Development of Base Technology for Robots to Measure Water Levels inside the Suppression Chambers (S/C) and Demonstrative Tests

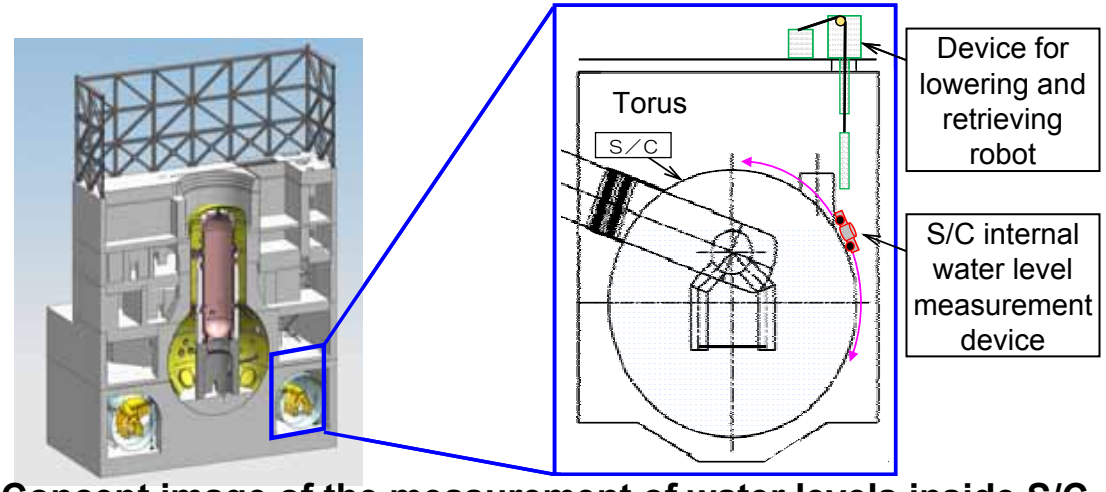
September 12, 2013

[Remote Technology Taskforce WG1]

S/C Internal Water Level Measurement WG

1. Objective

To support the "S/C Internal Water Level Measurement WG (Project Manager: Prof. Matsuhira from Shibaura Institute of Technology) and perform demonstrative tests at **Unit 5 and Unit 2** of remotely operated technology that employees ultrasound to measure water levels inside the S/C developed in accordance with the Agency for Natural Resources and Energy's FY2012 Project for Creating Base Technologies Related to Handling Nuclear Power Generation Reactor Accidents (Development of Remotely Operated Base Technology For Measuring Water Levels inside Cylindrical Containers)



Concept image of the measurement of water levels inside S/C

Details of Demonstration

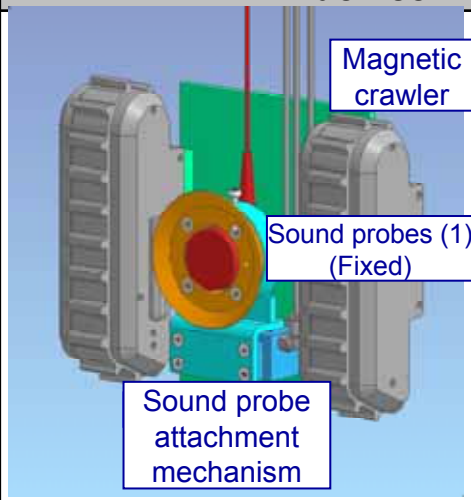
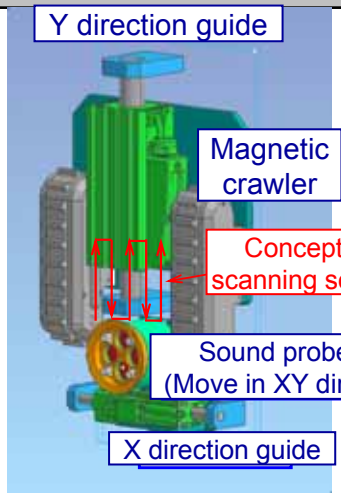
Location of demonstration	Device used in demonstration	Tests performed
Unit 5 Unit 2[Note)]	・Fixed point water level measurement device ・Scanning water level measurement device	・Crawling performance confirmation test ・Water level measurement confirmation test

Note) The order of demonstration tests performed at Unit 2 will be the fixed point device followed by the scanning device. However, the demonstration test for the scanning device will be omitted if it is possible to confirm water level using the fixed point device in order to reduce exposure

2. Developed technology
(technology for measuring water levels inside cylindrical containers)

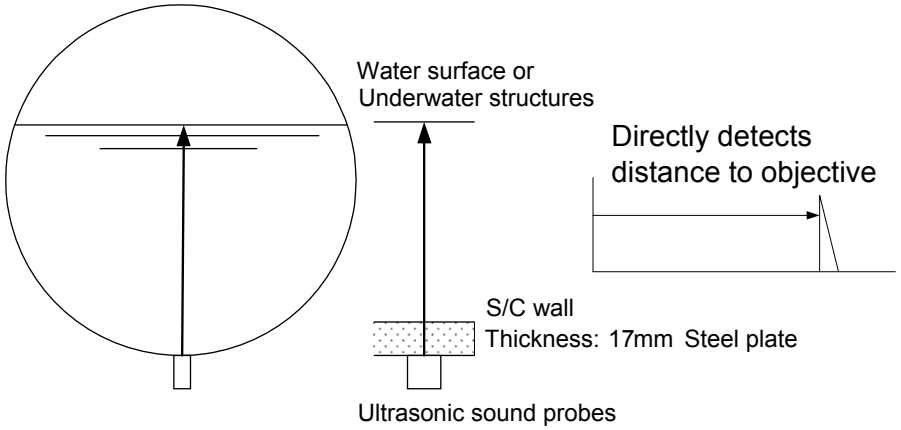
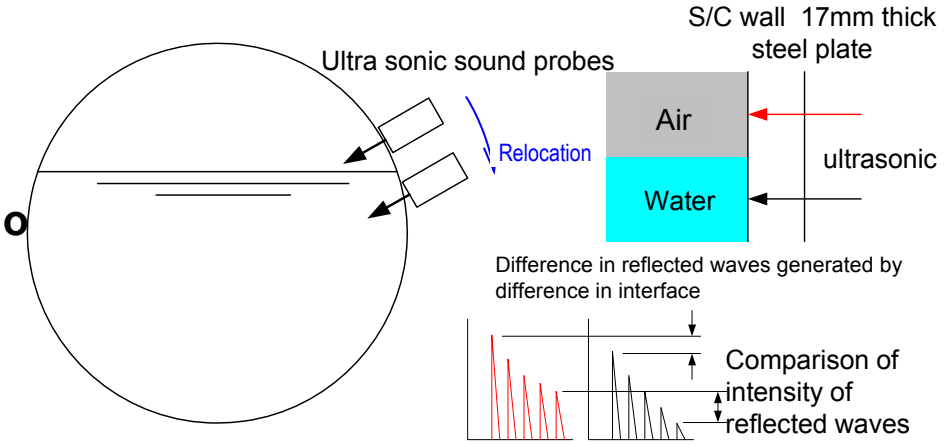
[Objective]
Since technology for measuring water levels inside sealed containers by having a remotely operated device move freely along the outside curve of a cylindrical container and use ultra sonic sounding probes to measure water levels does not exist, the objective is to develop technology for measuring water levels inside sealed cylindrical containers, including the mechanism for remotely moving sound probes. Furthermore, two types of devices, a fixed point device and a scanning device, will be developed so as to improve the reliability of water level detection.

Developed devices for measuring water levels inside sealed cylindrical containers

Model	Fixed point water level measurement device		Scanning water level measurement device	
Functions		Moves to measurement point using magnetic crawlers and takes measurements with fixed sound probes		Takes measurements with sound programs that scan over a 40mm x 30mm area and gradually moves using magnetic crawlers
Measurement method (refer to next slide)	**・Direct distance measurement ・Multipath reflection comparison measurement**		**・Multipath reflection comparison measurement**	

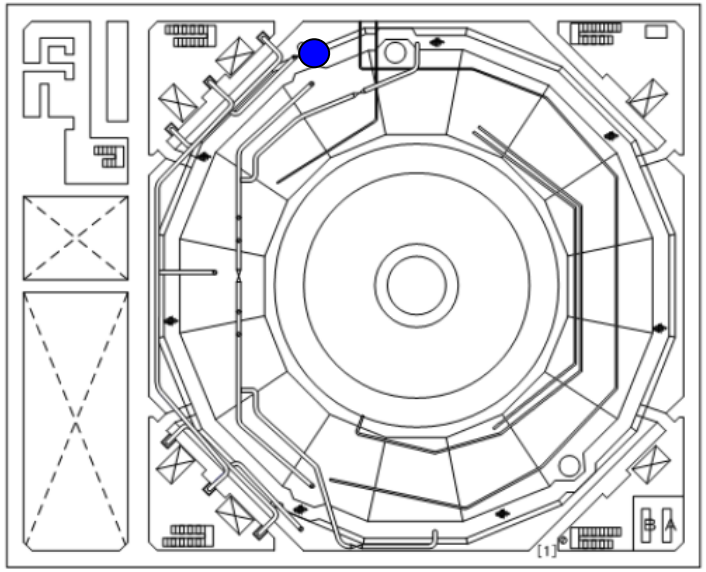
2. Developed technology (technology for measuring water levels inside cylindrical containers)

Methods to be developed for measuring water levels inside sealed cylindrical containers

Direct distance measurement	Multipath reflection comparison measurement
	
Directly scans the water level inside the cylindrical container and calculates distance.	Scans the reflected waves off the inside walls of the cylindrical container and determines whether they reflected off of air or water from the difference in the intensity of the echo.

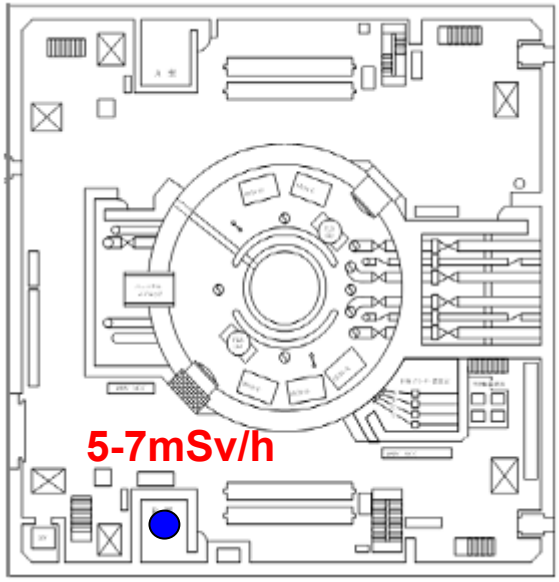
3. Demonstration Methods

- Since the atmospheric doses at Unit 5 are low and the outer surface of the S/C can be accessed directly the developed device will be attached to the outer wall of the S/C in the torus (B1 floor of reactor building) and it will be shown that the water level inside the S/C can be confirmed.
- At Unit 2 the device will be lowered remotely through a ϕ350 hole drilled in the R/B 1st floor south side RHR (B) heat exchanger into the torus, attached to the outer wall of the S/C and it will be shown that the water level inside the S/C can be confirmed.



B1 floor of Unit 5 R/B

Unit 5 demonstration test location

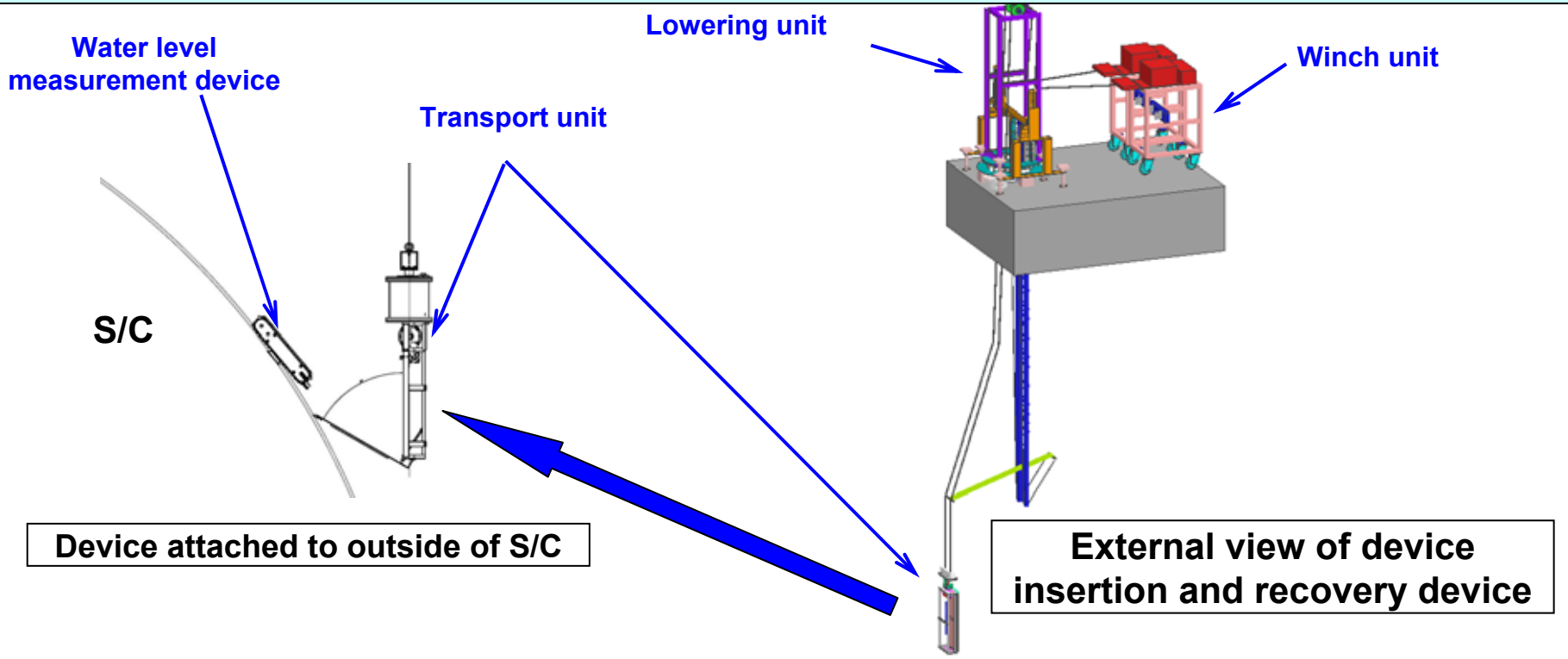


1st floor of Unit 2 R/B

Unit 2 demonstration test location

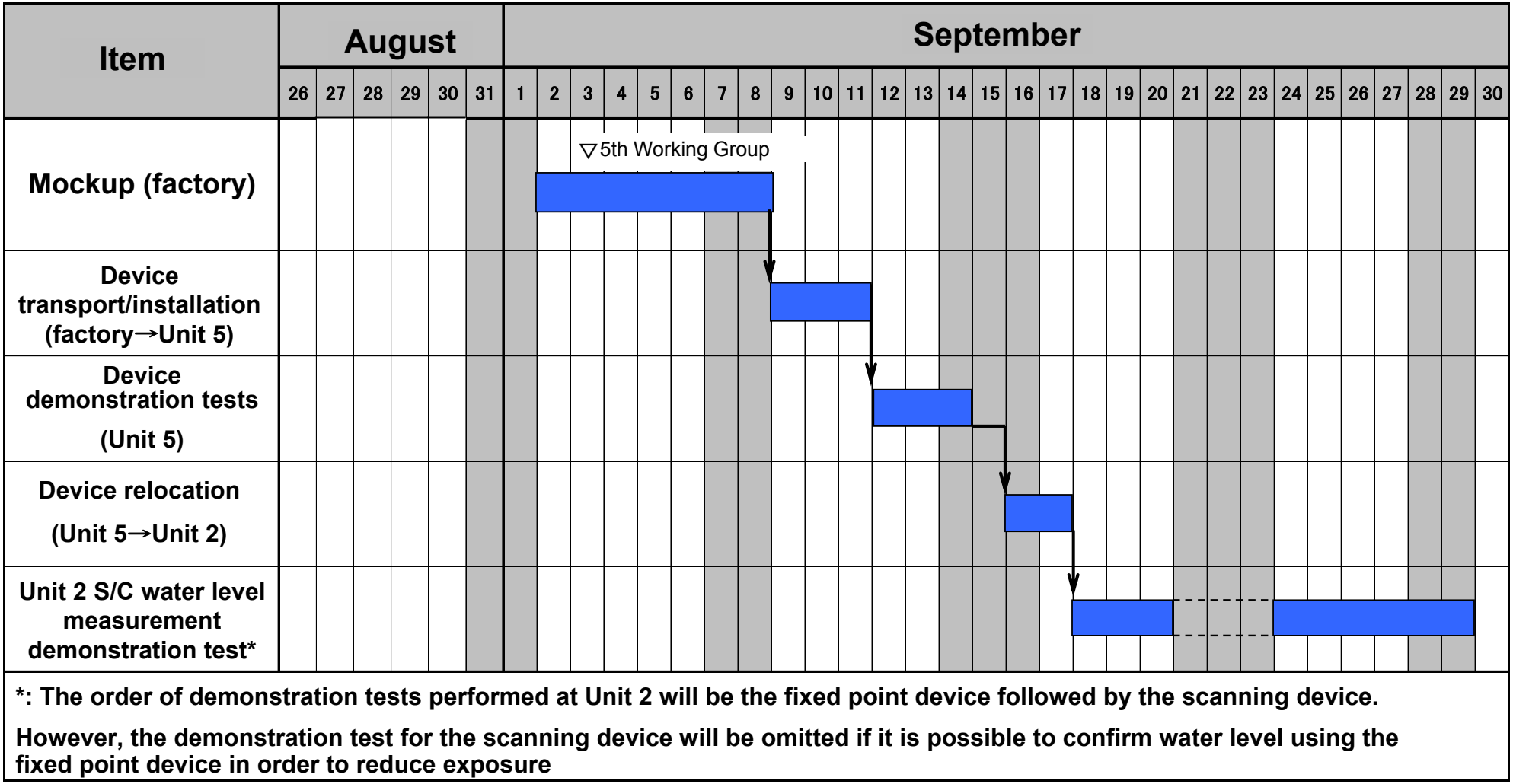
3. Demonstration Method (Unit 2)

During the demonstration test at Unit 2 a device insertion and recovery device will be used to lower the water level measuring device into the torus, attach it to the outside of the S/C and measure the water level.
Furthermore, if a pre-inspection with a camera reveals dirt, such as oil accretions, on the outside of the S/C, a cleansing robot also developed will be used to remove the dirt after which the water level measuring robot will be inserted.



Concept image of demonstration tests at Unit 2

4. Schedule (Proposed)



*: The order of demonstration tests performed at Unit 2 will be the fixed point device followed by the scanning device.

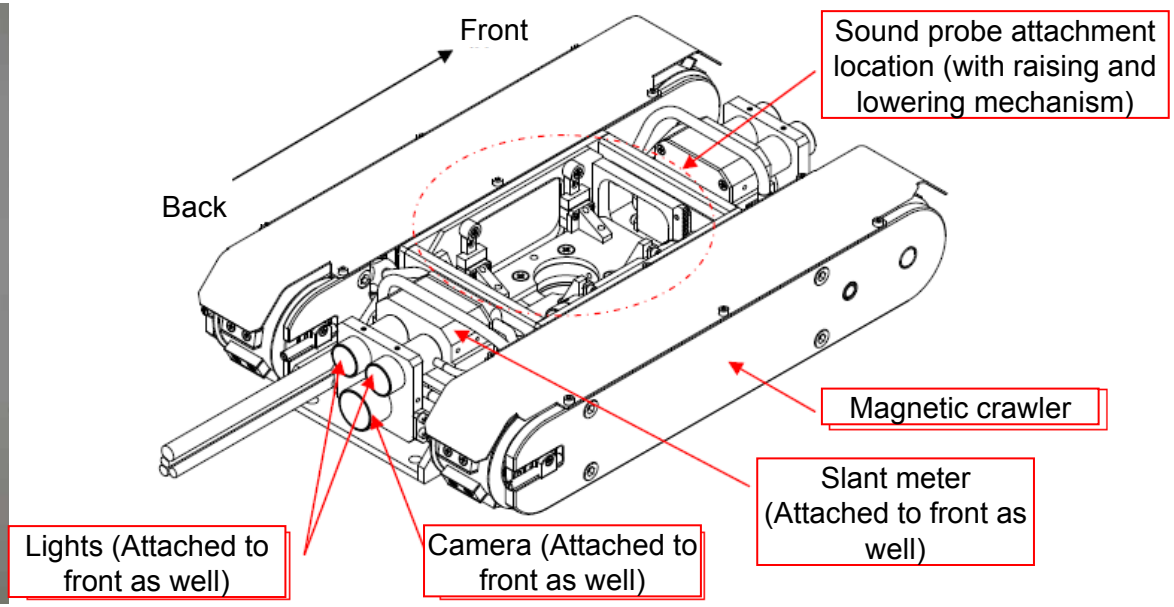
However, the demonstration test for the scanning device will be omitted if it is possible to confirm water level using the fixed point device in order to reduce exposure

[Reference] Name changes of developed devices

Originally it was thought that the **fixed point water level measurement device** [post-change name] would **only employ the direct distance method of measurement (direct detection method)** however in the course of development it was found that the **multipath reflection comparison method (indirect detection method) could also be used to measure water level**.
During the demonstration test the fixed location water level measurement device will also use the multipath reflection comparison method of measurement.
Therefore, the name of the device was changed from one that differentiated the device by measurement method to a name that differentiates the devices by **function**.

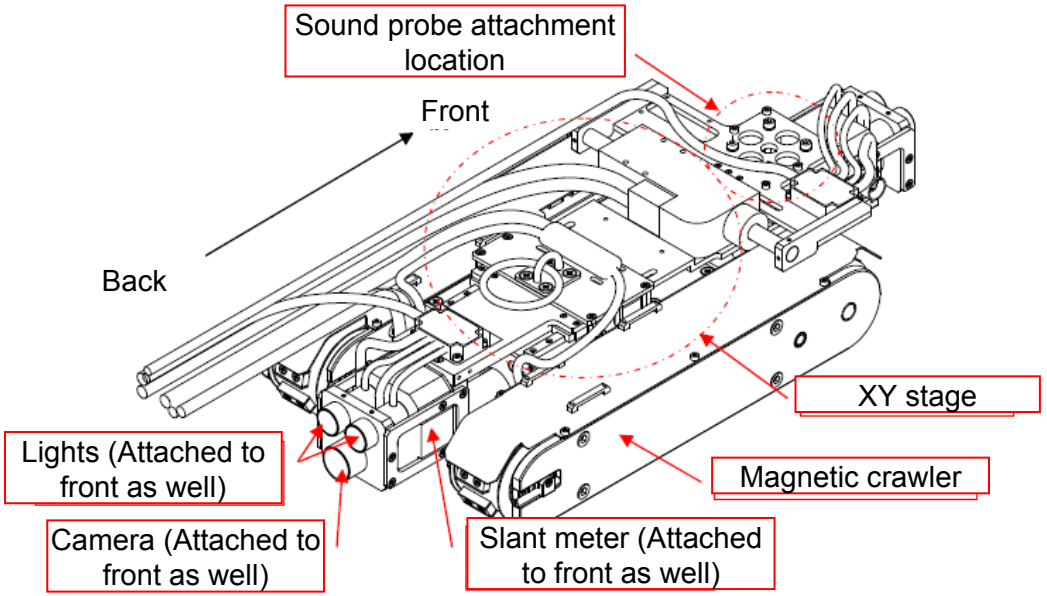
Prior to change	After change
Direct detection water level measurement device (Measurement method: direct distance measurement) →	**Fixed location water level measurement device** (Measurement method: direct distance measurement, multipath reflection comparison method)
Indirect detection water level measurement device (Measurement method: multipath reflection comparison measurement) →	**Scanning water level measurement device** (Measurement method: multipath reflection comparison measurement)

[Reference] Device Specifications (fixed location water level measurement device)



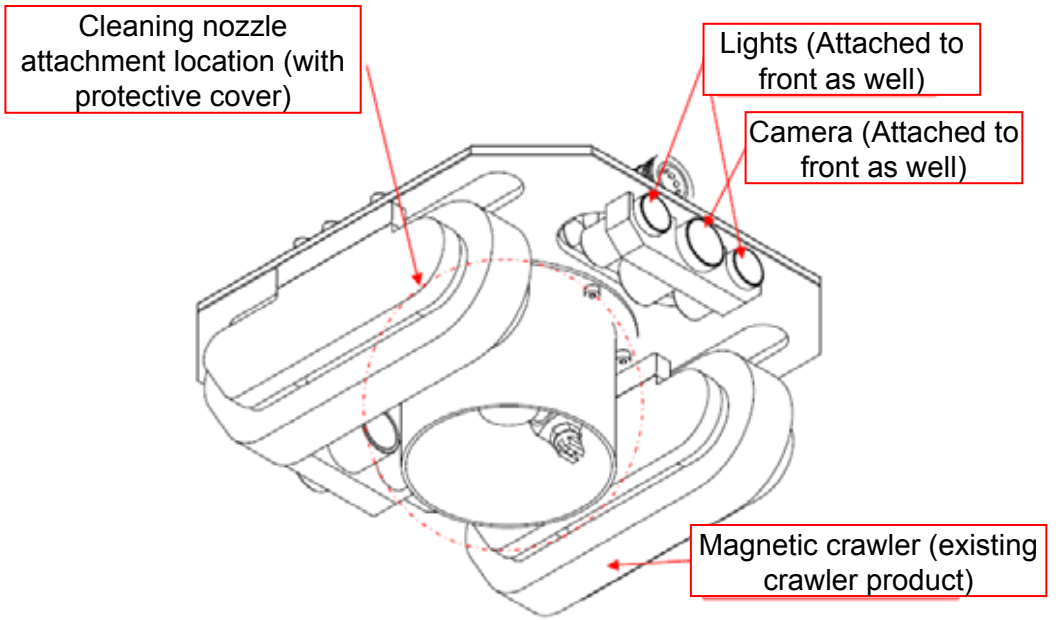
Device Specifications	
Outer Dimensions	L364mm × W244mm × H74mm
Weight	Approx. 8kg (excluding cables)
Running Speed	MAX 3m/min
Movement Technology	Can move Forward, Backward, and Turn

[Reference] Device Specifications (scanning water level measurement device)



Device Specifications	
Outer Dimensions	L519mm × W244mm × H102mm
Weight	Approx. 12kg (excluding cables)
Running Speed	MAX 3m/min
Movement Technology	Can move Forward, Backward, and Turn
Range of motion of sound probes	X axis: 40mm, Y axis: 80mm

[Reference] Device Specifications（cleansing device）



Device Specifications	
Outer Dimensions	L260mm × W230mm × H125mm
Weight	Approx. 6kg (excluding cables)
Running Speed	MAX 9m/min
Movement Technology	Can move Forward, Backward, and Turn
Cleansing Capability	Spray pressure: 8MPa, Spray volume: 400L/h