suction force for adhering to surfaces
- Quick retrieval performed from poolside or platform









Flow-less Vortex Generator



FENOC Decon Project

- Perry Nuclear Power Plant
- FENOC approached Diakont to develop robotic decon system
- Initial decon in Spring 2017 Outage







Decon System Team

- 3-man team
 - ROV operator and navigator
 - Roving technician for hose and cable management
 - Rotating equipment technician







Decon Procedure

- FME check
- Control station set up on the refueling floor away from refueling cavity edge
- System function check
- Tool connected to vacuum pump in cavity
- Tool deployed into water via crane
 - Attention paid to no disrupt water surface
- HD PTZ camera deployed to monitor operations







Decon Procedure

- Decontaminated floors, walls, and curved drywell head
- Cleaning brush operated at various speeds for different sections
 - Slower speeds used for areas with high levels of debris to avoid excessively disturbing the material
 - Process monitored to ensure vacuum captured all dislodged material





Decontamination Video





Dose-Saving And Outage-Shortening

- Successful underwater decontamination during Spring 2017 Outage
- No additional manual decon required after drain-down
- Contamination levels were reduced to <50K dpm/100 cm²
- Plant met INPO/Industry collective radiation exposure goals
- Plant made plans to use tool to examine underwater boots next summer in the
 - suppression pool







Robotic Pipeline Inspection

- Self-propelled robotic crawler for inspecting buried pipelines
- Driven by robot operator in real time
- Robust track system presses into ID of pipe for traction and vertical navigation
- Able to navigate:
 - Vertical Sections (90 degrees up or down)
 - Unbarred tees / Horizontal tees
 - Inclines and declines
 - 90 degree bends
 - Back-to-back bends
 - Reducers



Does not require launchers, receivers, or flow





Upper Track – Raises up and presses on the top of the pipe

Robot's center of gravity raises up to accommodate multiple pipe diameters without exiting pipe

North Anna **Aux Service Lines**

- Two 24-inch auxiliary supply lines from the ASW valve pit north of the station's protected area fence to the valve pit in the turbine building
- The two lines were not receiving impressed current in alignment with output of CP Subsystem
- Because the segments were not receiving impressed current as designed, it was unknown if the sleeved segments had experienced OD corrosion
- Sleeved lines could not be excavated and inspected







Access Point

Operator removed valve for opening.







Pipeline Inspection







Post Inspection





Inspection Results

- Successfully inspected a total of 300.9' of pipeline
- Verified pipeline integrity and system put back into service
- The Inspection method eliminated the need for excavations and personnel pipe crawls







Online Tank Floor Inspection

- Class 1 Div. 1 system
- Complete NDE coverage, including annular ring critical area
- Motorized brush and plow for sludge displacement
- Real-time automated tank floor mapping
- 3D imaging sonars for obstacle avoidance
- Fail-safe redundancy and emergency retrieval features



Utilizes a combination of MFL for detection, and a 96element UT array for sizing





System Deployment

- Temporary hatch fitted in place of manway blind following roof launch
- Cable seals to block VOC emissions
- Environmental basin fastened around manway during robot recovery





Hatch seal with vapor seal for umbilical cable





1) Inspection tool 2) Deployment module 3) Operation vehicle (outside berm)





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