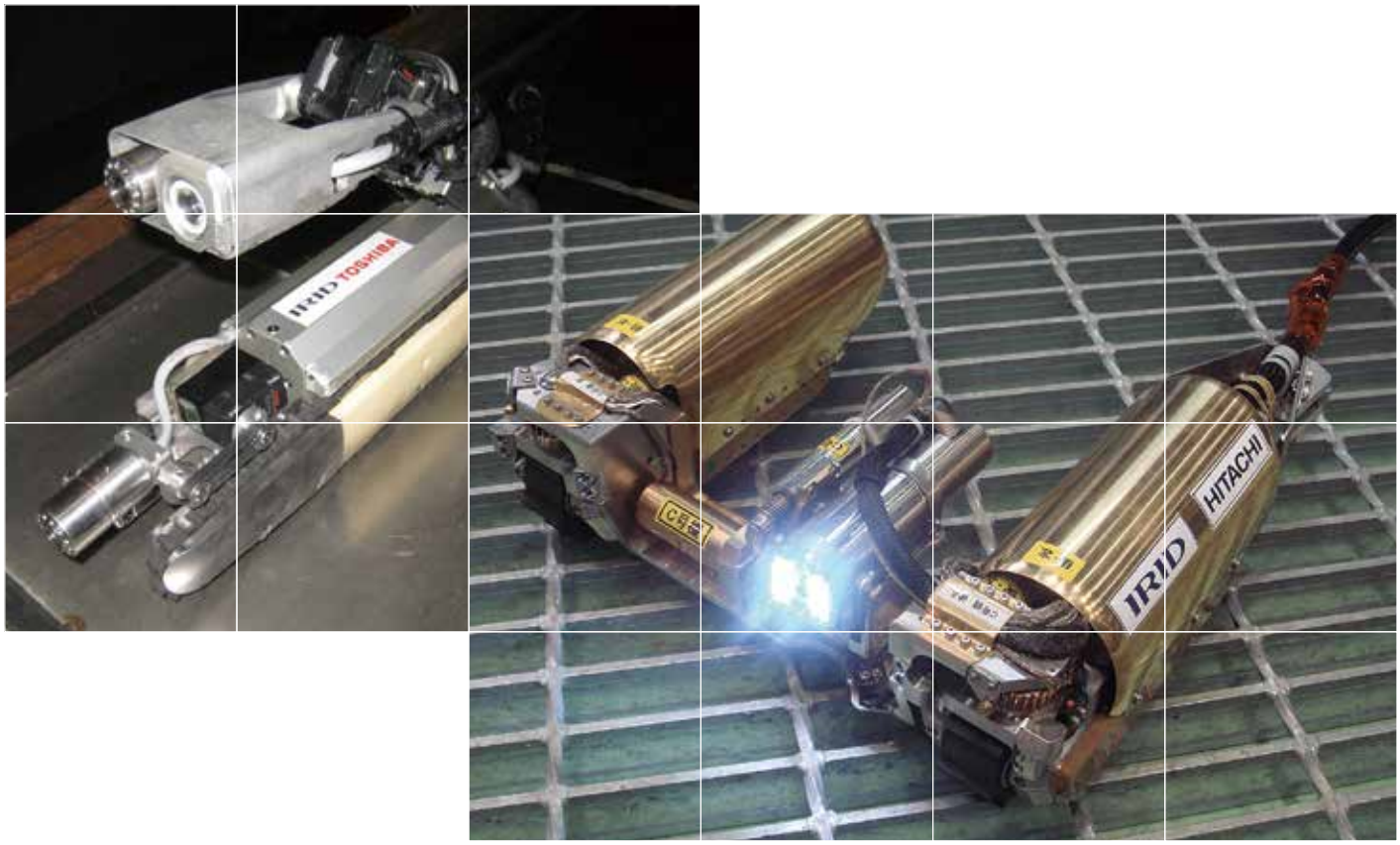


Robots

Various robots that support and take the place of human beings in decommissioning works at Fukushima Daiichi Nuclear Power Station.

IRID
International Research Institute for Nuclear Decommissioning

Message

Since its inception, IRID has been engaged in developing robots for decommissioning works. Concerning the current status of developments, the following is a message from Dr. Hajime Asama, the leading figure in the field of robotics.

Professor, Dr. Eng.
Department of Precision Engineering
School of Engineering
The University of Tokyo
Hajime Asama

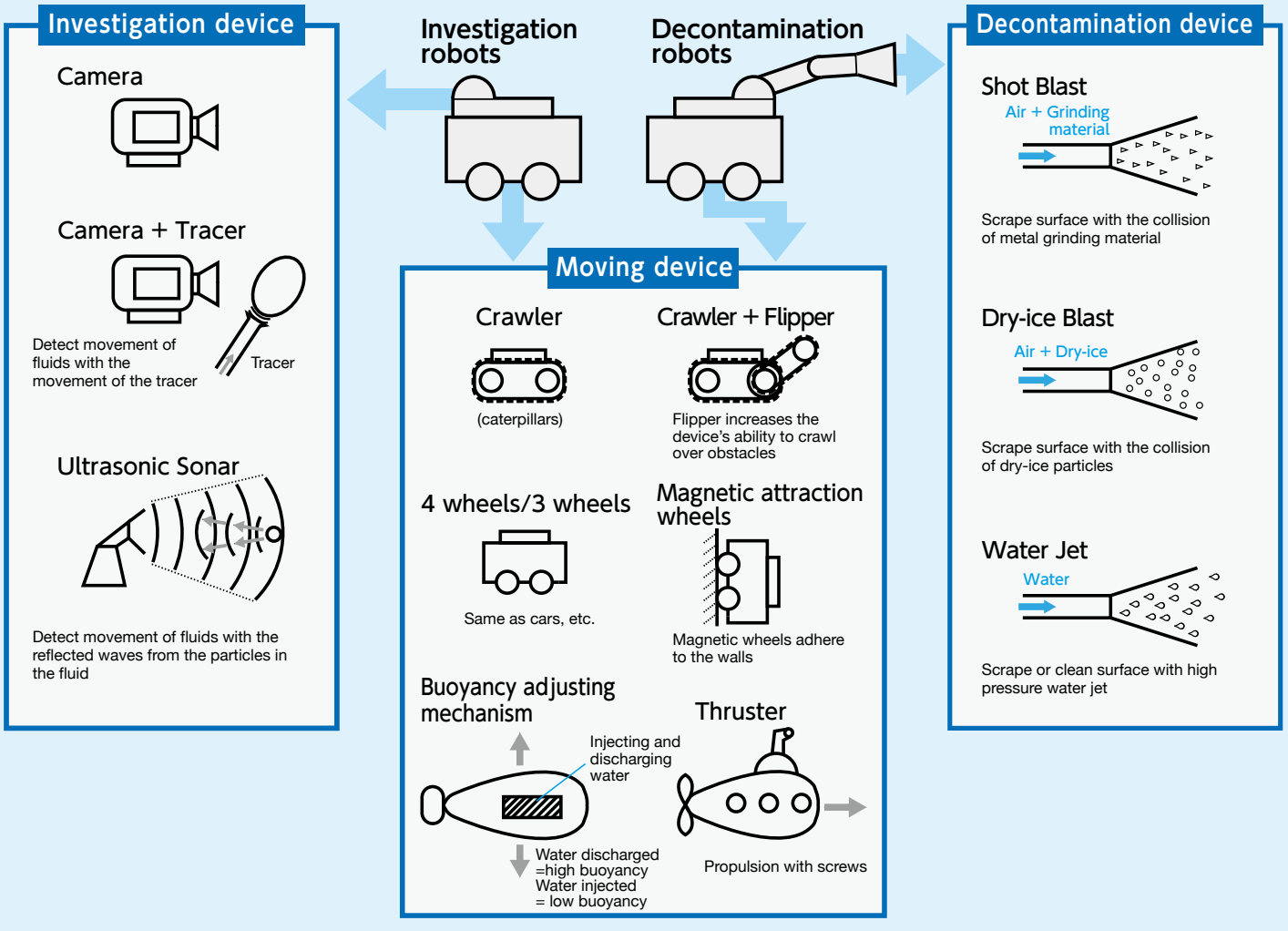
There are still many areas with high levels of radiation, making it difficult for people to approach such environments. Robots and remote control technologies are therefore crucial for decommissioning of the TEPCO Fukushima Daiichi Nuclear Power Station.

Up to now, various robots and remotely controlled devices have been deployed to remove rubble, investigate inside buildings (capturing images, measuring levels of radiation, etc.), decontaminate, and take samples (dust, contaminated water, concrete core, etc.). Just after the accident, robots for military use and unmanned construction machines were primarily used, but considering the unprecedented requirements for accidents occurring at nuclear power plants , 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 in charge of developing many of the more than 40 remotely controlled devices that have been deployed 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 deployed 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 fixing water leakages. 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 this agenda.

Main functions and names of parts of the remotely controlled robot



Various robots that support and take the place of human beings in decommissioning works at Fukushima Daiichi Nuclear Power Station.

IRID

Working Robots

Decontamination Equipment for Upper Floors of the Reactor Building

Photo shows suction/blast type of robot

Scope of Work: Decontamination using the following 4 technologies: suction, blast, dry-ice blast, high pressure water jet
Location of Work: Unit 1–3. Floor surfaces and bottom area wall surfaces on the 2nd and 3rd floor of the reactor building
Companies in charge of development: Mitsubishi Heavy Industries, Hitachi-GE, Toshiba
Demonstration Testing Schedule: Second half of fiscal year 2015 (actual robots will be used in tasks from 2016)

Notes

Working Truck Mobility: Crawler
Dimensions: W 750mm x L 1700 mm x H 1700 mm
Weight: Approximately 550 kg
Carrier/Supporting Truck* Mobility: Crawler
Dimensions: W 714 mm x L 2410 mm x H 350 mm
Weight: Approximately 750 kg
Intermediary Truck* Mobility: Crawler
Dimensions: W 1100 mm x L 2000 mm x H 500 mm
Weight: Approximately 680 kg
*Measurement and weight of junction truck section varies depending on the device loaded.

Suction/Blast Decontamination Devices (MEISTeR)

Scope of Work: Decontamination with shot blast
Location of Work: Unit 1–3. Floor surfaces and lower wall surfaces on 1st floor of reactor building
Company in charge of development: Mitsubishi Heavy Industries
Demonstration testing schedule: Second half of fiscal year 2013.

Notes

Mobility: Crawler (convert MHI-MEISTeR)
Devices: Arm + Shot blast device, air transport device, blasting dust collector
Dimensions: W 700 mm x D 1250 mm x H 1300 mm
Weight: Approximately 500 kg

Dry-Ice Blast Decontamination Device

Scope of Work: Decontamination with dry-ice blast
Location of Work: Unit 1–3. Floor surfaces and lower wall surfaces on 1st floor of reactor building
Company in charge of development: Toshiba
Demonstration testing schedule: First half of fiscal year 2014.

Notes

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

High Pressure Water Jet Decontamination Device (Arounder)

Scope of Work: Decontamination with water jet
Location of Work: Unit 1–3. Floor surfaces and lower wall surfaces on 1st floor of reactor building
Company in charge of development: Hitachi-GE
Demonstration testing schedule: First half of fiscal 2014

Notes

Mobility: Crawler
Devices: Arm + Water jet device, water supply device, water collecting device
Dimensions: W 600 mm x D 1600 mm x H 1300 mm
Weight: Approximately 850 kg

Dry-Ice Blast Decontamination Device for High Places

Scope of work: Decontamination with dry-ice blast
Location of Work: Unit 1–3. Wall surfaces, ceilings, ducts, cable trays etc. at a height of 5-8 meters on 1st floor of reactor building
Company in charge of development: Toshiba
Demonstration Testing Schedule: Second half of fiscal 2015

Notes

Mobility: Crawler
Devices: Working truck for remote decontamination of high places, supporting truck etc. (also used for low places)
Dimensions: W 930 mm x L 2069 mm x H 1961 mm
Maximum reachable height of device: 8000 mm
Weight: Approximately 1700 kg

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

Scope of Work: Decontamination with shot blast
Location of Work: Unit 1–3. High wall surfaces and structures on 1st floor of reactor building
Company in charge of development: Mitsubishi Heavy Industries
Demonstration Testing Schedule: Second half of fiscal 2015 (actual robots will be used in tasks from 2016)

Notes

Mobility: Four-wheel drive, four-wheel steering (convert NEDO Super-Giraffe)
Devices: Arm + Shot blast device, air transport device, blasting dust collector
Dimensions: W 1300 mm x D 2350 mm x H 1700 mm
Maximum reachable height of device: 8000 mm
Weight: Approximately 4000 kg

High Pressure Water Jet Decontamination Device for High Places

Scope of Work: Decontamination with water jet
Location of Work: Unit 1–3. High wall surfaces of 2 meters or more and structures on 1st floor of reactor building
Company in charge of development: Hitachi-GE
Demonstration Testing Schedule: Second half of fiscal 2015 (actual robots will be used in tasks from 2016)

Notes

Mobility: Crawler
Devices: Arm + Water jet device, water supply device, water collecting device
Dimensions: W 760 mm x D 2098 mm x H 1555 mm
Maximum reachable height of device: 6105 mm (high pressure water can be ejected up to a height of 8000 mm)
Weight: Approximately 1300 kg

Shielding Block & Iron Plate Detaching Device (TEMBO)

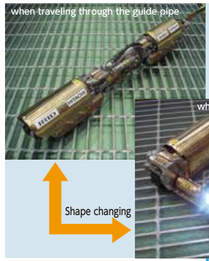
Scope of Work: Removing shielding blocks and iron plates
Location of Work: Unit 2, 1st floor of reactor building.
Company in charge of development: Mitsubishi Heavy Industries
Demonstration Testing Schedule: First half of fiscal 2015

Notes

Mobility: 3 wheels
Devices: Manipulator, end effector
Dimensions: W 1100 mm x D 4000 mm x H 2100 mm
Weight: Approximately 3500 kg

Investigation Robots

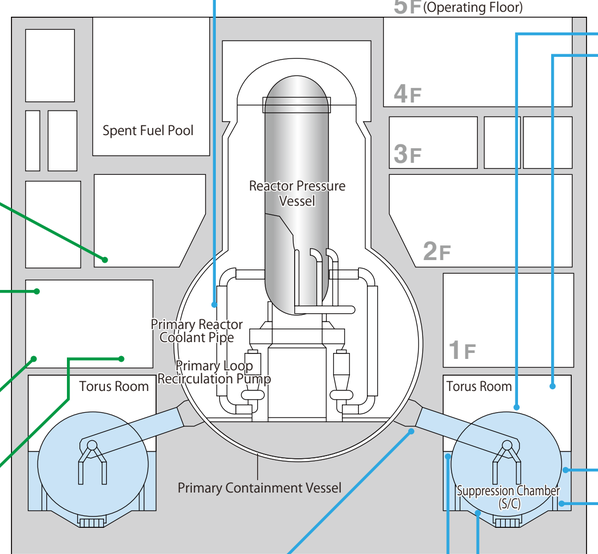
Investigation Device to Inspect Interior of Unit 1 Primary Containment Vessel (PCV) (shape-changing robot)



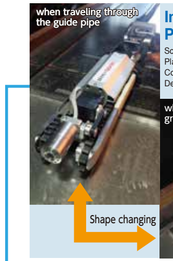
Scope of Investigation: Capturing images, measuring radiation levels and temperature on grating on 1st floor outside pedestal inside PCV of Unit 1.
Location of Investigation: Grating on the 1st floor outside the pedestal inside the PCV of Unit 1
Company in charge of development: Hitachi-GE
Demonstration Testing Schedule: First half of fiscal 2015

Notes

Mobility: Crawler
Investigation devices: camera, dosimeter, thermometer
Dimensions: (when traveling through the guide pipe) approximately L 600 mm x W 70 mm x H 95 mm / (when traveling through grating) approximately L 220 mm x W 290 mm x H 95 mm
Weight: Approximately 10 kg (excludes weight of cables)



Investigation Device to Inspect Interior of Unit 2 Primary Containment Vessel (PCV)



Scope of Investigation: Check status of platform on the inside of pedestal in the PCV of Unit 2
Place of Investigation: Platform on the inside of the pedestal in the PCV of Unit 2
Company in charge of development: Toshiba
Demonstration Testing Schedule: Planned for 2016

Notes

Mobility: Crawler
Investigation devices: camera, dosimeter, thermometer
Dimensions: (when traveling through the guide pipe) approximately L 590 mm x W 90 mm x H 90 mm / (when traveling through grating/CRD rail) approximately L 280 mm x W 90 mm x H 220 mm
Weight: Approximately 5 kg

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

Scope of Investigation: Investigation of penetration points in the wall surface underwater
Location of Investigation: Penetration points in the torus room and turbine building (underwater)
Company in charge of development: Hitachi-GE
Demonstration Testing Schedule: First half of fiscal 2014

Notes

Mobility: thruster, buoyancy adjusting mechanism
Investigation devices: camera, water temperature gauge
Dimensions: L 500 mm x W 400 mm x H 400 mm
Weight: Approximately 22 kg (in air), neutral buoyancy (in water)
Water pressure resistance: 10 meters

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

Scope of investigation: Investigation of water flow at penetration points in wall surface under muddy water
Location of investigation: Penetration points in torus room and turbine building (underwater)
Company in charge of development: Hitachi-GE
Demonstration Testing Schedule: First half of fiscal 2014

Notes

Mobility: Crawler, thruster
Investigation devices: camera, ultrasonic sonar, water temperature gauge
Dimensions: L 600 mm x W 500 mm x H 400 mm
Weight: Approximately 40 kg (in air), approximately 1.5 kg (in water)
Water pressure resistance: 10 meters

Device to Inspect Joint Section Between Vent Pipe – Dry Well (D/W) (VT-ROV)

Scope of Investigation: Adhering to outer surface of vent pipe, autonomous maneuvering device moves to inspection point, joint section of the vent pipe and D/W shell, and using light and camera, checks for leaks from vent pipe and D/W joint section and checks water flow inside lower area of the concrete wall outlet
Location of Investigation: Joint section of vent pipe in the torus room and PCV shell (in the air) (schedule for actual use of robots in tasks has not yet been decided)
Company in charge of development: Toshiba
Demonstration Testing Schedule: First half of fiscal 2014

Notes

Mobility: Magnetic Attraction Wheels
Investigation device: camera
Dimensions: L 280 mm x W 280 mm x H 90 mm Weight: 10 kg

Sand Cushion Drain Pipe Inspection Device (DL-ROV)

Scope of Investigation: Device will drift through the water in the torus room up to the submerged sand cushion drain pipe outlet, and detect leaks of 1 liter/min or more from the submerged sand cushion drain pipe outlet using lights, camera and a tracer release mechanism
Location of Investigation: Exit of sand cushion drain pipe in the torus room (underwater) (schedule for actual use of robot in tasks has not yet been decided)
Company in charge of development: Toshiba
Demonstration Testing Schedule: First half of fiscal 2014

Notes

Mobility: Thruster (2thrusters, 1 on top, 1 on bottom)
Investigation devices: After releasing the tracer, use camera
Dimensions: L 530 mm x W 290 mm x H 300 mm Weight: 14 kg

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

Scope of Investigation: Investigate leaks from the upper structure of the S/C from C/W
Location of Investigation: S/C Upper Part of the S/C in Torus Room of Unit 1
Company in charge of development: Hitachi-GE
Demonstration Testing Schedule: First half of fiscal 2014

Notes

Mobility: Crawler, flipper
Investigation devices: camera,dosimeter,thermometer/hygrometer, microphone
Dimensions: L 600 mm x W 500 mm x H 800 mm

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

Scope of Investigation: Investigate flow in penetration points in wall surface by suspending sonar device from C/W
Location of Investigation: Penetration points in torus room and the turbine building (underwater) of Unit 1
Company in charge of development: Hitachi-GE
Demonstration Testing Schedule: First half of fiscal 2014

Notes

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

Investigation Device for Upper Part of Suppression Chamber (S/C) in Unit 1 (Tele-runner: Torus Room Wall Surface Survey (Camera))

Scope of Investigation: Investigate leaks in the penetration points in wall surface by suspending camera from C/W
Location of Investigation: Penetration points in torus room and turbine building (underwater) of Unit 1
Company in charge of development: Hitachi-GE
Demonstration Testing Schedule: First half of fiscal 2014

Notes

Mobility: Crawler, flipper
Investigation device: Camera, dosimeter, thermometer/hygrometer, microphone
Dimensions: L 600 mm x W 500 mm x H 1200 mm

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

Scope of Investigation: Adhering to outer surface of S/C, autonomous maneuvering device moves to inspection point of the lower outer S/C, and using light and cameras (4 cameras mounted front and rear, right and left), checks for holes with a diameter larger than 30 mm in the lower outer surface of the S/C
Location of Investigation: Outer surface of the S/C in the torus room of Unit 2
Company in charge of development: Toshiba
Demonstration Testing Schedule: First half of fiscal 2014

Notes

Mobility: Magnetic Attraction Wheels
Investigation device: Camera
Dimensions: L 280 mm x W 280 mm x H 140 mm Weight: 10 kg

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