Post-quake status of the Kashiwazaki-Kariwa Nuclear Power Station (Report #11)
- Update on the status of inspection and restoration work through to November 8 -

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Japan Nuclear Technology Institute

The Report #11 follows on from Report #10 in summarizing the post-quake status of the Kashiwazaki-Kariwa Nuclear Power Station and giving the overview of the initiatives, trends and other details involving Tokyo Electric Power Company (TEPCO) and other relevant organizations

1. Earthquake response evaluation of reactor buildings

TEPCO briefed on the earthquake response evaluation of the power station's reactor buildings at the 6th meeting of the Structural Working Group under the Anti-Quake Structural Design Subcommittee, Nuclear Safety Committee, METI Advisory Committee for Natural Resources and Energy, convened on October 23.

This assessment used seismic observation records to simulate the earthquake response of the reactor buildings for analysis, and calculated their maximum response shear strain accordingly, to compare the figure against the benchmark figure for the development of shear cracks (Allowable Stress Design, Architectural Institute of Japan Standards for Structural Calculation of Steel Reinforced Concrete Structures and Brief Commentary, 1999).

(1) Simulation reproducing the earthquake response of reactor buildings

When the following conditions are taken into account, the simulation of reactor buildings' earthquake response produced results that match the seismic observation records relatively well.

i. Young's modulus for concrete
ii. Wall setting for rigidity evaluation (Wall that meets the criteria stipulated in Article 19 of the AIJ Standards for structural Calculation of Steel Reinforced Concrete Structures and Brief Commentary [Allowable Stress Design], 1999)
iii. Ground foundation around the reactor buildings

(2) Maximum response shear strain of the reactor buildings

The conditions of the simulation were applied to calculate the maximum response shear strain of the reactor buildings, and the results for all the reactor buildings were below the benchmark figure for the development of shear cracks, indicating that the structures fell within the designed scope of resilience. WG members did not present any major arguments that deny the finding.

(3) Summary of TEPCO's assessment results and immediate initiatives

i. The analysis that took actual earthquake conditions into account was able to reproduce the seismic observation records relatively well. (Figures 1 and 2 show the example of Unit 2, which suffered seismic motions that exceeded the level assumed at the time of plant designing most drastically.)
ii. The maximum response shear strain, obtained in the analysis, indicates that the reactor buildings fall within the designed scope of resilience. (Figure 3 shows the example of Unit 2.)
iii. The results are to be compared against the outcome of crack checks and other inspections currently underway to confirm the buildings' integrity.

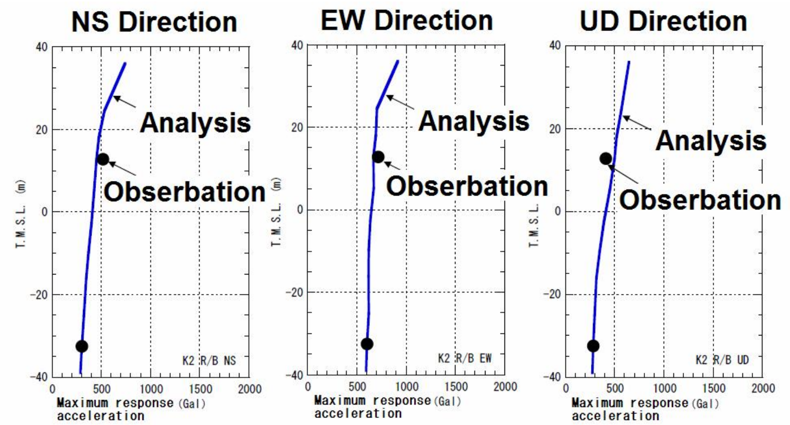


Fig. 1 Maximum response Acceleration (Unit 2)
Source: Courtesy of the TEPCO

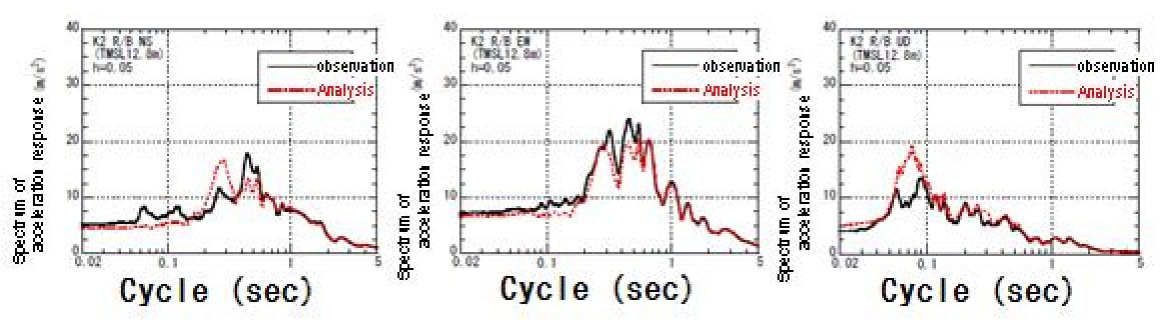


Fig. 2 Comparison of floor response spectrum (on a mid floor) (Unit 2)

Source: Courtesy of the TEPCO

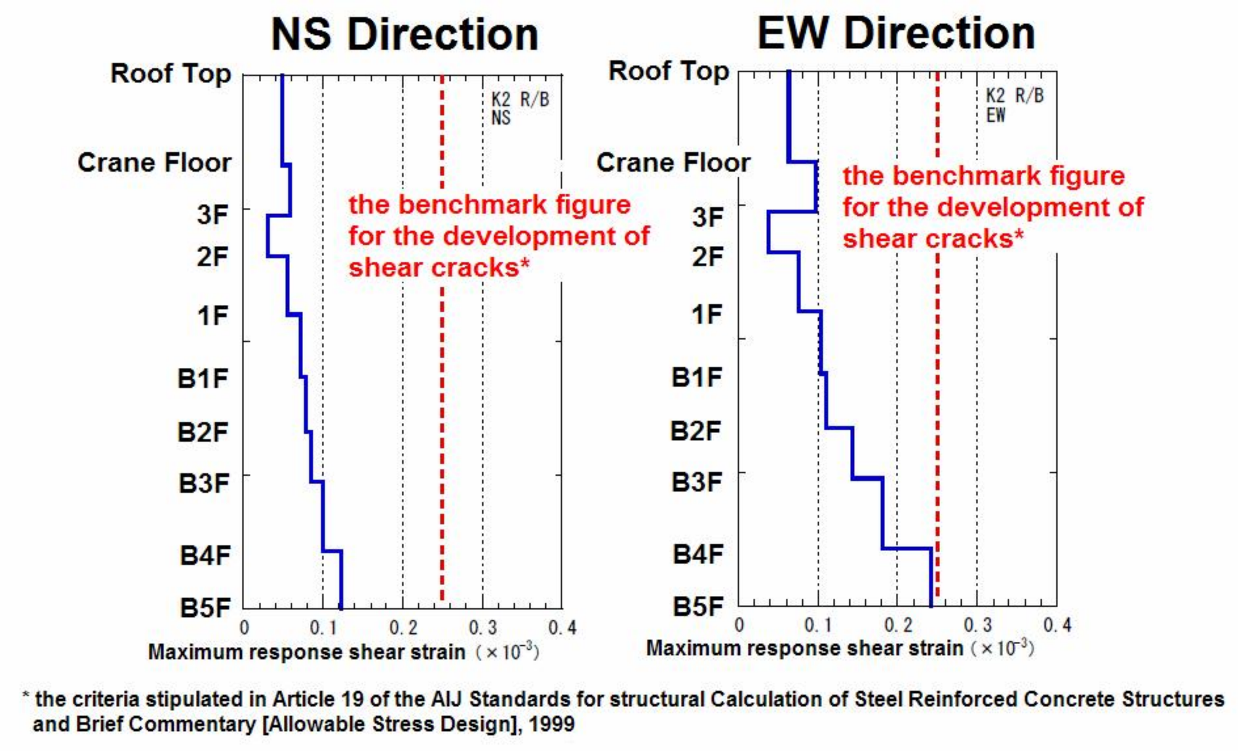


Fig. 3 Maximum response shear strain of the reactor building (Unit 2)

Source: Courtesy of the TEPCO

2.Status of main inspection and restoration work

Detailed inspection and restoration work on equipment, etc. is systematically being carried out at the Kashiwazaki-Kariwa Nuclear Power Station at present. TEPCO releases inspection findings as they become available. See the attachment for a list of performed and planned inspection / restoration work.

According to the reference materials released by TEPCO thus far, no serious plant damage has been identified in the course of the inspection / restoration work. The following describes the results of some of the inspections that have caught the attention of JANTI:

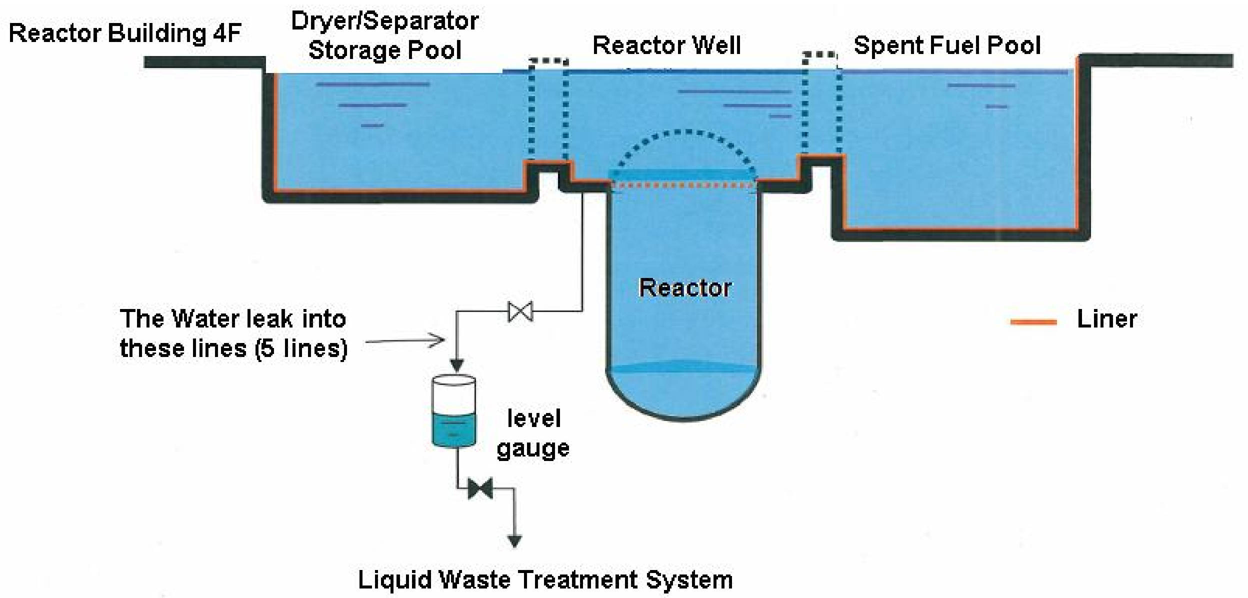
(1)-1 Water leakage at Unit 7

TEPCO completed filling the Unit 7 reactor with water on October 8, 2007. Although some seepage has subsequently been identified as described below, the amount of water involved is minute with no radiation effects to the outside environment.

a. Detection of drain water from the reactor well liners

TEPCO found some water inside a level gauge connected to the well liner, and conducted trend monitoring as well as analysis of the water itself, to detect a minute amount of radioactive material (antimony 124).

It is believed that some of the water used for filling the upper reactor flowed into the level gauge via the liner. (See the diagram below.)



Layout of leakage detected system for unit 7 reactor well

Source: Courtesy of the TEPCO

This leakage did not cause any radioactive impact on the external environment.

The liner is currently being inspected, with minor damage that could lead to leakage identified in two locations. The damaged sections are to be temporarily repaired before an in-core inspection is conducted.

b. Water leakage in radiologically controlled areas on the 2nd floor of the reactor building

TEPCO identified water seepage from minor wall cracks and puddles of water on the floor in radiologically controlled areas on the 2nd floor of the reactor building. Analysis of the leaked water detected a minute amount of radioactive materials (cobalt-60 and cesium-137).

The amount of water leaked totaled 6.5 liters containing radioactivity of 250Bq, which is equivalent to radioactivity found in around 30cc of radon spa water.

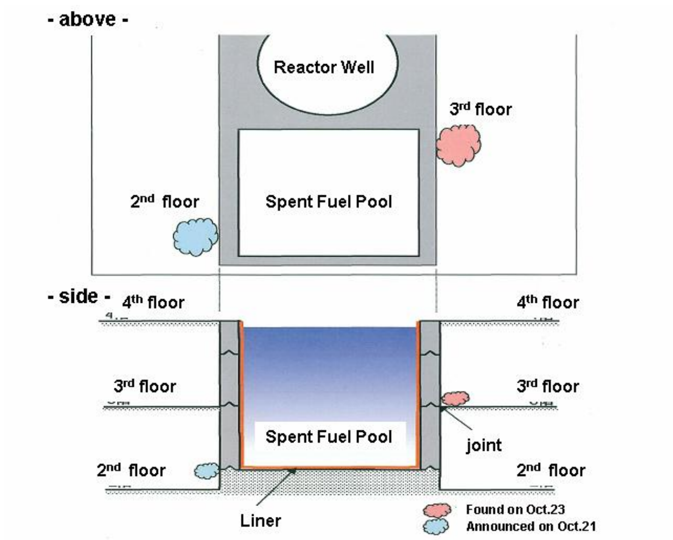
The leakage stayed within the radiologically controlled area, thereby posing no radiation impact on the external environment.

Since the amount of leakage drops when the water level of the reactor well goes down, TEPCO suspects that the leakage came from the well. An investigation on the well will be conducted in the future (See the attachment for a schedule of Well Inspection of Unit 7) to identify the location of the leakage. (See the diagrams on the below.)

c. Water seepage at a concrete joint on the north side of the reactor building's 3rd floor

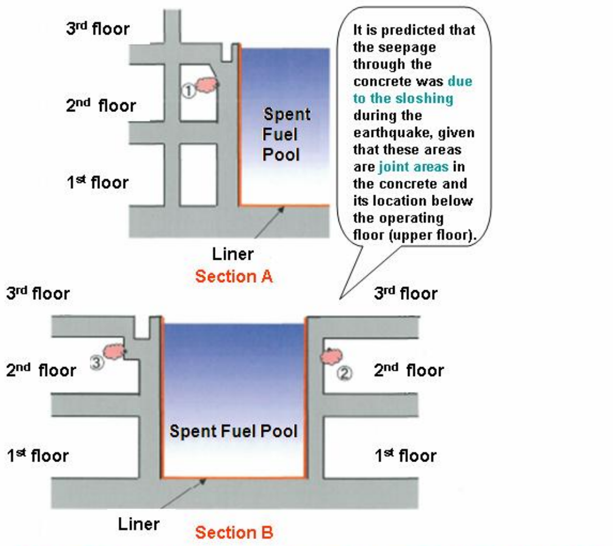
TEPCO also identified minute water seepage at a concrete joint on the north side of the reactor building's 3rd floor. Analysis of the water detected a minute amount of radioactive material (cobalt-60). The amount of water leaked totaled 200cc containing radioactivity of 0.8Bq, which is equivalent to radioactivity found in around 0.1cc of radon spa water. (See the diagram on the right.)

The leakage was contained within the radiologically controlled area, thereby posing no radiation impact on the external environment.



Water leak point at the Unit 7 reactor building

Source: Courtesy of the TEPCO



Seepage point at the Unit 1 reactor building

(1)-2 Status of large tanks containing radioactive materials such as spent fuel pools

As part of the investigation into drain water from the reactor well liners at Unit 7, TEPCO have checked the status of large tanks containing radioactive materials, such as spent fuel pools, at all Units. (See the attachment for a list of confirmed statuses [Source: TEPCO press release]). As of now, the investigation has found no significant water leakage suggesting leakage from a reactor well liner in Units other than Unit 7.

At Unit 1, minor water seepage, suspected to be attributable to sloshing and resulting infiltration of overflowed water (See Report #4), was found on the concrete wall of the spent fuel pool at the lower part of the reactor operating floor. A minute amount of radioactive material was detected in the water, and TEPCO plans to continue monitoring the site. (See the diagram on the above. Source: Courtesy of the TEPCO)

(2)Control rod removal trouble at Unit 7

After the removal of fuel assemblies that started on October 11, Unit 7 was having its control rods pulled out and encountered trouble in doing so with one of the control rods.

This did not cause safety issues because all the adjacent fuel assemblies had already been removed, and also because the control rod was held in a stable state with support fittings.

The applicable control rod has since been pulled out according to the procedure pre-defined for anticipated problems*. In the overhaul of the control rod drive unit, conducted over seven days from November 3, detailed inspections and assessment were carried out on the labyrinth seal and latch mechanism, but did not find any attributable cause.

While the investigation is still in progress, since another scram attempt successfully removed the control rod, it is suspected that a temporary increase of frictional resistance in the CRD played a part. Although the investigation indicates that the event was a temporary issue, TEPCO plans to inspect reactor-side equipment (control rods, fuel support, fuel guide) to be safe.

The inspection schedule is as shown in the attachment (Source: TEPCO press release).

※Pre-defined procedure

The applicable control rod is designed to use “electrical drive” to conduct regular insertion / removal but use “hydraulic pressure” for emergency insertion (scram). A recovery procedure is pre-defined to address any failure that can be anticipated because of the CRD structure.

In this case, the applicable control rod received regular removal operation (electrical drive), before the CRD was applied with the hydraulic pressure similar to that used in a scram to conduct full control-rod insertion, and then a normal removal operation again.

(3)Status of turbine internal inspections

At all the plants, all turbine casings are to be opened for detailed inspection according to the schedule shown in the attachment (Source: TEPCO press release).

A turbine internal inspection was conducted from October 11 to October 25 at Unit 6, which was in the shutdown state at the time of the earthquake. This was the first turbine internal inspection conducted.

<Contact marks on the Unit 6 turbine>

Although the inspection found contact marks at several locations, they were all minor, and will be restored through applying maintenance work or replacing parts. More specifically:

- Minor contact marks, only recognizable as contact sheen, were found on the moving and static blades of both high-pressure and low-pressure turbines. These marks do not affect the turbines' functionality, but are to be put to a non-destructive test in a detailed inspection in the future.
- Cracks were found on the oil seal ring of the main turbine's thrust bearing. The part will be replaced.

- Contact marks were also present on bearing metal, gland gaskets, oil slingers and diaphragm nozzle gaskets, but they were all minor and do not affect their functionality. The parts will be either given maintenance work or replaced.

(4)Gradient changes at power station buildings (interim report)

The changes of building gradient have been identified as shown below, indicating no significant tilting that could deal a structural impact on the buildings. The extent of tilting is well under the subsidence limit (0.5~1.0×10-3rad(1/2,000~1/1,000): "Benchmark of the subsidence limit under constant load", Recommendations for Design of Building Foundations, revised in 2001 [Architectural Institute of Japan]).

However, since this earthquake struck geodetic control stations designated by the Geographical Survey Institute, the reactor buildings are tentatively defined as the fixed points, making it impossible to determine the absolute extent of land movements at this stage. This land survey was rated Level 4, and has the allowable margin of 6mm against 100m.

Unit	Building name	Maximum gradient change from (2) pre-earthquake to (1) post-earthquake	Maximum gradient change from (3) initial survey to (1) post-earthquake
		Gradient	Gradient
1	Reactor building	Approx. 1/19,000	1/14,000
	Turbine building	1/29,000	1/8,300
2	Reactor building	1/9,700	1/8,700
	Turbine building	1/11,000	1/8,300
3	Reactor building	1/32,000	1/13,000
	Turbine building	1/14,000	1/27,000
4	Reactor building	1/20,000	1/27,000
	Turbine building	1/7,400	1/7,000
5	Reactor building	1/12,000	1/9,200
	Turbine building	1/12,000	1/11,000
6	Reactor building	1/7,300	1/6,400
	Turbine building	1/14,000	1/14,000
	Control building	1/6,400	1/5,600
	Waste processing building	1/12,000	1/7,800
7	Reactor building	1/4,700	1/6,100
	Turbine building	1/8,400	1/7,800

(Source: Courtesy of the Tokyo Electric Power Company, Inc.)

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