Robotic Underwater Decontamination and Robotic Inspection Services

Presented by
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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

- Robotics and Manipulators
- Inspection/NDE Tooling and Services
- Rad-Tolerant VT Systems
- Nuclear Digital I&C Systems
- Rotary & Linear Actuation
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
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
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
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 96-element 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)
Contact

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