Urgent Safety Measures in Japan after Great East Japan Earthquake

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1. Introduction

Due to tsunami triggered by the Great East Japan Earthquake, the operating and refueling reactor facilities at Fukushima Dai-ichi and Dai-ni Nuclear Power Plants caused a nuclear hazard. Given the fact, Japanese electric power companies voluntarily began to compile various urgent measures against tsunami.

And then the Nuclear and Industrial Safety Agency (NISA) ordered the licensees to put into practice the voluntarily compiled urgent safety measures, in order to ensure the effectiveness of the means for recovering cooling functions along with avoiding the release of radioactive substances to the possible minimum, even if a huge tsunami following a severe earthquake hits nuclear power plants.

The following describes the state and the effect of the urgent safety measures implemented for 44 reactors (under operation) and 1 reactor (under construction) in Japan and also describes the measures to be implemented by the licensees of reactor operation in the future.

2. Urgent safety measures

The direct cause of the expansion of accidents to nuclear hazards is that due to the loss of all AC power supply, all cooling functions were lost and nuclear reactors and relevant components could not be cooled down.

Therefore, we are taking measures to stably cool down reactor cores, etc. even at the loss of all AC power supply caused by the occurrence of an earthquake/tsunami equivalent to that hit Fukushima Dai-ichi Nuclear Power Plant.

When planning the measures, conservative (excessive) assumptions are set, to make sure all unclear points at that point are covered securely enough.

Specifically, it is assumed that a tsunami equivalent to that hit Fukushima Dai-ichi Nuclear Power Plant may hit other power plants, +9.5 m is added to the previous tsunami height assessment (up to 15 m), regardless of the existence of a plate boundary which can cause the same scale of tsunami as Fukushima Dai-ichi, in the surrounding ocean areas of each power plants.

In addition, measures are implemented to make it possible to prevent damage to nuclear cores and spent fuel, and release of radioactive materials, and recover the cooling functions of the nuclear reactor facilities even when the three functions (all AC power supply, seawater cooling function and spent fuel storage pool cooling function) are lost.

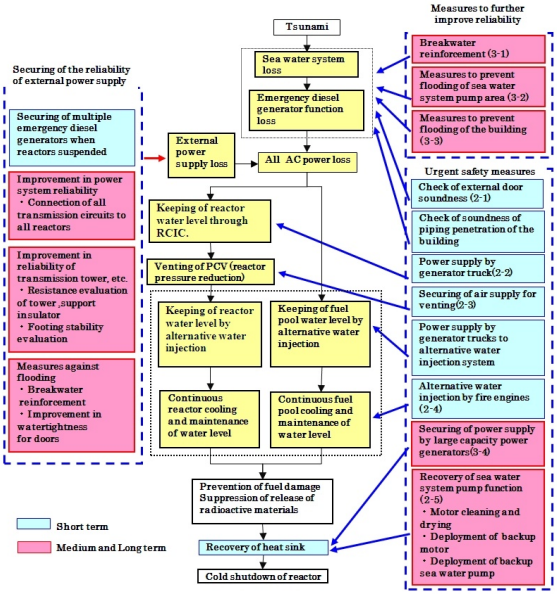

FIG.1. Flow of Fukushima Dai-ich Nuclear Power Plant accident and measures against it

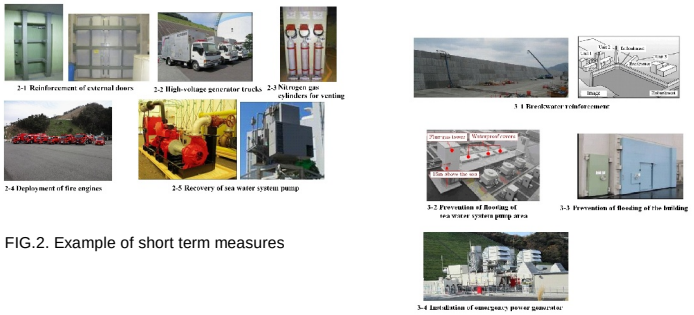

FIG.2. Example of short term measures

FIG.3. Example of medium and long term measures

3. Confirmation of effectiveness of measures

3.1 Confirmation by NISA

NISA compiled and announced the Review Standards to verify the appropriateness of the urgent safety measures. The appropriateness of the measures implemented by each licensee was verified in accordance with the Review Standards through on-site inspections for the operating 44 reactors at nuclear power plants which began in the middle of April, 2011.

Strict inspections were conducted on the preparation of materials and equipment such as generator trucks and fire engines, the development of an emergency response manual, and the implementation of emergency response drills, etc. As a result, it was found that short term measures were appropriately implemented at the time of inspection.

The Review Standards are as follows:
(a) Implementation of urgent inspection
(b) Review of an emergency response plan and implementation of drills
(c) Securing of power supply during an emergency
(d) Securing of ultimate heat sink during an emergency
(e) Implementation of measures necessary on the basis of the structure of each site.
The national government also verified the measures to improve power supply reliability and the severe accident measures.

3.2 Compilation of guideline and confirmation of urgent safety measure effects by the Japan Society of Maintenology

The Japan Society of Maintenology compiled and announced “Guideline for Assessing Large Tsunami Countermeasures in Japanese Nuclear Power Plants” in July 2011 which confirms that tsunami countermeasures for light-water nuclear power plants in Japan are appropriate in terms of achieving and maintaining a stable cooling state of a reactor and a spent fuel storage pool.

The basic ideas of the evaluation in the Guideline are as follows:

(a) Evaluation in the case the area affected by tsunami gradually expands in the plant premises (evaluation along the space axis)

List the systems and equipment which may be affected by tsunami and evaluate to what extent the functions will be maintained at each stage. If a measure to prevent flooding is implemented, evaluation is made on the assumption that tsunami is blocked and does not affect the equipment.

(b) Evaluation according to the development of an event caused by tsunami striking (evaluation along the time axis)

List the systems and equipment which may be affected by tsunami and evaluate to what extent the functions will be maintained at each stage according to the development of an event caused by tsunami striking.

3.3 Confirmation of effects of urgent safety measures through stress test

On July 22, 2011, NISA ordered the licensees of reactor operation to conduct “comprehensive safety assessment of existing nuclear power generation facilities” called stress test and to report the test result. This stress test includes a requirement to evaluate the effect of the urgent safety measures by comparing the cliff edges before and after the urgent safety measures are implemented.

As of the end of March 2012, 8 licensees submitted the reports on 17 reactors at 11 power plants. The table I shows the results of some power plants.

The results clarify that the urgent safety measures bring about effects of improving the cliff edge for tsunami as well as the measures are greatly effective in dealing with SBO (station blackout) and LUHS (loss of ultimate heat sink). On the other hand, it is found that no or slight effects have been achieved against the occurrence of an earthquake as these measures were not implemented only for the purpose of addressing earthquake-induced damages.

It must be noted that some figures with small magnification ratio have enough margin in the cliff edge even before the measures are implemented, resulting in no effect.

Table I. Effects of urgent safety measures clarified by stress test (reactor)

Reactor	Type	Yrs. [a]	The effect of the measures is shown in magnification ratio. [b]			
			Earthquake	Tsunami	SBO	LUHS
Tomari-1	PWR	22	1.0 (1.86)	1.4 (15.0)	96 (20)	30 (142)
Higashidori-1	BWR	6	1.0 (2.00)	1.1 (15.0)	45 (15)	87 (167)
Kashiwazaki-1	BWR	26	1.0 (1.29)	3.0 (15.0)	32 (12)	196 (196)
Shiga-2	ABWR	6	1.1 (1.93)	1.3 (15.3)	210 (70)	1.0 (480)
Mihama-3	PWR	35	1.2 (1.76)	2.7 (11.1)	57 (12)	1.7 (12)
Ohi-4	PWR	19	1.0 (1.80)	2.4 (11.4)	76 (16)	2.6 (16)
Takahama-1	PWR	37	1.0 (1.70)	2.7 (10.8)	72 (15)	5.0 (15)
Ikata-3	PWR	17	1.0 (1.86)	1.3 (14.2)	51 (10.7)	∞ (∞)
Genkai-2	PWR	31	1.0 (1.75)	1.7 (13.0)	24 (65)	140 (378)
Sendai-1	PWR	27	1.1 (1.86)	2.4 (15.0)	499 (104)	521 (939)
Tsuruga-2	PWR	25	1.0 (1.77)	2.0 (11.6)	340 (71)	186 (560)

[a] Full years as of the end of March 2012
[b] The each item unit is shown below. The figure in ( ) shows the figure in each item unit.
Earthquake: Multiples of standard seismic motion, Tsunami: m, SBO: day, LUHS: day

4. Conclusion and future items

As a result of the inspection of the national government, the verification based on the guideline of the Japan Society of Maintenology and also the stress test, it is confirmed that effective measures have been appropriately implemented as for the urgent safety measures by each licensee.

It is essential to ensure that medium and long term measures shown in the urgent safety measures will be implemented as scheduled, and equipment and devices installed for each measure will be maintained and operated properly.

The items that we, Japanese licensees of reactor operation, plan to deal with is to promote the installation of filter venting systems and air cooling diesel generators which are planned based on the lessons obtained from the hazard and to secure the world best safety of nuclear power generation facilities.

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