

Investigation System for Fukushima Reactor

Fukushima Daiichi, Japan



| The Challenge

To design and construct a remotely controlled, boom-type robotic arm system to investigate the nature and location of nuclear fuel debris in the highly radioactive and contaminated environment of the disabled Unit 2 Reactor.



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| Veolia's Solution

The Primary Containment Vessel Investigation (PCVI) System consists of a 21m long boom-type robotic arm which is housed in an air-tight enclosure and maintained by a Dexter™ manipulator. The boom will be deployed, with tools and imaging systems mounted on it, through a small port in the side of the reactor building to move around inside the damaged reactor vessel.

The enclosure dimensions are approximately 8.8m x 2.2m x 1.9m, is equipped with ports to allow the clean import and export of tools and equipment. It also contains rails to allow the Dexter™ manipulator to travel along the full length of the enclosure, to the location where activities need to be undertaken.

Controls and Software, Virtual Reality: VNS UK has developed the human machine interface used for operating and monitoring all the equipment. Together with specialist supplier Tree C, VNS UK has also developed a digital twin of the system for visualising the operations during live operations, which provides additional context and situational awareness. This is beneficial if camera views are compromised. It is also used for training, simulating and planning operations offline which reduces risk to operations. Furthermore, an operations management system has been developed to plan and record every step of every step of operations.

Contract Facts:

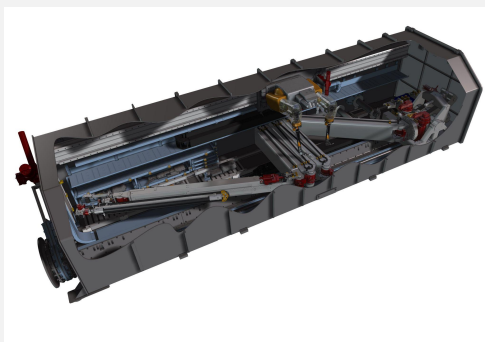


PROJECT: Unit 2 Reactor Investigation
 DURATION: 2015 to date
 CLIENT: Mitsubishi Heavy Industries (MHI)
 EXPERTISE: Robotics and Remote Handling and VR Simulation

Remote Operation (at 1km) of 21m long Boom

Enclosure approximately 8.8m x 2.2m x 1.9m

Simulated operational environment (VR) to verify planned Boom movements



The control room will be located 1km away from the operations, where radiation is lower and safe for operators to work. It is ergonomically designed and based on VNS UK's previous experience from other international projects to carry out remote handling operations.

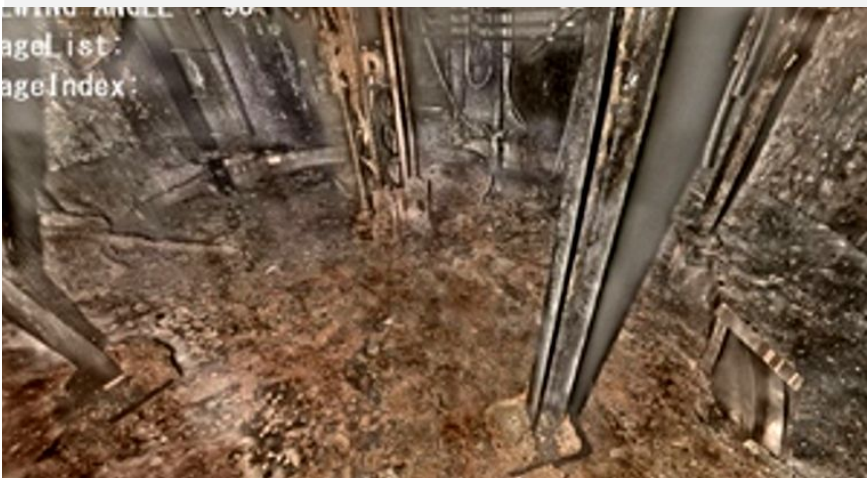
Role of Dexter™: Operators will use Dexter™ to support the main robotic investigation boom:

- Change inspection equipment on the boom that enters the reactor
- Post equipment into and out of the enclosure where the boom is housed
- Operate tools inside the boom enclosure
- Carry out maintenance on the boom

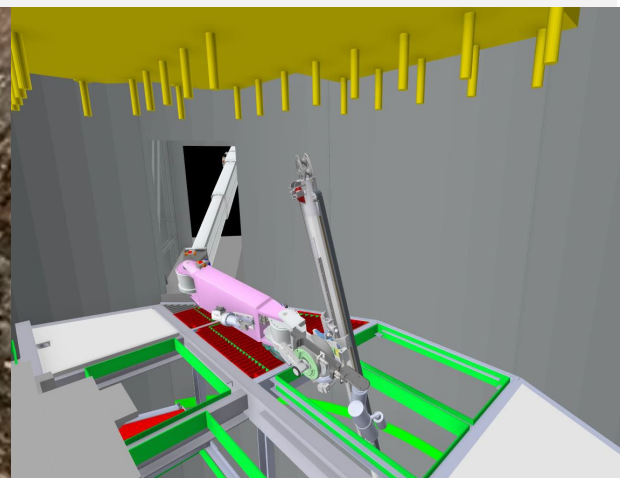
Boom description: The Boom comprises the Carriage assembly, Links assembly and Distal assembly. The Carriage is on rails and can move the whole Boom 6.6m and also tilt and raise/lower it. The folding Links assembly comprises six yawing welded stainless steel rectangular elements each approximately 2m long. The Distal assembly includes a Telescope, Wrist, Wand, Tool Pan and Tilt and End Tool. The Telescope has 2.1m of extension and also tilts and yaws and carries a foot, with incorporated load-cell, to locate the Boom on the environment. The Wrist carries the telescopic Wand assembly which it can yaw and tilt. A viewing and lighting system is carried on the Wrist. On the end of the Wand is mounted the Tool Pan and Tilt assembly onto which the End Tool is located.

In the event that the Wand assembly becomes stuck in the reactor environment it can be jettisoned from the Boom by means of an actuated release mechanism. The system was delivered to Kobe in Japan in 2021 for final testing.

When deployed the system will enter the damaged reactor and is intended to use its full 21m length to inspect the internals of the Reactor.



FUKUSHIMA DAIICHI UNIT 2 PCV ENVIRONMENT



VIRTUAL REALITY STUDY: BOOM INSIDE REACTOR



VNS Expertise:

- Design & build of Dexter™
- Design of remote systems for use in hazardous and complex environments
- Remote Handling training for Operations
- Using full scale mock-ops to train operators and verify operational capability

MHI has stated that this is the most technically demanding remote handling project in nuclear decommissioning anywhere in the world. VNS UK has been given a single supplier contract for this project, following recognition by the Japanese government of VNS UK's capabilities.

In 2017 VNS won the prestigious Nuclear Decommissioning Authority (NDA) Export Award for creating and designing the remote handling solution for the investigation work as part of the fuel debris retrieval at Fukushima Daiichi, Unit 2.