Message

IRID has been engaged in developing robots for the nuclear decommissioning since its establishment. Dr. Hajime Asama, a leading person in the robotics field, offers a message.

In the Fukushima Daiichi Nuclear Power Station (NPS) owned by the Tokyo Electric Power Company (TEPCO) Holdings, Inc., there are still many areas with high-dose radiation, making it difficult for humans to approach the area. Robots and remote-control technologies are therefore crucial for the decommissioning of the TEPCO Fukushima Daiichi NPS.

Up to now, various robots and remotely controlled devices have been utilized for rubble removal, investigation inside buildings (capturing images and measuring radiation dose, etc.), decontamination, and sampling (of dust, contaminated water and concrete core, etc.). Just after the accident, robots for military use and unmanned construction machines were mainly used, but considering the unprecedented requirements for accidents occurring at the nuclear power plant, specialized devices that address particular situations must be developed in order to make progress with specific decommissioning work.

The International Research Institute for Nuclear Decommissioning (IRID) has been involving in developing many of the more than 40 remotely controlled devices that have been utilized so far. Developing remotely controlled devices that can operate stably and complete the assigned surveys and tasks in unknown situations and operating environments is extremely challenging; training is also required for the operators who maneuver the devices. IRID has developed and utilized various devices so far and has successfully accomplished many missions. However, there have, of course, been failures as well. The accumulation of our past experiences, and the various types of expertise which have been acquired with the development of remotely controlled devices will be crucial for the further development.

From now on, the primary focus will be on retrieval of fuel debris. However, it is not only the development of remote control technologies for the retrieval of fuel debris such as cutting and handling of the fuel debris that are required, but also new remote control technologies which assist in the process leading to the retrieval, such as technologies for the investigation of fuel debris and sampling, decontamination, and stopping water leaks. Further development of remotely controlled devices that can conduct surveys and tasks in more complicated, high radioactive and underwater environments will also be demanded. Development of such devices is not an easy task. It is therefore of paramount importance that we gather wisdom and intelligence from around the world to address issues.

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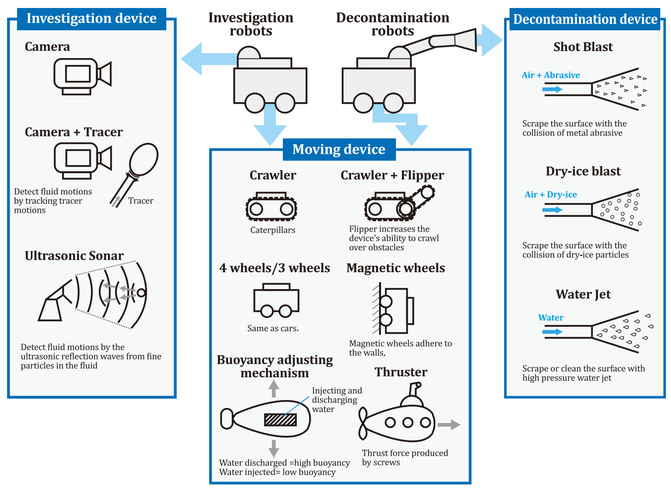
Major functions and names of remote-control robots



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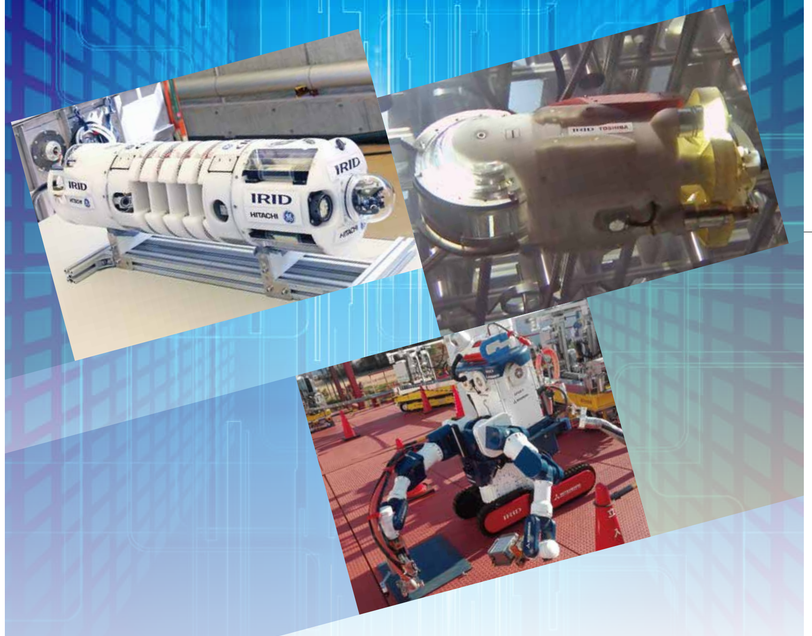
Robots

Robots help humans with decommissioning of Fukushima Daiichi Nuclear Power Stations.



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International Research Institute for Nuclear Decommissioning

Useful robots that help humans with decommissioning of Fukushima Daiichi Nuclear Power Station.

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Working Robots

Decontamination Device for Upper Floors of the Reactor Building

Scope of Work: Decontamination using four technologies: suction, blast, dry-ice blast and high-pressure water jet
Location of Work: Floor surfaces and bottom area wall surfaces on the 2nd and 3rd floor of the reactor building in Unit 1-3,
Developed by Mitsubishi Heavy Industries, Hitachi-GE Nuclear Energy (Hitachi-GE), and Toshiba Energy Systems & Solutions (Toshiba ESS)
Verification periods: Second half of FY 2015

A photo shows suction/blast type of devices.

Notes

Work Truck
Mobility: Crawler
Dimensions: W 750 mm × L 1700 mm × H 1700 mm
Weight: Approximately 550 kg

Carrier/Supporting Truck*
Mobility: Crawler
Dimensions: W 714 mm × L 2410 mm × H 350 mm
Weight: Approximately 750 kg

Relay Truck*
Mobility: Crawler
Dimensions: W 1100 mm × L 2000 mm × H 500 mm
Weight: Approx. 680 kg

* Measurement and weight of the trucks varies depending on the device loaded.

Dry-Ice Blast Decontamination Device for High Places

Scope of work: Decontamination with dry-ice blast
Location of Work: 5-8 meters-height wall surfaces, ceilings, ducts and cable trays on 1st floor of the reactor building in Unit 1-3
Developed by Toshiba ESS
Verification periods: Second half of FY 2015

Notes

Mobility: Crawlers
Device: Working truck for remote-control decontamination of high places and supporting truck, etc. (used for low places)
Dimensions: W 930 mm × L 2069 mm × H 1961 mm
Maximum reachable height of device: 8000 mm
Weight: Approx. 1700 kg

Suction/Blast Decontamination Devices (MEISTeR)

Scope of Work: Decontamination with shot blast
Location of Work: Floor surfaces and lower wall surfaces on 1st floor of reactor building in Unit 1-3
Developed by Mitsubishi Heavy Industries
Verification periods: Second half of FY 2013

Notes

Mobility: Crawler (converted MHI-MEISTeR)
Device: Arm + Shot blast device, air transport device and blasting dust collector
Dimensions: W 700 mm × D 1250 mm × H 1300 mm
Weight: Approx. 500 kg

Suction/Blast Decontamination Device for High Places (Super-Giraffe)

Scope of Work: Decontamination with shot blast
Location of Work: High wall surfaces and structures on 1st floor of reactor building in Unit 1-3
Developed by Mitsubishi Heavy Industries
Verification periods: Second half of FY 2015

Notes

Mobility: Four-wheel drive, four-wheel steering (converted NEDO Super-Giraffe)
Device: Arm + Shot blast device, air transport device and blast collection device
Dimensions: W 1300 mm × D 2350 mm × H 1700 mm
Maximum reachable height of device: 8000 mm
Weight: Approx. 4000 kg

Dry-Ice Blast Decontamination Device

Scope of Work: Decontamination with dry-ice blast
Location of Work: Floor surfaces and lower wall surfaces on 1st floor of reactor building in Unit 1-3
Developed by Toshiba ESS
Verification periods: First half of FY 2014

Notes

Mobility: Crawler
Device: Decontamination truck, supporting truck
Dimensions: W 923 mm × D 1460 mm × H 1841 mm
Weight: 730 kg

High Pressure Water Jet Decontamination Device for High Places

Scope of Work: Decontamination with water jet
Location of Work: High wall surfaces and structures with 2-meter-high or more on 1st floor of reactor building in Unit 1-3
Developed by Hitachi-GE
Verification periods: Second half of FY 2015

Notes

Mobility: Crawlers
Device: Arm + Water jet device, water supply device and water collecting device
Dimensions: W 760 mm × D 2098 mm H 1555 mm
Maximum reachable height of device: 6105 mm (high pressure water can be ejected up to a height of 8000 mm)
Weight: Approx. 1300 kg

High Pressure Water Jet Decontamination Device (Arounder)

Scope of Work: Decontamination with water jet
Location of Work: Floor surfaces and lower wall surfaces on 1st floor of the reactor building in Unit 1-3
Developed by Hitachi-GE
Verification periods: First half of FY 2014

Notes

Mobility: Crawler
Device: Arm + Water jet device, water supply device and water collecting device
Dimensions: W 600 mm × D 1600 mm × H 1300 mm
Weight: Approx. 850 kg

Shielding Block & Iron Plate Detaching Device (TEMBO)

Scope of Work: Removal of shielding blocks and iron plates
Location of Work: 1st floor of the reactor building in Unit 2
Developed by Mitsubishi Heavy Industries
Verification periods: First half of FY 2015

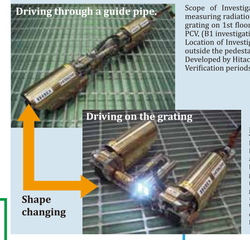
Notes

Mobility: 3 wheels
Device Manipulator and end effecter
Dimensions: W 1100 mm × D 4000 mm × H 2100 mm
Weight: Approx. 3500 kg

Investigation Robots

★ : New robots

Unit 1: Investigation Device for inside Primary Containment Vessel (PCV) (shape-changing robot, PMORPH-1)

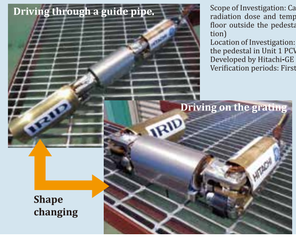


Scope of Investigation: Capturing images, and measuring radiation dose and temperature on the grating on 1st floor outside the pedestal in Unit 1 PCV, (B1 investigation)
Location of Investigation: Grating on the 1st floor outside the pedestal in Unit 1 PCV
Developed by Hitachi-GE
Verification periods: First half of FY 2015

Notes

Mobility: Crawler
Investigation device: Camera, dosimeter and thermometer
Dimensions: (when driving through a guide pipe) approx. L 600 mm × W 70 mm × H 95 mm / (when driving on the grating) approx. L 220 mm × W 290 mm × H 95 mm
Weight: Approx. 10 kg (excludes weight of cables)
Resistance to radiation: Over 1000 *Gy*

Unit 1: Investigation Device for inside Primary Containment Vessel (PCV) (shape-changing robot, PMORPH-2)



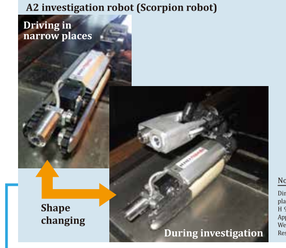
Scope of Investigation: Capturing images, and measuring radiation dose and temperature on the grating on 1st floor outside the pedestal in Unit 1 PCV (B2 investigation)
Location of Investigation: Grating on the 1st floor outside the pedestal in Unit 1 PCV
Developed by Hitachi-GE
Verification periods: First half of FY 2016

Notes

Mobility: Crawler
Investigation device: Camera and dosimeter
Dimensions: (when driving through a guide pipe) approx. L 699 mm × W 72 mm × H 93 mm / (when driving on the grating) approx. L 316 mm × W 286 mm × H 93 mm
Weight: Approx. 10 kg (excludes weight of cables)
Resistance to radiation: Over 1000 *Gy*

Unit 2: Investigation Device for Primary Containment Vessel (PCV)

A2 investigation robot (Scorpion robot)



Scope of Investigation: Confirming the platform conditions inside the pedestal in PUnit 2 PCV
Location of Investigation: On platform inside of the pedestal in the Unit 2 PCV
Developed by Toshiba ESS
Verification periods: Second half of FY 2016

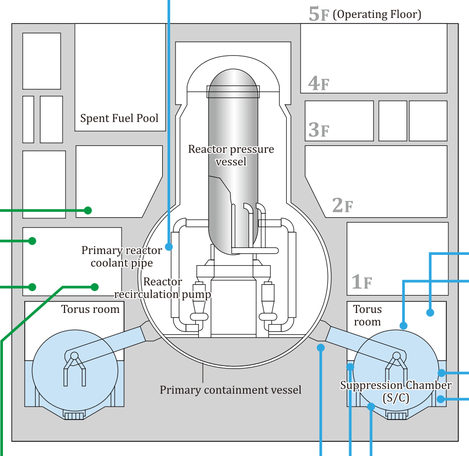
Notes

Dimensions: (when driving in narrow places) Approx. L 590 mm × W 90 mm × H 90 mm / (when During investigation) Approx. L 260 mm × W 90 mm × H 220 mm
Weight: Approx. 5 kg
Resistance to radiation: Over 1000 *Gy*

Deposit removal device

Notes

Mobility: Crawlers
Purpose: Ensuring of investigation routes for robots, while removing deposits on the rail by water pressure.
Dimensions: Approx. L 300mm × W 90mm × H 90mm
Weight: Approx. 3 kg
Resistance to radiation: Over 1000 *Gy*



★Unit 1: Boat-type Access Device with Submersible Functions for Investigation inside PCV (ROV-A)

Scope of Investigation: Investigation of the structure conditions of a wide-range pedestal periphery, distribution of deposits and the pedestal opening.
Location of Investigation: Basement floor of outside the pedestal in Unit 1 PCV
Developed by Hitachi GE
Verification periods: Second half of FY 2019

Notes

Mobility: Boat type with submersible functions
Purpose: Cable guide (guide ring) installation for wide-range movement of the pedestal periphery
Dimensions: φ250 mm diameter, approx. 1100 mm length
Weight: Approx. 40kg

Unit 3: Investigation Device for inside Primary Containment Vessel (PCV)

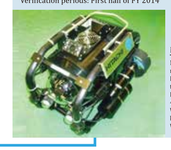
Scope of Investigation: Investigation of the conditions inside the pedestal in the Unit 3 PCV (damaged conditions in the pedestal).
Location of Investigation: Inside the pedestal in Unit 3 PCV
Developed by Toshiba ESS
Verification periods: First half of FY 2017

Notes

Mobility: Submersible type
Investigation device: Camera
Dimensions: Approx. 130mm outside diameter, 300mm length
Weight: Approx. 2 kg (in the air) and neutral buoyancy (in water)
Cable length: Approx. 60m
Resistance to radiation: Over 200 Gy

Investigation Device for Torus Room Wall Surface (Gengo ROV: Underwater Floating Robot)

Scope of Investigation: Investigation of underwater penetration parts in the wall surface
Location of Investigation: Penetration parts in the torus room and the turbine building (underwater)
Developed by Hitachi-GE
Verification periods: First half of FY 2014



Notes

Mobility: Thruster and buoyancy adjusting mechanism
Investigation devices: Camera and water temperature gauge
Dimensions: L 500 mm × W 400 mm × H 400 mm
Weight: Approx. 22 kg (in air), neutral buoyancy (in water)
Water pressure resistance: 10 meters

Unit 1: Investigation Device for the Upper Part of the Suppression Chamber (S/C) (Tele-runner: Investigation of Upper Part of S/C)

Scope of Investigation: Investigation of leaks from the upper structure of the S/C and the C/W
Location of Investigation: Upper part of the S/C in the Unit 1 Torus Room
Developed by Hitachi-GE
Verification periods: First half of FY 2014

Notes

Mobility: Crawler and flipper
Investigation devices: Camera, dosimeter, thermometer/hygrometer and microphone
Measurement: L 600 mm × W 500 mm × H 800 mm
Weight: Approx. 70 kg

Unit 1: Investigation Devise for Upper Part of Suppression Chamber (S/C) (Tele-runner: Investigation of Torus Room Wall Surface (Sonar))

Scope of Investigation: Investigation of water flow in penetration points on the wall surface by suspending a sonar device from the C/W
Location of Investigation: Penetration points in the Unit 1 torus room and the turbine building (in water)
Developed by Hitachi-GE
Verification periods: First half of FY 2014

Notes

Mobility: Crawler and flipper
Investigation devices: Ultrasound sonar, camera, dosimeter, thermometer/hygrometer and microphone
Dimensions: L 600 mm × W 500 mm × H 1200 mm
Weight: Approx. 100 kg

Investigation Device for Torus Room Wall Surface (Tri-Diver: The Crawling Robot)

Scope of investigation: Investigation of water flow at penetration parts of wall surface in muddy water
Location of investigation: Penetration parts in the torus room and the turbine building (in water)
Developed by Hitachi-GE
Verification periods: First half of FY 2014

Notes

Mobility: Crawler and thruster
Investigation device: Camera, ultrasonic sonar and water temperature gauge
Dimensions: L 600 mm × W 500 mm × H 400 mm
Weight: Approx. 40 kg (in air), approx. 1.5 kg (in water)
Water pressure resistance: 10 meters

Investigation Device for Connection Part Between Vent Pipe – Dry Well (D/W) (VT-ROV)

Scope of Investigation: Investigation of water leaks from vent pipes and the D/W connection parts, and water flow inside lower area of the concrete wall outlet by using lights and camera, while self-driving to the investigation point adhering to outer surface of vent pipes.
Location of Investigation: Vent pipes in the torus room and the connection parts of the PCV shell (in the air)
Developed by Toshiba ESS
Verification periods: First half of FY 2014

Notes

Mobility: Magnetic attraction wheels
Investigation device: Camera
Dimensions: L 280 mm × W 280 mm × H 90 mm
Weight: 10 kg

Investigation Device for Sand Cushion Drain Pipe (DL-ROV)

Scope of Investigation: Detection of water leaks of 1 liter/min. or more from the submerged sand cushion drain pipe outlet using lights, camera and tracer release mechanism, while moving the underwater torus room up to the submerged outlet.
Location of Investigation: Exit of sand cushion drain pipes in the torus room (in water)
Developed by Toshiba ESS
Verification periods: First half of FY 2014

Notes

Mobility: Thruster {2 thrusters;1 on the top and 1 on the bottom}
Investigation: Using a camera after injecting a tracer,
Dimensions: L 530 mm × W 290 mm × H 300 mm
Weight: 14 kg

Investigation Device for Lower Outer Surface of Suppression Chamber (S/C) (SC-ROV)

Scope of Investigation: Investigating whether there are holes with a diameter larger than 30mm in the lower outer surface of the S/C by using lights and camera (4 cameras mounted front and rear, right and left), while self-driving to the investigation point adhering to outer surface of S/C.
Location of Investigation: Outer surface of the S/C in the Unit 2 torus room
Developed by Toshiba ESS
Verification periods: First half of FY 2014

Notes

Mobility: Magnetic attraction wheels
Investigation device: Camera
Dimensions: L 280 mm × W 280 mm × H 140 mm
Weight: 10 kg