Results of the Fourth Soundness Inspection of Unit 4 Reactor Building at Fukushima Daiichi Nuclear Power Station

February 13, 2013

Tokyo Electric Power Company

TEPCO 東京電力

1. Purpose of Inspection

Unit 4 Reactor Building and Spent Fuel Pool are inspected on a regular basis (four times a year) for soundness. The previous inspections were done in May, August and November 2012. Based on the results, it was confirmed that the spent fuel can be stored safely. The fourth regular inspection was performed as follows.

[Overview of the regular inspections performed]

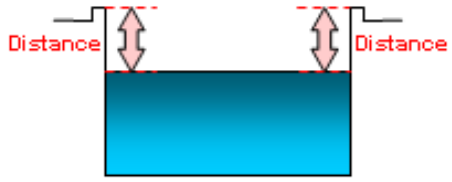
(1) First regular inspection (May 17-25, 2012)
(2) Second regular inspection (August 20-28, 2012)
(3) Third regular inspection (November 19-28)
[Inspection items]
1. Water level measurement, 2. Outer wall measurement, 3. Visual inspection, 4. Concrete strength evaluation
[Outline of the results] No crack or building tilt was found and a sufficient level of concrete strength was maintained. The condition allows for safe storage of spent fuel. No significant change was found from the first regular inspection results.

(4) Fourth regular inspection (February 4-12, 2013)
[Inspection items] 1. Water level measurement, 2. Outer wall measurement, 3. Visual inspection, 4. Concrete strength evaluation

2. Results (1) Building Tilt Measurement (Water Level)

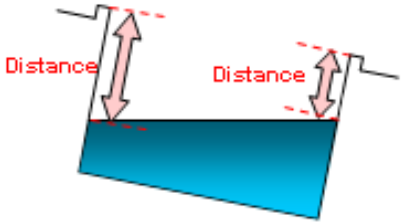
Given that the water surface is always horizontal, the distances between the 5th floor surface and the water levels of the reactor well and spent fuel pool were measured to check if the building is tilted or not. It has already been confirmed that the building is not tilted based on the measurement results obtained on February 7, April 12, May 18, August 21 and November 20, 2012.

1) Building not tilted

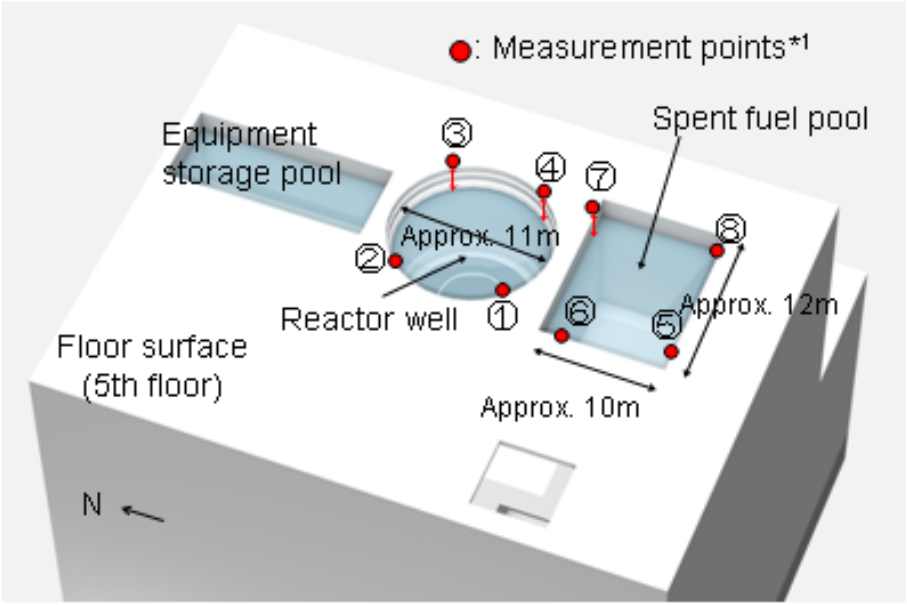


The distances are the same

2) Building tilted



Difference in the distances

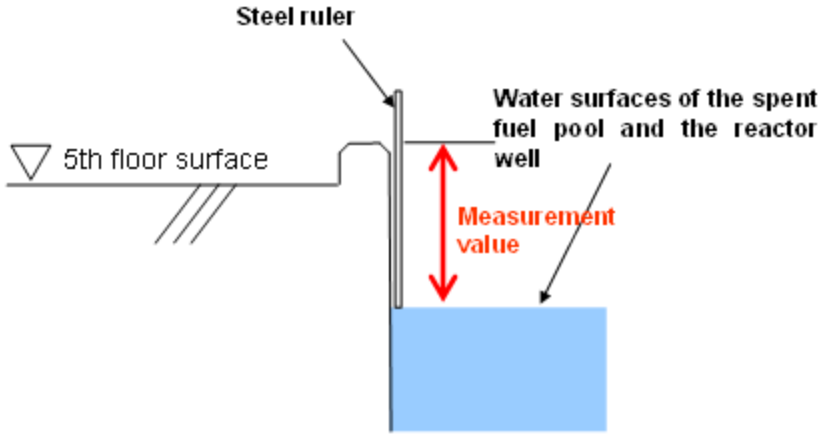


Measurement points (Floor surface of the 5th floor)

*1 The measurement points are set according to the progress status of cover installation for fuel removal.

2. Results (1) Building Tilt Measurement (Water Level)

Considering that the water level measurement values on the four corners were about the same, it has been concluded that the 5th floor surface and the water levels of the spent fuel pool and the reactor well are parallel and the building is not tilted similarly to the past results.



Measurement method*1

*1 Error must be taken into account as the measurement is done visually by a person
*2 Water levels are subject to change daily depending on the operation status of cooling equipments.
*3 On February 7, 2012, measurement was done only on the reactor well.

Water level*2 measurement results

Unit [mm]

Reactor well	Measurement date					
	Feb. 7, 2012	Apr. 12, 2012	May 18, 2012	Aug. 21, 2012	Nov. 20, 2012	Feb. 6, 2013
①	462	476	492	462	463	465
②	463	475	492	462	464	464
③	462	475	492	461	463	463
④	464	475	492	461	463	463

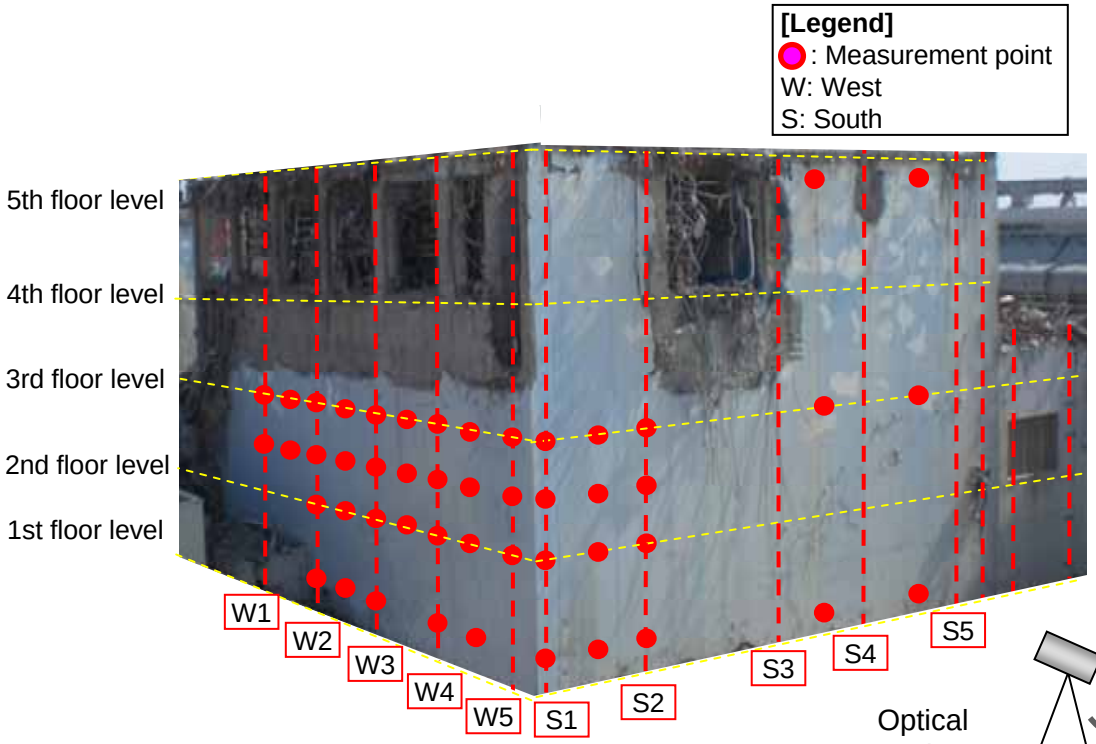
Spent fuel pool	Measurement date					
	Feb. 7, 2012	Apr. 12, 2012	May 18, 2012	Aug. 21, 2012	Nov. 20, 2012	Feb. 6, 2013
⑤	— (*3)	468	461	453	443	444
⑥		468	461	453	444	443
⑦		468	461	452	442	443
⑧		468	461	452	443	443

2. Results (2) Outer Wall Measurement (Measurement Points)

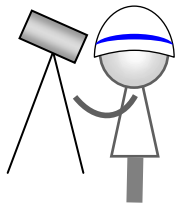
The horizontal differences*1 of the outer walls were measured by an optical equipment (with fixed points set on the upper and lower sides of the walls) and the deformation characteristics of the outer walls were evaluated.

Though partial bulge was found on the outer walls, it has been confirmed that the building itself is not tilted based on the results of the first regular inspection (May 2012), detailed inspection of outer walls (June 2012) and the second and third regular inspections (August and November 2012).

*1 Horizontal distance between the fixed point on the first floor and the fixed point on the upper floor



Measurement points



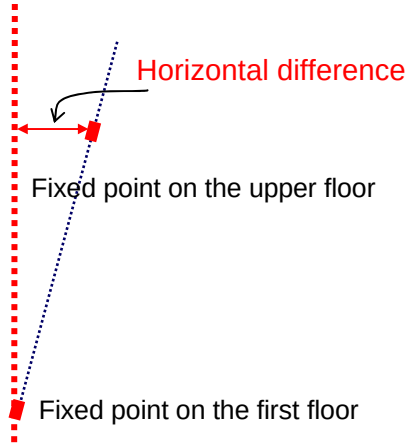
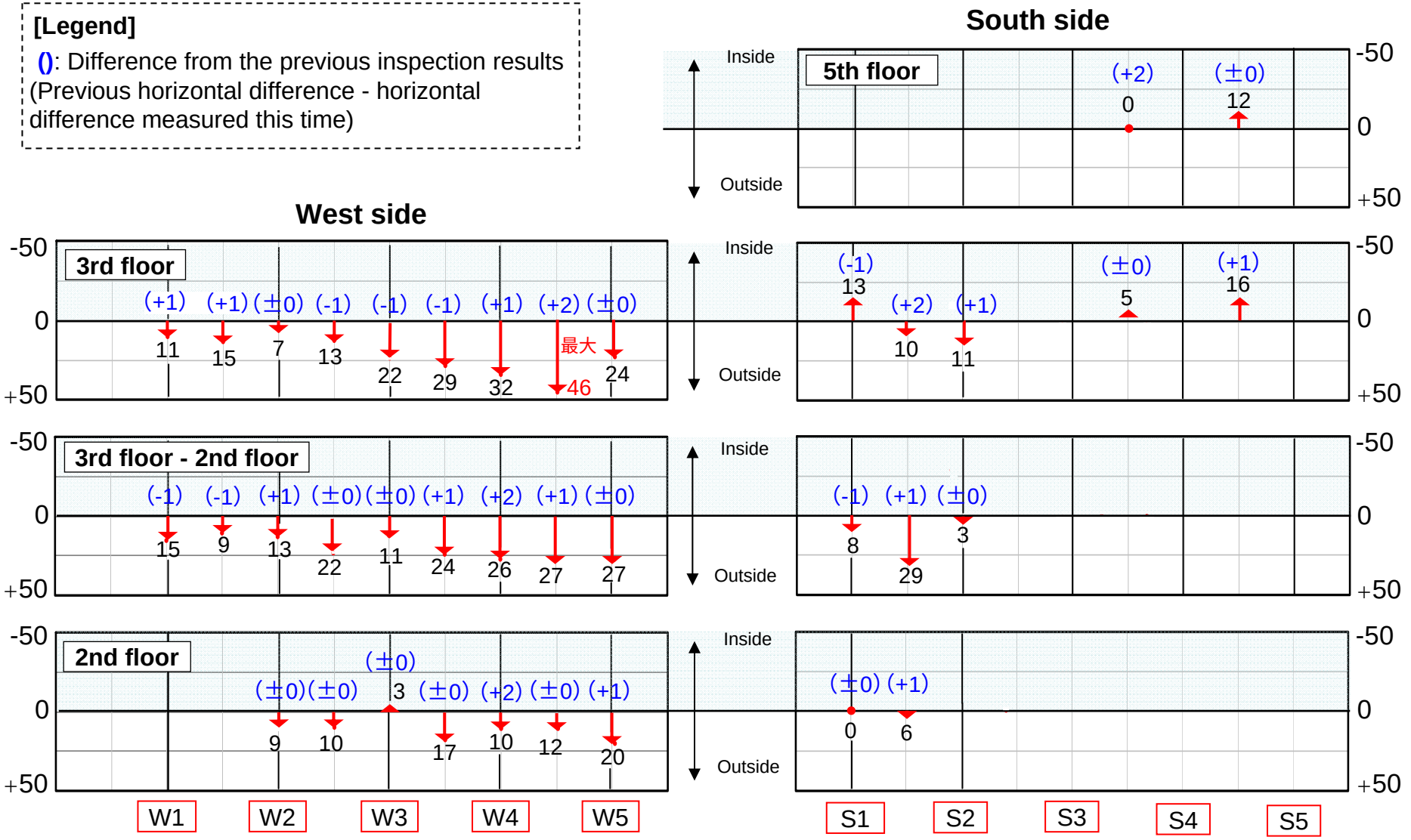


Image processing was partially applied for the purpose of physical protection.

2. Results (2) Outer Wall Measurement (Measurement Results)

[Legend]

(): Difference from the previous inspection results (Previous horizontal difference - horizontal difference measured this time)

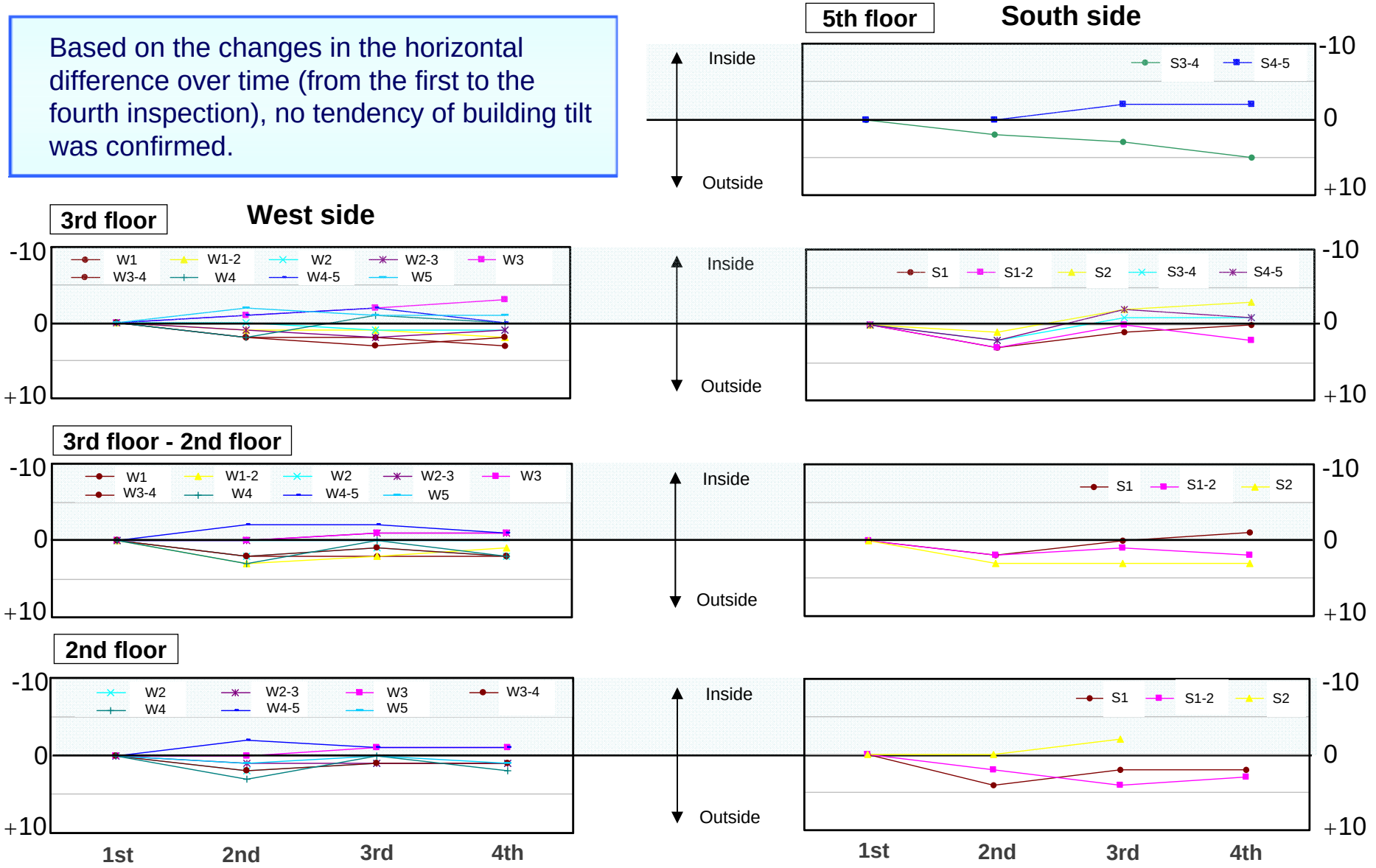


Horizontal difference*1 calculation results (Unit: mm)

*1 Horizontal distance between the fixed point on the first floor and the fixed point on the upper floor

2. Results (2) Outer Wall Measurement (Measurement Results)

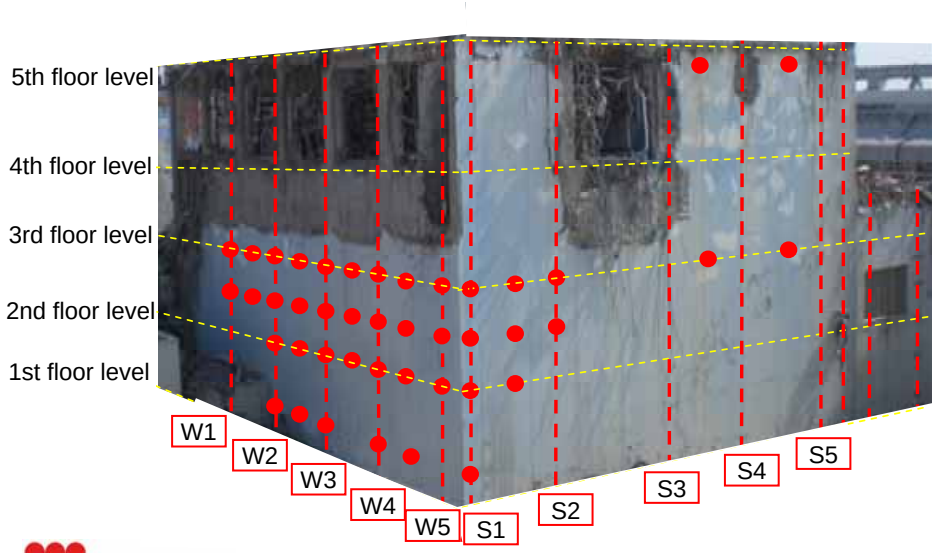
Based on the changes in the horizontal difference over time (from the first to the fourth inspection), no tendency of building tilt was confirmed.



Changes in the horizontal difference over time (Unit: mm)

2. Results (2) Outer Wall Measurement (Consideration)

- The horizontal differences measured this time were about the same as those in the first inspection (May 2012), the detailed inspection of outer walls (June 2012) and the second and the third inspections (August and November 2012), and the deformation characteristics on the measurement points were also similar.
- The small difference from the previous measurement results may be due to factors such as error of the optical equipment (Measurement error of ±2mm may cause approx. 4mm (Max.) error in horizontal difference) and thermal expansion of concrete (thermal expansion coefficient: Approx. 7-13×10^{-6}/℃) which may cause approx. 3-7mm error because of the difference of average monthly temperatures between November and January/February.
- As for the south outer wall, the measurement points which will interfere with the cover installation for fuel removal at Unit 4 will be excluded considering that no significant change has been found in the past 9 months. (For the measurement performed this time, a total of 5 measurement points on the south wall on the first and the second floor were excluded.)

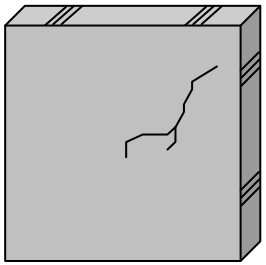


Cover being constructed for fuel removal at Unit 4

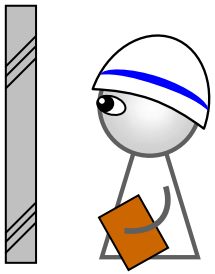
2. Results (3) Visual Inspection (Plan, Criteria)

Visual inspection*1 was done on the concrete floor and walls. In the case that a crack of a width of 1mm or more is found, repair must be done as appropriate. No crack of a width of 1mm or more was found in the first inspection (May 2012), the detailed inspection of outer walls (June 2012) and the second and third inspections (August and November 2012).

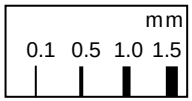
*1 The visual inspection was done while avoiding interference with the cover installation work for fuel removal.



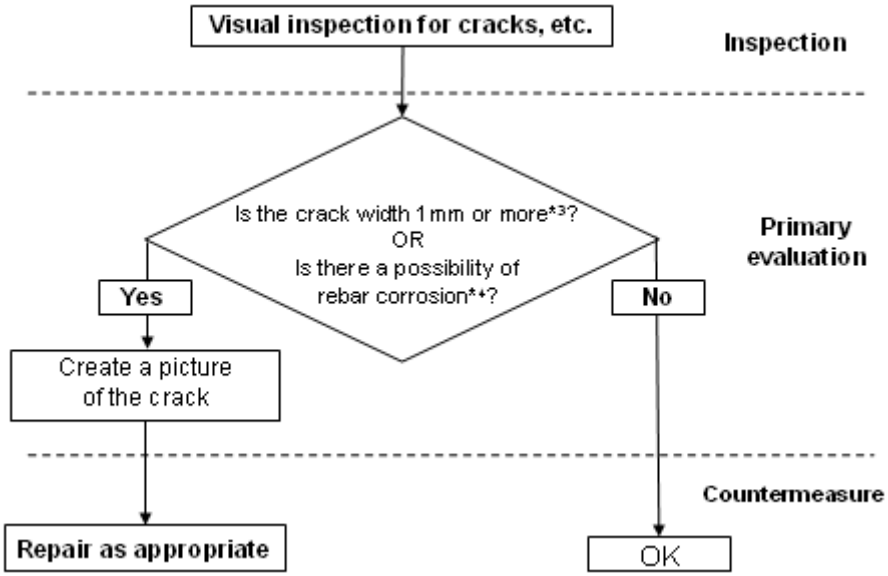
Check for cracks on the walls and the floor



Visual inspection



Crack scale*2



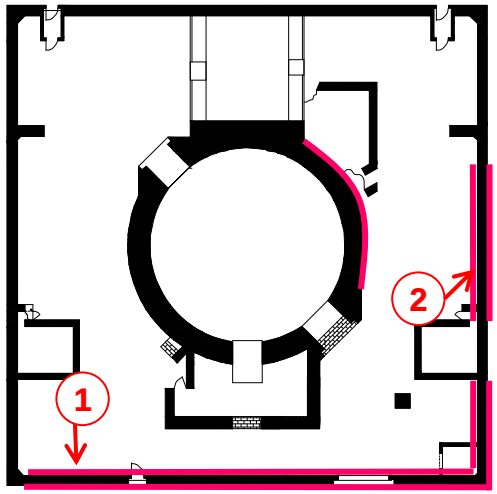
Flow of Visual Inspection

*2 Crack scale: Used to measure the width of a crack. (The scale is placed on a crack to measure its width.)
*3 In the case that the crack width is 1mm or more, the durability of the building must be reviewed in accordance with the "Maintenance and Management of Structures in Nuclear Facilities" specified by the Architectural Institute of Japan.
*4 In the case that rebar corrosion which may affect the building durability is found on the inspected area.

2. Results (3) Visual Inspection (Results)

Since no crack of a width of 1mm or more or with possible rebar corrosion was found as a result of visual inspection (similarly to the past results), it has been concluded that there is no hazardous deterioration of structural durability.

[Legend] : Inspected areas



First floor

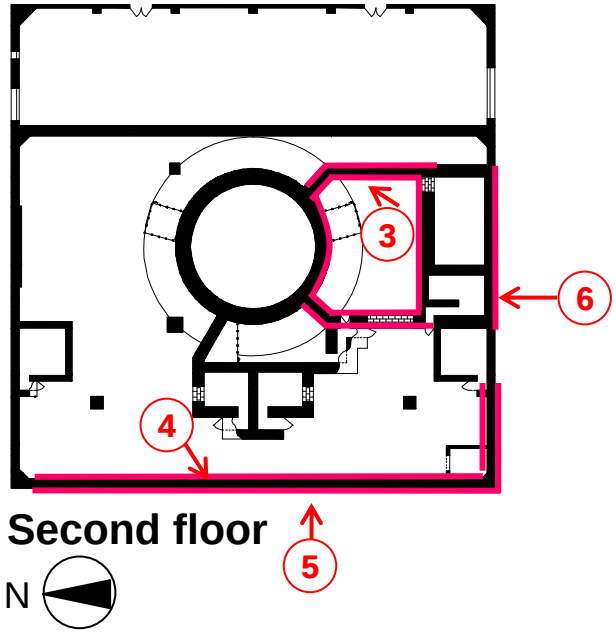
N

① West wall

② South wall

2. Results (3) Visual Inspection (Results)

[Legend] : Inspected areas



③ SFP side wall

④ West wall (Inner wall)

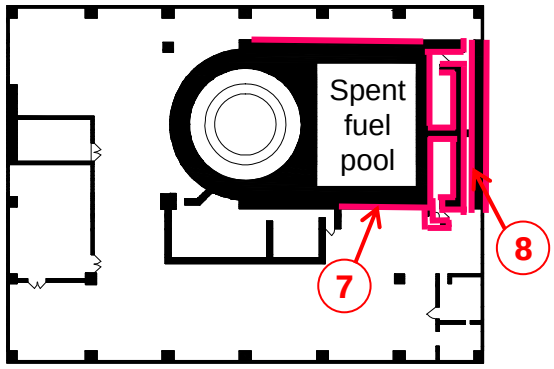
⑤ West wall (Outer wall)

⑥ South wall (Outer wall)

*SFP: Spent fuel pool

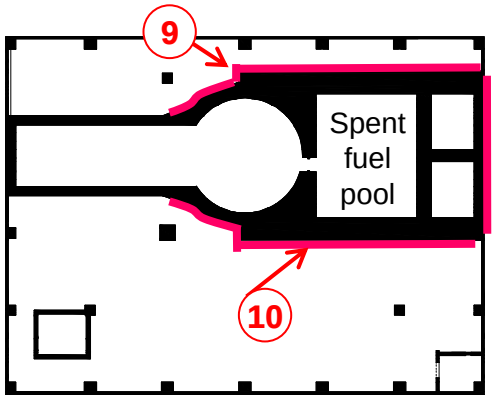
2. Results (3) Visual Inspection (Results)

[Legend] : Inspected areas



Third floor

N



Fourth floor

N

⑦ SFP side wall (East side)

⑧ SFP side wall (South side)

⑨ SFP side wall (East side)

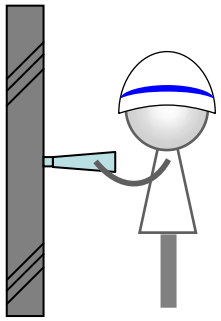
⑩ SFP side wall (West side)

*SFP: Spent fuel pool

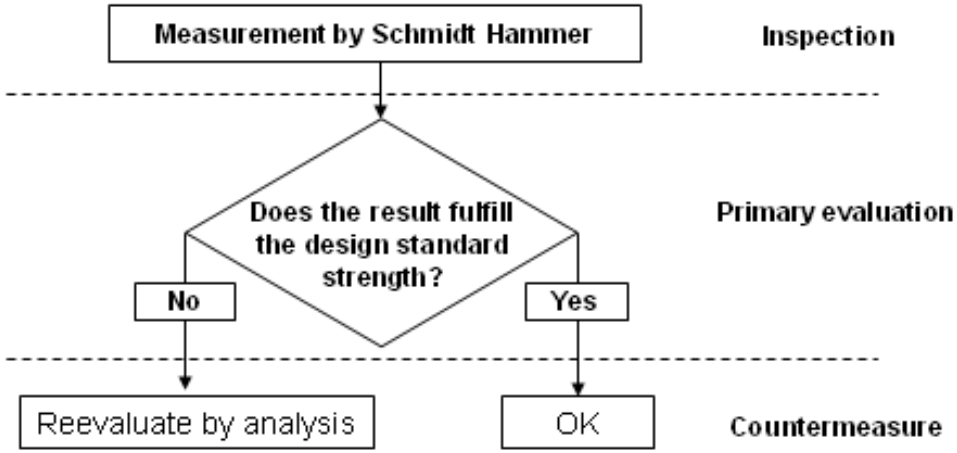
2. Results (4) Concrete Strength Evaluation (Plan, Criteria)

The concrete strength of the spent fuel pool frame was evaluated*1 by non-destructive inspection technique (Schmidt Hammer*2) to confirm that the strength fulfills the design standard. The concrete strength fulfilled the design standard in the first inspection (May 2012), the detailed inspection of the outer walls (June 2012) and the second and third inspections (August and November 2012).

*1 The evaluation was done while avoiding interference with the cover installation work for fuel removal.



Non-destructive inspection
(Schmidt Hammer*2)

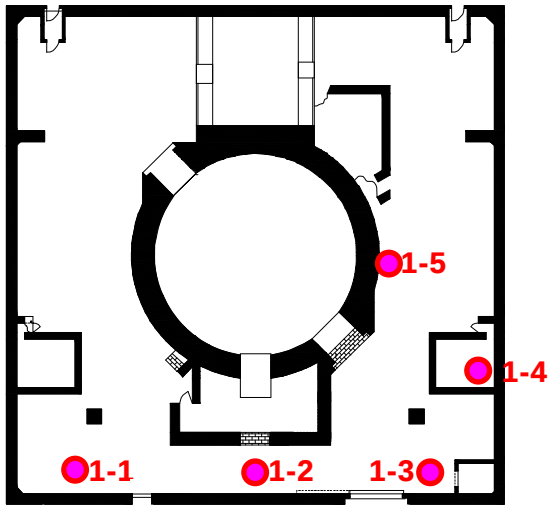


Flow of Non-destructive Inspection

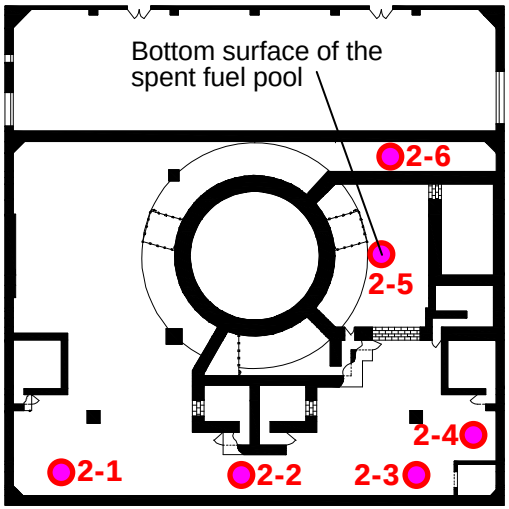
*2 Schmidt Hammer Technique: A non-destructive inspection technique to estimate concrete strength by hammering the concrete and measuring the impact returned.

2. Results (4) Concrete Strength Evaluation (Measurement Points)

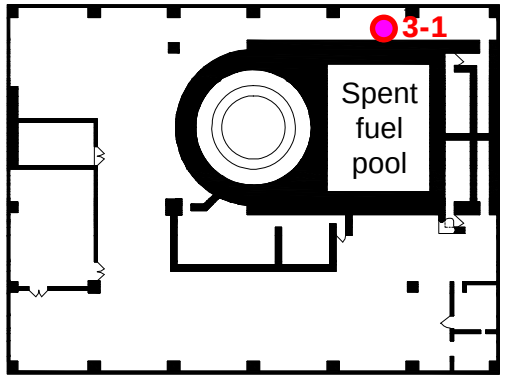
The concrete strength measurement points*1 are indicated below.



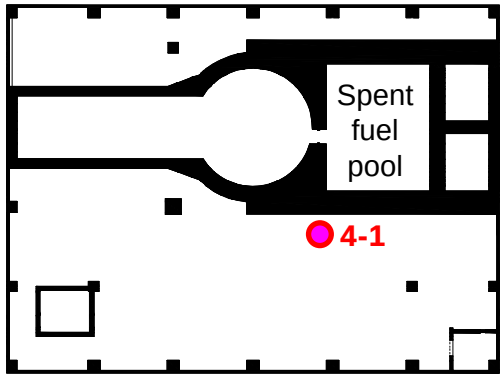
First floor



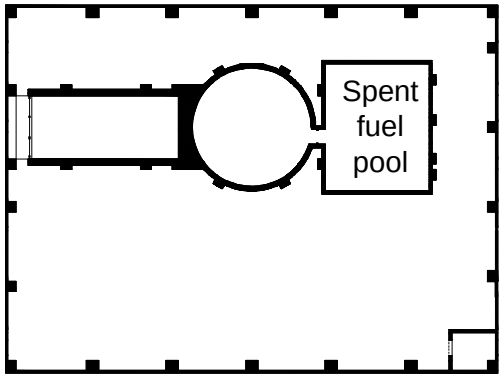
Second floor



Third floor



Fourth floor



Fifth floor

[Legend] ●: Measurement points

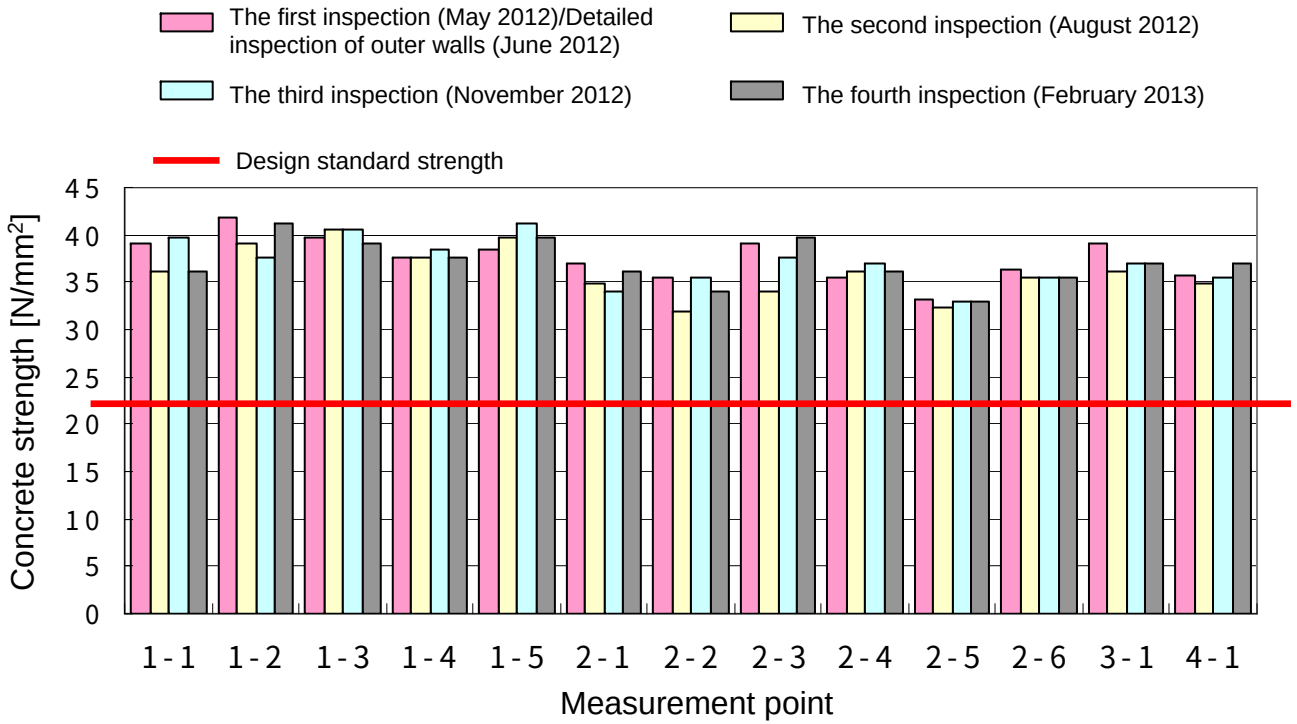
*1 The measurement points were set at slightly different locations from the previous measurement points.

2. Results (4) Concrete Strength Evaluation (Result)

As a result of measurement, the concrete strengths on all the measurement points were above the design standard (22.1N/mm^2) similarly to the past results. The concrete strength is considered to be about the same as the past results taking into considerations the error of Schmidt Hammer*1 and that the measurement points were set at slightly different locations from the previous ones.

*1 Error of approx. 3N/mm^2 is assumed for the experimental value and the strength criterion formula according to the "Guidelines for evaluation of concrete compressive strength by Schmidt Hammer" (August 1958, Material Testing Research Association of Japan).

Concrete strength evaluation results



Summary

- As a result of the fourth inspection, it has been concluded that the building is not tilted and a sufficient concrete strength is maintained with no cracks that would affect the structural strength of the building.
- The condition of Unit 4 Reactor Building has not changed much since the first, second and third inspections and is capable of safely storing the spent fuel pool.
- The inspection will be conducted on a regular basis in order to check for changes over time.
- Part of the visual inspection and concrete strength evaluation was performed with an outside expert. The past inspection results including the seismic capacity analysis results were also reviewed by the expert.

Outside expert observing the inspection

Outside expert (on the left)

Outside expert (on the left)

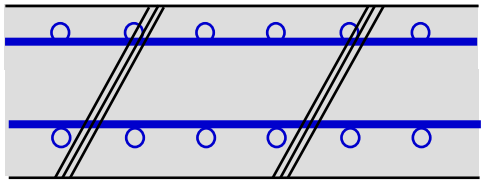
(Reference) Corrosion prevention measures implemented at Unit 4 Reactor Building

Since the concrete surface of the posts and beams in Unit 4 Reactor Building came off and rebar is partially visible due to the hydrogen explosion, corrosion prevention measure (spraying mortar onto the exposed parts) will be implemented for the purpose of ensuring the durability of the members starting from around March 2013.

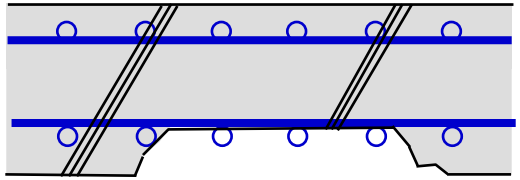
Corrosion prevention measure

(Legend) : Rebar : Concrete : Area mortar is sprayed

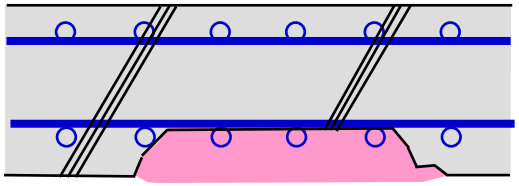
1. Before the earthquake



2. Rebar being exposed (Current)



3. After spraying mortar



Trial measure implementation

Trial implementation was done at the site to confirm if mortar spraying can be applied.

Date: November 24, 2012

Location: Post on the fourth floor

Photo 1: Before trial implementation

Photo 2: After trial implementation