Soundness Verification Results of Unit 4 Reactor Building at Fukushima Daiichi Nuclear Power Station

May 25, 2012

Tokyo Electric Power Company

TEPCO 東京電力

Inspection Overview

Inspection Period

May 17-23, 2012

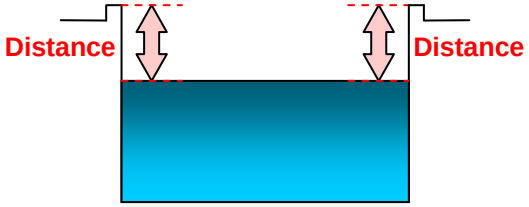
Inspection Points

1. Building tilt measurement (Water level)
2. Building tilt measurement (Exterior wall)
3. Visual inspection
4. Concrete strength verification

1. Building Tilt (Water Level Measurement)

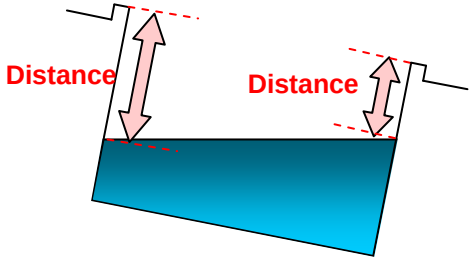
The distances between the floor surface and the water levels of the reactor well and spent fuel pool are measured to check if the building is tilted or not. (It has already been confirmed that the building is not tilted based on the measurement results acquired on February 7, 2012 and April 12, 2012.)

1) Building not tilted

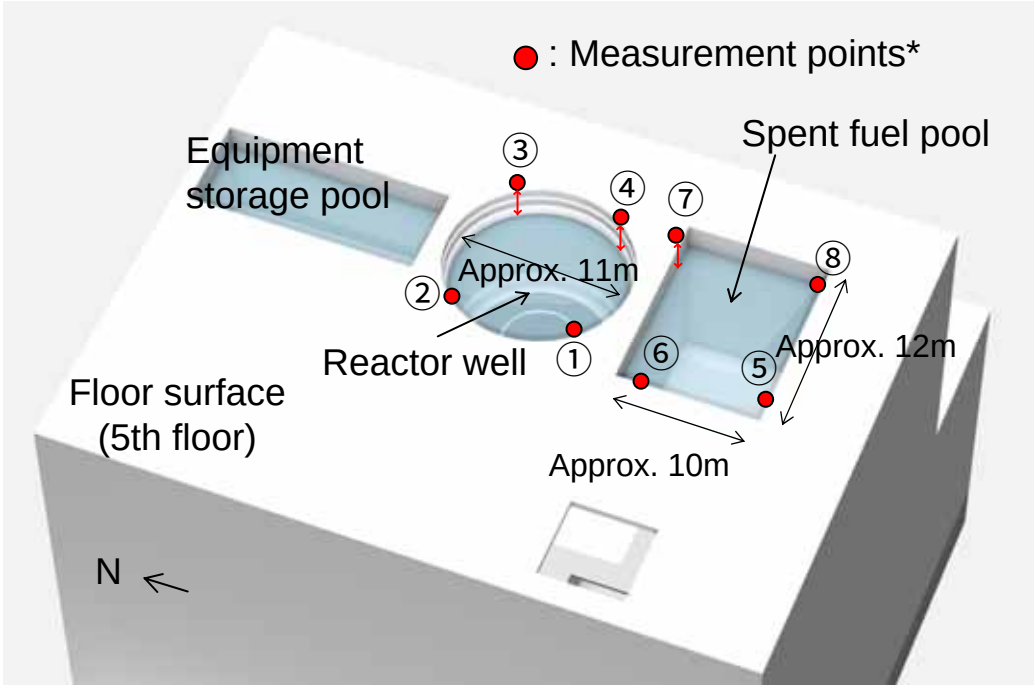


The distances are the same

2) Building tilted



Difference in the distances

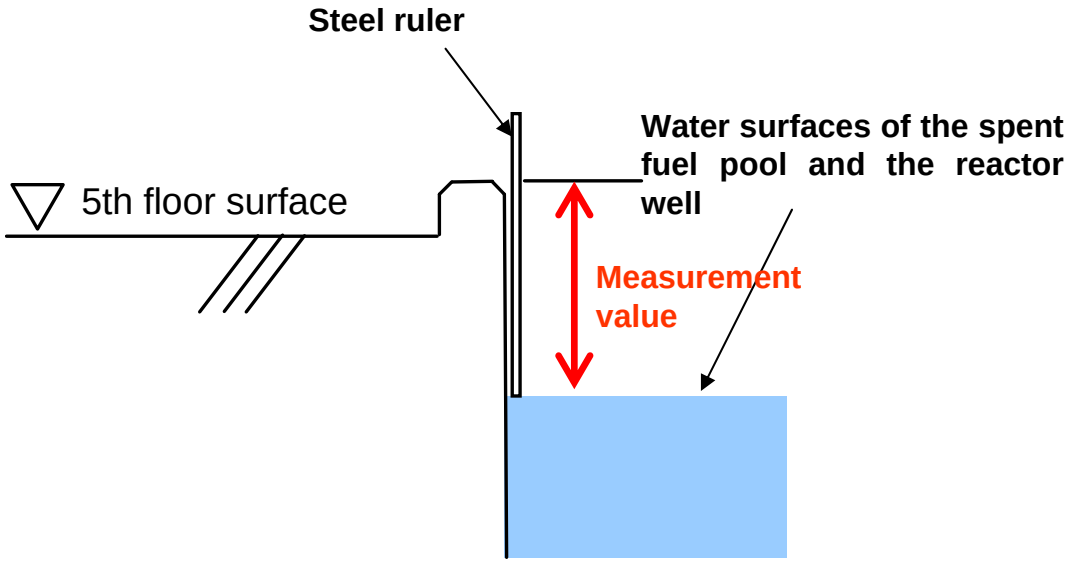


Measurement Points (Floor surface of the 5th floor)

* The measurement points are set according to the progress statuses of debris removal and cover installation for fuel removal.

1. Building Tilt (Water Level Measurement)

As the measurement values on the four corners are about the same, it can be concluded that the 5th floor surface and the water levels of the spent fuel pool and the reactor well are parallel. (It has already been confirmed that the building is not tilted based on the measurement results acquired on February 7, 2012 and April 12, 2012.)



Measurement Method

* Error must be taken into account as the Measurement is done visually by a person

Measurement Result

Unit [mm]

Reactor well	Measurement Date		
	Feb 7, 2012	Apr 12, 2012	May 18, 2012
①	462	476	492
②	463	475	492
③	462	475	492
④	464	475	492

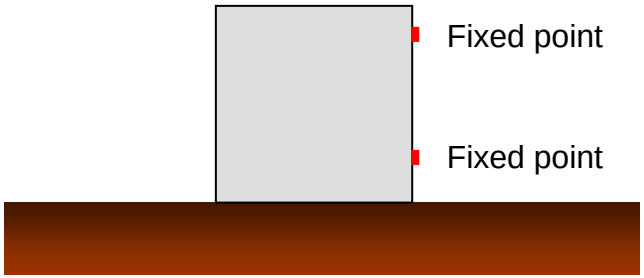
Spent fuel pool	Measurement Date		
	Feb 7, 2012	Apr 12, 2012	May 18, 2012
⑤	–	468	461
⑥	–	468	461
⑦	–	468	461
⑧	–	468	461

* On February 7, 2012, measurement was done only on the reactor well.
* Water levels are subject to change daily depending on the operation statuses.

2. Building Tilt (Outer Wall Measurement)

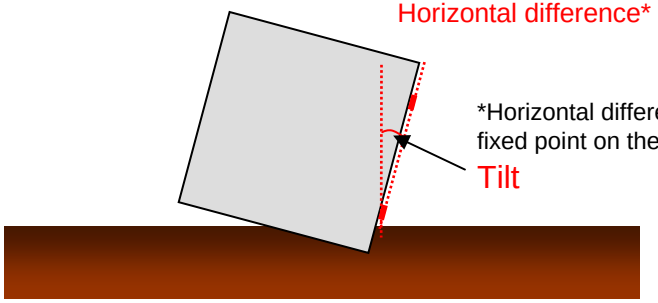
The exterior wall perpendicularity was measured by using an optical equipment (fixed points set on the upper and lower side of the wall).

1) Building not tilted



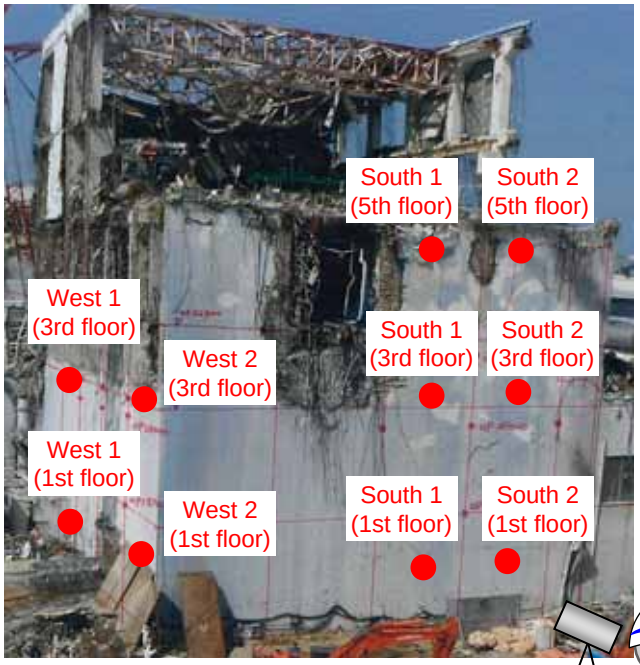
No tilt

2) Building tilted



Tilted

*Horizontal difference: The horizontal difference between the fixed point on the first floor and the fixed point on the upper floor



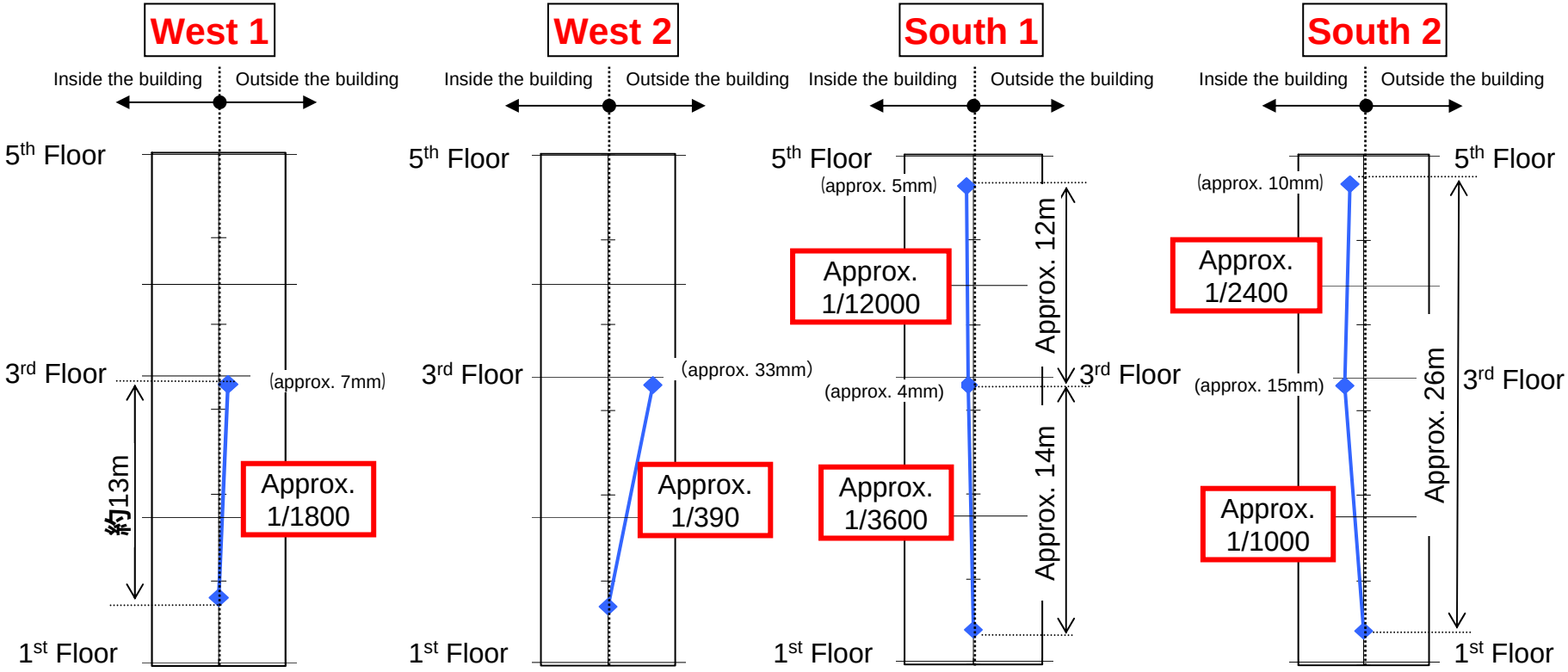
Measurement

* Measurement points were set on the locations near the spent fuel pool (South 1 & 2), the central part of the west surface (West 1) and a location near the vaulted floor which is assumed to have been largely effected by explosion (West 2).

2. Building Tilt (Outer Wall Measurement)

The results of the exterior wall perpendicularity were all below the limits given in the Building Standard Act*. It can be concluded that the building itself is not tilted and the structure safety is secured.

*According to the Building Standard Act, 1/200 is the set limit for the tilt of the building in the allowable stress calculation.



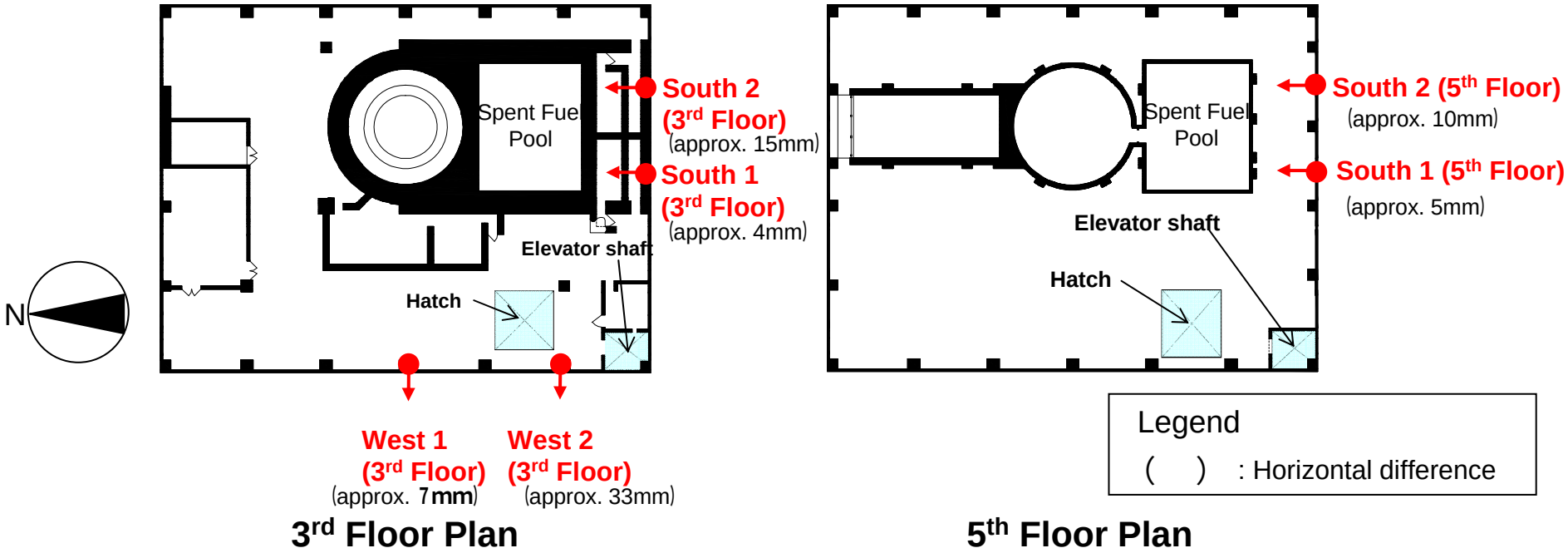
Measurement results of the outer walls

-The scales of the pictures above are incorrect. The width is 80 times largely emphasized than the height.
-JASS5N (the Building Standard Act) sets the acceptable value of the construction error for reinforced concrete structure as ±20mm.

2. Building Tilt (Outer Wall Measurement)

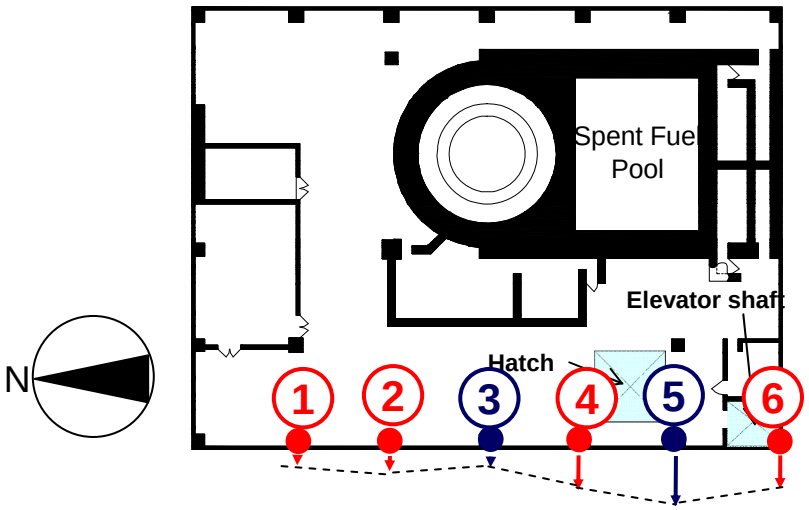
The point West 2 is presumed to have partially expanded due to the weak force constraints because of the existence of the vaulted floors for hatches and elevator shafts near the point.

⇒Should the existence of the wall neglected, the weight that comes from the earthquake load is little as 10%, compared to the overall weight of the building. The effects that the whole building and the spent fuel pool get from this deformation are little, since they are both separated from the walls. We will further continue analyzing in order to evaluate quantitively the effects of the partial deformation.



2. Building Tilt (Outer Wall Measurement)

We measured a few points near the measurement point on the west wall where partial deformation was confirmed, to confirm the deformation tendency, on May 25.



3rd Floor Plan

Measurement results

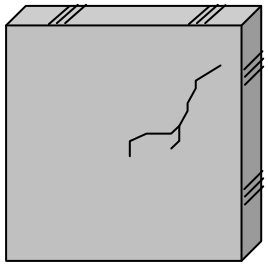
Measurement point	Horizontal difference
1	6mm
2	10mm
3 West 1 (3rd Floor)	7mm
4	23mm
5 West 2 (3rd Floor)	33mm
6	22mm

Red: additional point Blue: past measured point

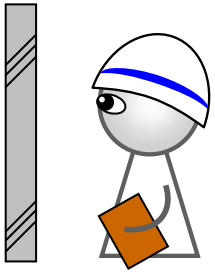
⇒The expansion of the west exterior wall was confirmed as a partial deformation.

3. Visual Inspection

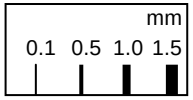
We inspected the defects such as cracks on the concrete floor and walls of the spent fuel pool (building frame) .



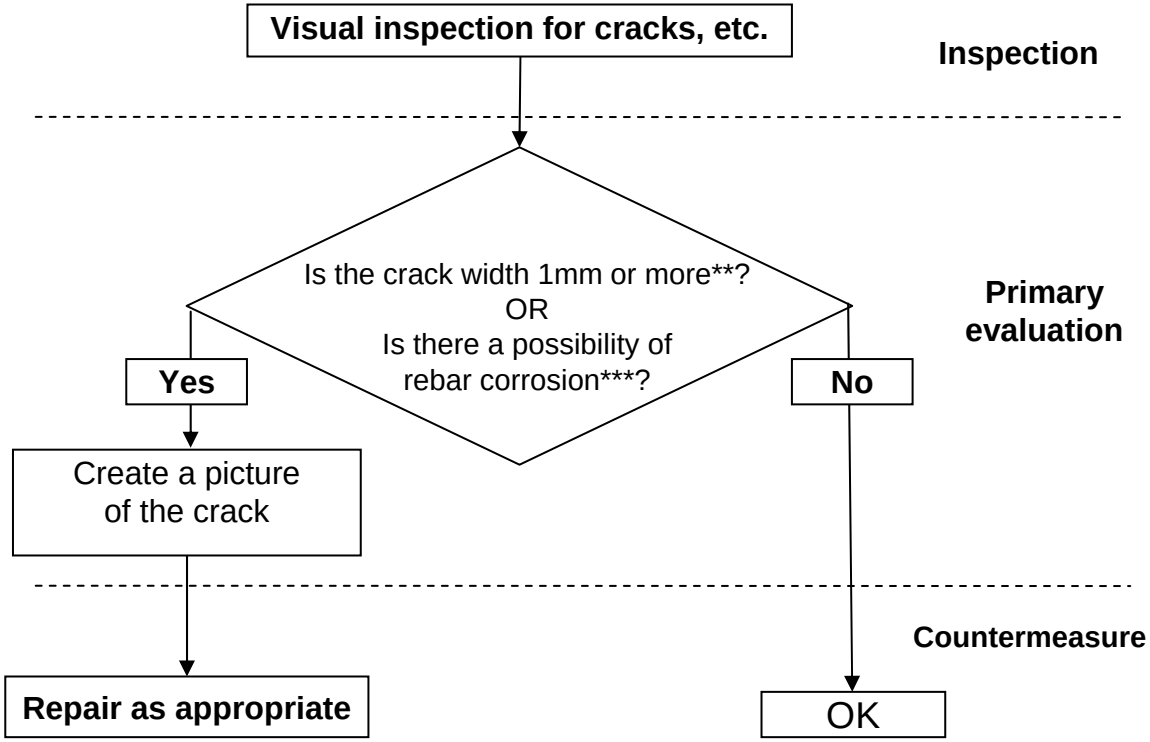
Check for cracks on the walls and the floor



Visual inspection



Crack scale* (Sample)

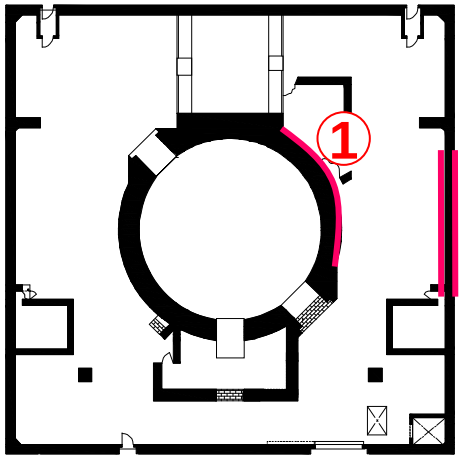


Flow of Visual Inspection

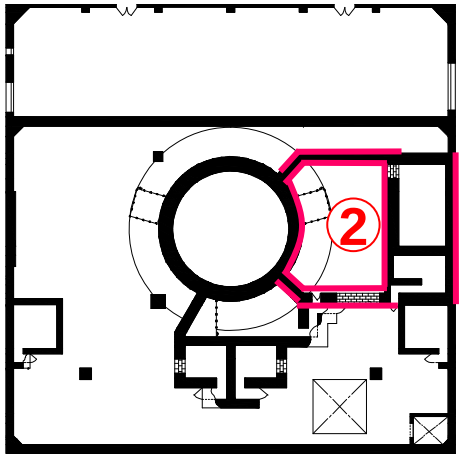
* Crack scale: Used to measure the width of a crack. (Put the scale on a crack to measure its width.)
** In the case that the crack width is 1mm or more, the durability of the building must be reviewed in accordance with "Maintenance and Management of Structures in Nuclear Facilities" specified by the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

3. Visual Inspection

As a result of visual inspection, cracks of which the width exceed 1mm or which have the possibility of rebar corrosion were not confirmed.



1st Floor Plan



2nd Floor Plan

Legend

Visual inspection

① 1st Floor

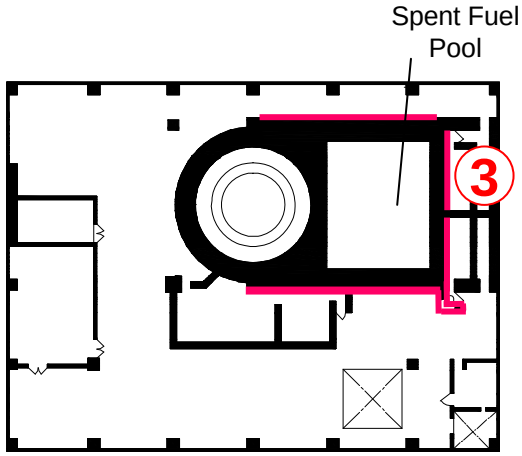
The wall that supports the spent fuel pool

② 2nd Floor

The wall that supports the spent fuel pool

東京電力 TEPCO

3. Visual Inspection

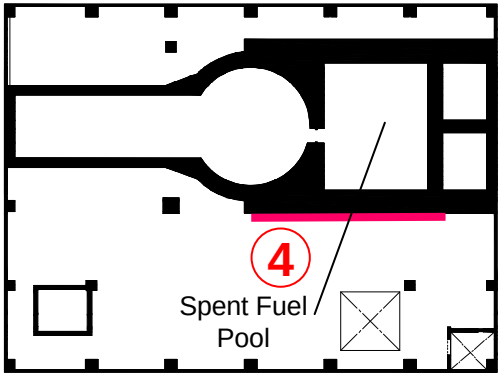


3rd Floor Plan

3

3rd Floor

The spent fuel pool wall



4th Floor Plan

Legend

Visual inspection

4

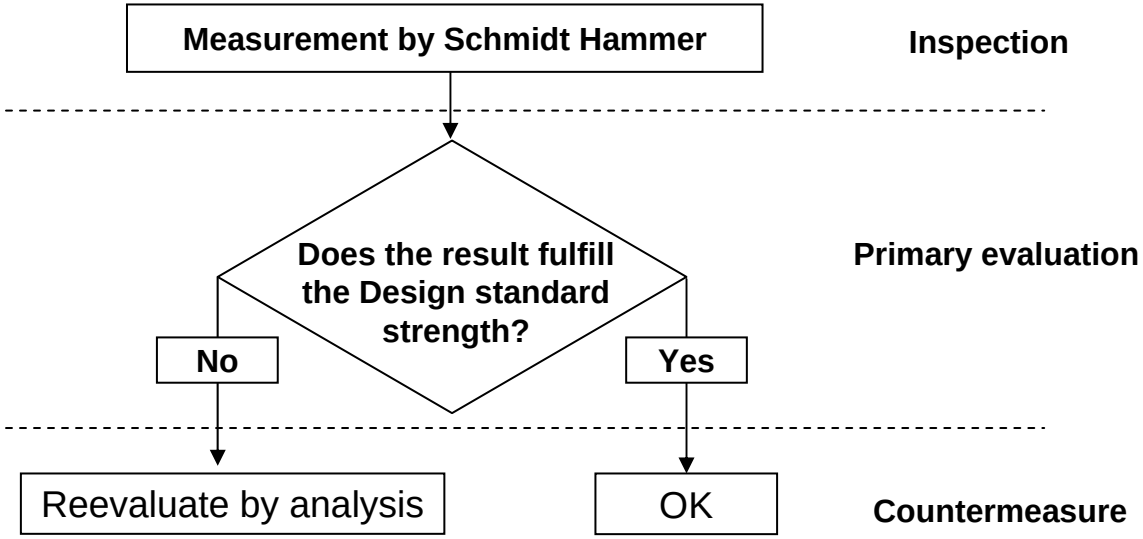
4th Floor

The spent fuel pool wall

4. Concrete Strength Verification

The concrete strength of the spent fuel pool was measured by non-destructive inspection techniques (Schmidt Hammer*) to confirm that the strength fulfills the design standard.

non-destructive inspection (Schmidt Hammer*)

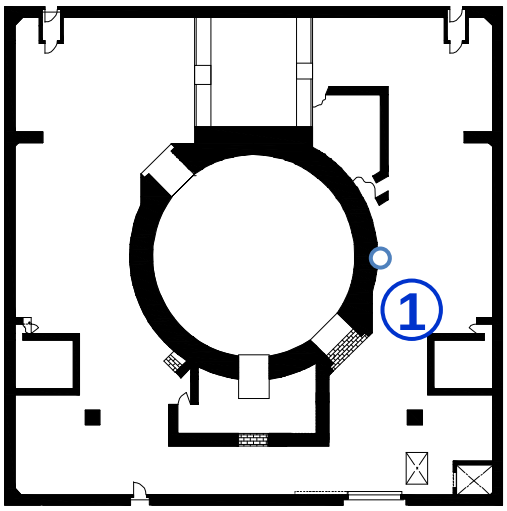


Flow of Non-destructive Inspection

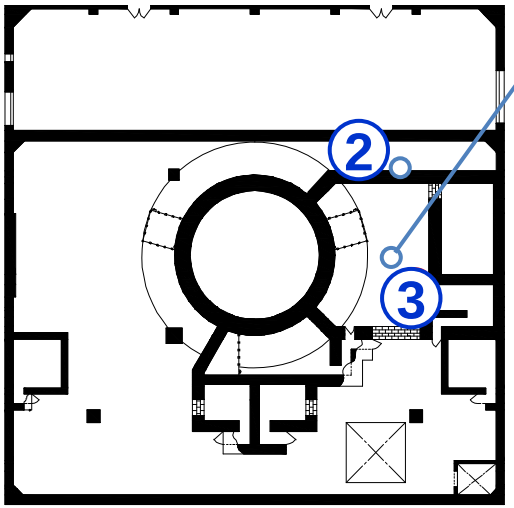
* Schmidt Hammer Technique: A non-destructive inspection technique to estimate concrete strength by hammering the concrete and measuring the impact returned.

4. Concrete Strength Verification: Areas Subject to Verification

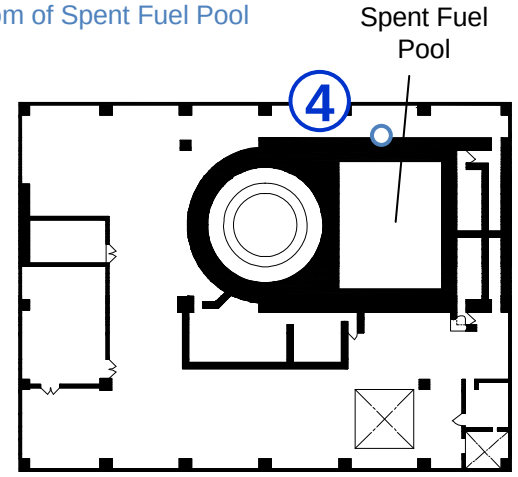
➢The concrete strength verification points are shown below.



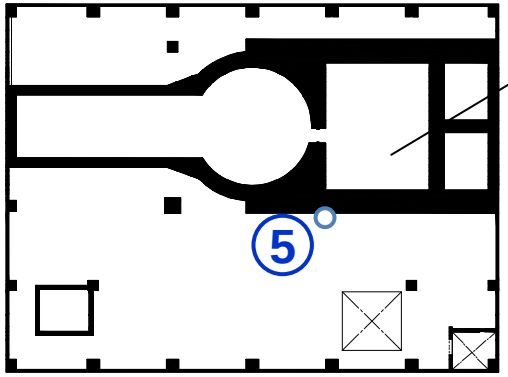
1st Floor



2nd Floor



3rd Floor



4th Floor

Legend

- The concrete strength verification points

4. Concrete Strength Verification

➢At all points, we confirmed enough structural strength since the concrete strength was above the design standard（22.1N/mm2）.

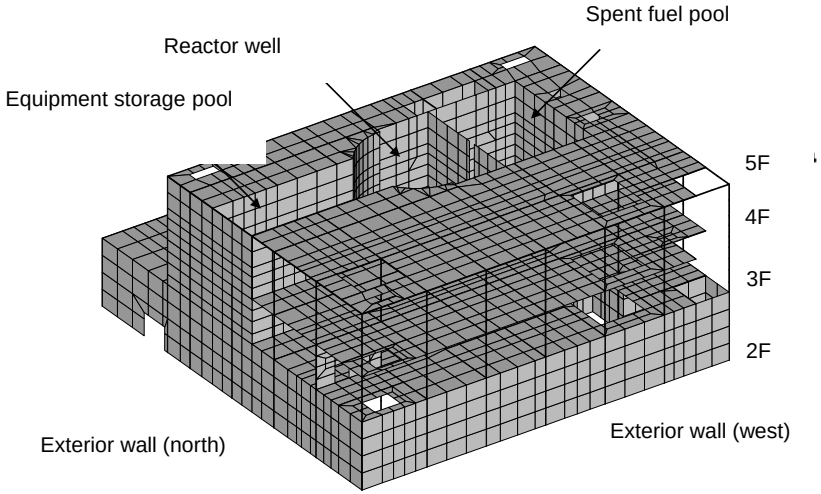
Results of Concrete Strength Verification

No.	Verification Points	Concrete Strength※ (N/mm^2)
①	1st Floor Reactor Shell Wall （Walls that supports spent fuel pools）	38.4
②	2nd Floor Wall （ Walls that supports spent fuel pools ）	36.3
③	2nd Spent Fuel Pool (Bottom)	33.1
④	3rd Floor Spent Fuel Pool Wall	39.1
⑤	4th Floor Spent Fuel Pool Wall	35.6

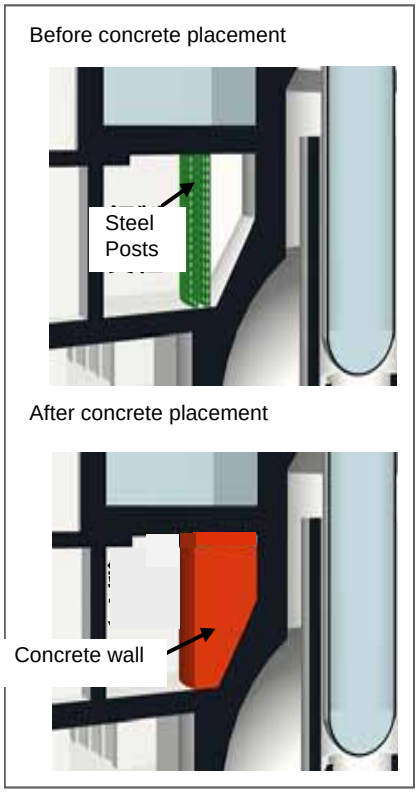
※Concrete strength was assumed by using Shumitt Hammer

Summary 1

- We have confirmed that the spent fuel pool is safe even if it faces an earthquake of the same level of Tohoku-Chihou-Taiheiyou-Oki Earthquake by an analysis which took into account of the damages by the explosion, etc.
- Furthermore, we reinforced the bottom of the spent fuel pool and improved more than 20% of its seismic margin.



Analysis Model that took into account of damages of the walls (FEM)

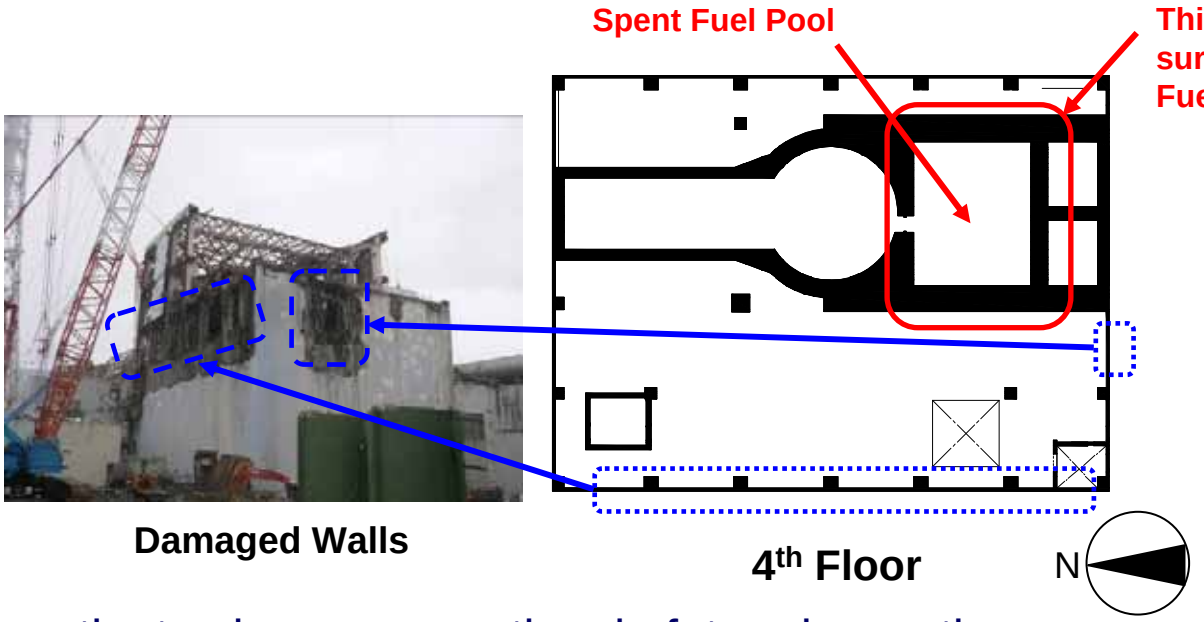


Reinforcement of the bottom of the spent fuel pool

Summary 2

- According to the investigation this time, we confirmed that the spent fuel pool can safely hold spent fuels since the strength of the concrete walls is maintained, there was no cracks or slants, the thickness of the important walls of the spent fuel pool is 140cm～185cm, even though some parts of upper layer of the exterior walls are damaged.

- Additionally, we confirmed that the building is not tilted from the measurements this time, even though it looks like being tilted depending on the viewpoint of pictures.



⇒We will investigate changes over time in future inspections.

Attachment: Shear Deformation

Even if the building tilt measurement (Water level) result had proven that the water surface of the spent fuel pool and the 5th floor are parallel, still there was a probability of shear deformation, where the building might be deformed in a parallelogram shape, but this has been proved not to be happening for the following reasons.

-The exterior walls have been proved not to be tilted by measurements.
-Noticeable shear cracks were not confirmed at places such as walls of the spent fuel pool by visual inspections.