Conceal troubles at nuclear power plants

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(Summary)

Periodic inspections of nuclear power plants approximately once per year are required by law. From the latter half of the eighties to the nineties, the Tokyo Electric Power Company, Limited (TEPCO) conducted self-inspections during the periodic inspections at the Fukushima first nuclear power plant, the Fukushima second nuclear power plant, and the Kashiwazaki Kariwa nuclear power plant. Although they found cracks in the core shroud which is installed inside the reactor pressure container, the evaluation, repair, record and report to the government were inadequate.

After that, it was discovered, TEPCO, the Chubu Electric Power Company, Incorporated (Chuden) and the Tohoku Electric Power Company, Incorporated did not report failures to the government while they found cracks in the Primary Loop of Recirculation system (PLR) piping at the nuclear power plant.

In addition, it was also discovered that the Japan Atomic Power Co., Ltd. didn't report the failures to the government while they observed cracks at the core shroud.

A large number of cracks were found in the equipments of many nuclear power plants, although, plant owners did not report these facts to the government and the cracks were repaired secretly or left without repaired. When this fact was finally appeared to the general public, a strong fear concerning the safety of nuclear power plants arose.

In response to these incidents, the electricity enterprises law was amended. The integrity evaluation system for nuclear power plants was introduced and the rules on fitness-for-service for nuclear power plant components prepared by Japan Society of Mechanical Engineers (JSME) are going to be utilized.

1. Component

The structure of the core shroud is shown in Fig.1. Many short metal cylinders are welded and form a long tubular structure. It is supported vertically by shroud support. The core shroud serves to support nuclear reactor core (fuel assembly), direct flow of coolant water around the reactor core, and hold water over the reactor core when an accident is occurred.

The structure of the PLR (Primary Loop of Recirculation system) piping is shown in Fig. 2. The PLR piping is piping which circulates the high temperature pure water in a reactor pressure vessel through a purifying facility, and has connected also with a condenser.

2. Event

As a rule for design and construction of nuclear power plant, there is a notification (No. 501) which defines technical standards of nuclear components.

This notification used not only as a technical stand for the design and construction, but also used as a technical standard for the in-service inspection (ISI). In other words, this means that manufactured performance should be maintained during the in-service period.

At the time of manufacture, a welding defect often arises. When the defect is detected by an inspection, repair and/or exchange is a fundamental principle. Therefore, the inspection standard for the design and construction rule is required only qualitative judgment of flaws. (judge existence of flaw, flaw size is not concerned). The radiographic testing (RT) is dominant as the inspection method for the design and construction rule (during pre-service period). In-service period, weld defects are supposedly not exist and fatigue crack and/or stress corrosion cracking (SCC) are frequently occurred. The ultrasonic testing is dominant as the inspection method for the in-service period. Regarding to the design and construction rule, when the flaws are detected by the in-service inspection, repair and/or exchange is basically required. This judgment doesn't take into account the difference in the method of RT and UT and the difference of flaw size and/or flaw nature.

It is natural result that cracks arise after the sufficient time passes during in- service period. By evaluating flaw size and flaw growth, continuous operation is permissible without repair and/or exchange for a certain period. However, this evaluation and permission is basically unaccepted. The repair and/or exchange are basically required.

A large number of stress corrosion cracking were found at both the core shroud and the PLR piping, although, the evaluation, repair, record and report to the government by companies were inadequate. From a viewpoint of engineers who participates in these matters, causes are considered as follows;

(1) Since applying non-destructive inspection standard of the design and construction rule to the in-service inspection is unreasonable, they ignored the standard.
(2) They had controlled material and environment to prevent SCC occurrence. Therefore, occurrence of SCC was outside assumption for them and they hid the fact which SCC occurred.

3. Course

On August 29th, 2002, a Nuclear and Industrial Safety Agency (NISA), Ministry of Economy, Trade and Industry (METI), Japan announced the investigation result officially that the TEPCO had found the SCC during the self-inspections during 1986s-1990s (General Electric International Inc. took charge), although, the record and the report to the government had been inadequate. This investigation was started triggered by provision of information to METI on July, 2000. On September 20th, 2002, it became apparent that the TEPCO, Chuden and the Tohoku Electric Power Company didn't report the SCC detected at PLR piping to the government. In addition, on September 25th, 2002, it was also discovered that the Japan Atomic Power Co., Ltd. didn't report the failures to the government while they observed cracks at the core shroud. The interim report about these incidents was compiled by NISA on October 1st, 2002.

4. Cause

Judgment of the engineer who involves is not the true cause. The problem is the organization which approves the judgment without check. In the present condition reformed from safety ensuring by a regulation system to safety ensuring by self-imposed control, exact quality assurance and risk management is required. The essential cause of conceal troubles at a nuclear power plants is lack of a quality assurance system and risk management.

5. Immediate Action

In order to prevent concealing, the subcommittee was established in the nuclear insurance and the safety department committee. They developed following preventative measures;

○ Reliability ensuring for the safety activity by companies.

○ Establishment of a quality assurance system for the safety activity by companies.

○ Strengthening of the company's efforts to comply with the rules.

○ Clarification and transparency of regulatory system operation.

○ The improvement of a report system operation.

○ Publication and sharing of information about small troubles.

○ Address for recovering the public trust to the safety regulation

○ Reexamination of the safety regulation system and operation.

6. Countermeasure

Some of above-mentioned preventative measures were already implemented. It is notable that the integrity evaluation system was introduced on October, 1, 2003.

Figure 3 explains a flow of the integrity evaluation system. The electricity enterprises law was amended and the periodical operator inspection and the integrity evaluation system for nuclear power plants were introduced. It is the innovative system that the system utilizes private-standard (JSME standard).

○Periodical Operator Inspection

The present self-inspection performed by the company was positioned as "Periodical Operator Inspection" on the statute. In a periodical operator inspection, it is obliged to do a nondestructive inspection (Ultrasonic testing). Rules on Fitness-for-service for Nuclear Power Plants by JSME (2002 edition) is utilized as a concrete inspection method.

○Integrity Evaluation

When the cracks were detected during the periodical operator inspection, crack growth should be predicted and the integrity of the system should be evaluated. The equipments evaluated by the integrity evaluation are the container and piping belonging to the apparatus which constitutes nuclear reactor pressure boundary (class-1 equipments) and a core shroud (Reactor core support structure). Although, PLR piping made by SUS316 is excluded from the integrity evaluation equipments, it will be included into the equipments because the reliability of an ultrasonic testing is confirmed.

Items of the integrity evaluation are flaw modeling, allowable flaw, crack growth analysis, and failure analysis. These evaluations were conducted by utilizing rules on fitness-for service for nuclear power plants by JSME.

○Evaluation results

The details of a matter of record and the report matter to a government are defined. Although, the result of the integrity evaluation is an object of a report, allowable flaw does not need to report.

○Establishment of a related private-standard

Although the above was revision of the regulation system, apart from this, the private-standard was enacted as a countermeasure against lack of a quality assurance system. As a countermeasure against lack of a quality assurance system which is the essential cause, "Quality Assurance Regulations Concerning Safety at Nuclear Power Stations (JEAC4111-2003)" was specified newly. This regulation uses ISO 9001 as a base, replaces a quality by a nuclear safety, and specifies top management's role.

Furthermore, a guideline for the ultrasonic crack sizing used as the base of integrity evaluation was added to the "Guidelines for the ultrasonic testing during in-service inspection of light-water reactor nuclear power plant (JEAG4207-2004)".

7. Knowledge

It seems that the regulations were made by accidents. However, the reality is different. Necessity of rule on fitness for service has been acknowledged by concerned parties and they started preparing regulations from 1993 and it was established from JSME (Japan Society of Mechanical Engineers) in 2000. The regulations would be referred to the technical standards of the government, but concealing of troubles was discovered just before authorization. That is, operation by the standard of the design and construction rule (not by the rule on fitness for service) causes troubles, and the trouble accelerated practical use of the rule on fitness for service. Originally, standard is established in order to prevent accidents. However, in fact, standard is not established or changed if an accident does not occur. All systems in Japan will not change without experiencing serious damage.

Only the way to modify such systems is to form specific safety guidelines as a law and practical use of a private-standard. Safety ensuring can not be realized only by laws. As far as the production field, companies should make standards themselves and should obey the standards. This is the best way to ensure the safety.

8. Primary Scenario

01. Poor Value Perception
02. Difference in Culture
03. Difference of principle

04. Organizational Problems
05. Inflexible Management Structure
06. Information communication insufficiency

07. Misjudgment
08. Narrow Outlook
09. Standard defectiveness

10. Usage
11. Operation/Use
12. Core shroud
13. Usage
14. Maintenance/Repair
15. Inspection
16. Failure
17. Fracture/Damage
18. Stress corrosion cracking (SCC)
19. Loss to Organization
20. Social Loss
21. Confidence losing
22. Damage to Society
23. Change in Perception
24. Atomic energy infidelity

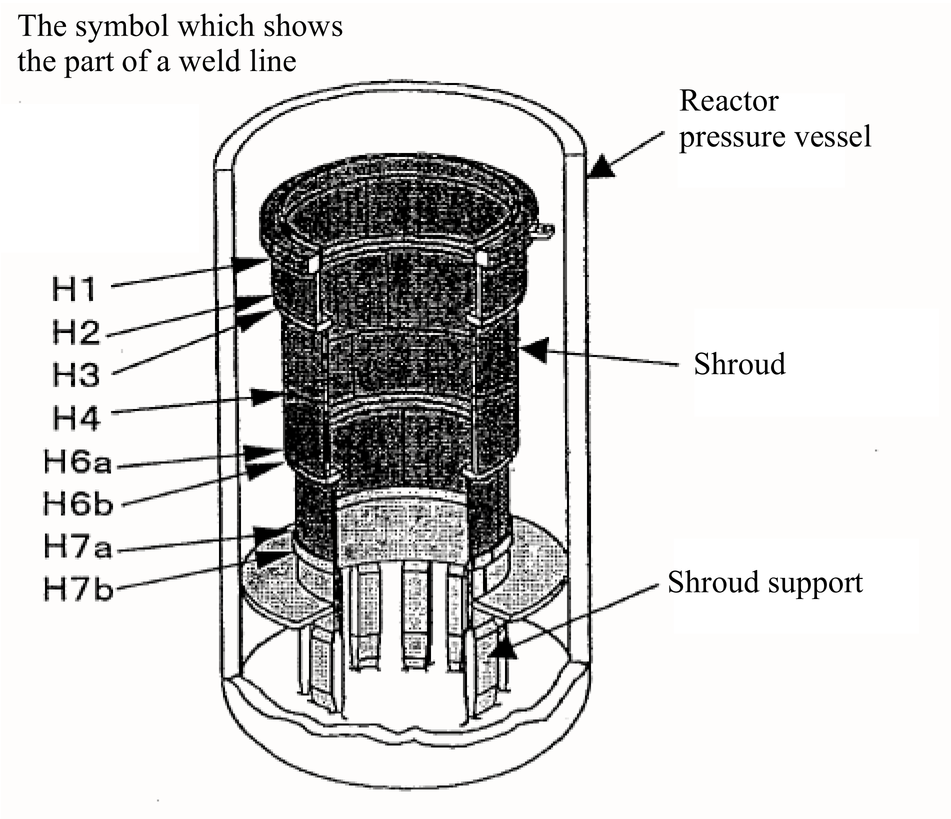

Fig. 1 Structure of a reactor core shroud.

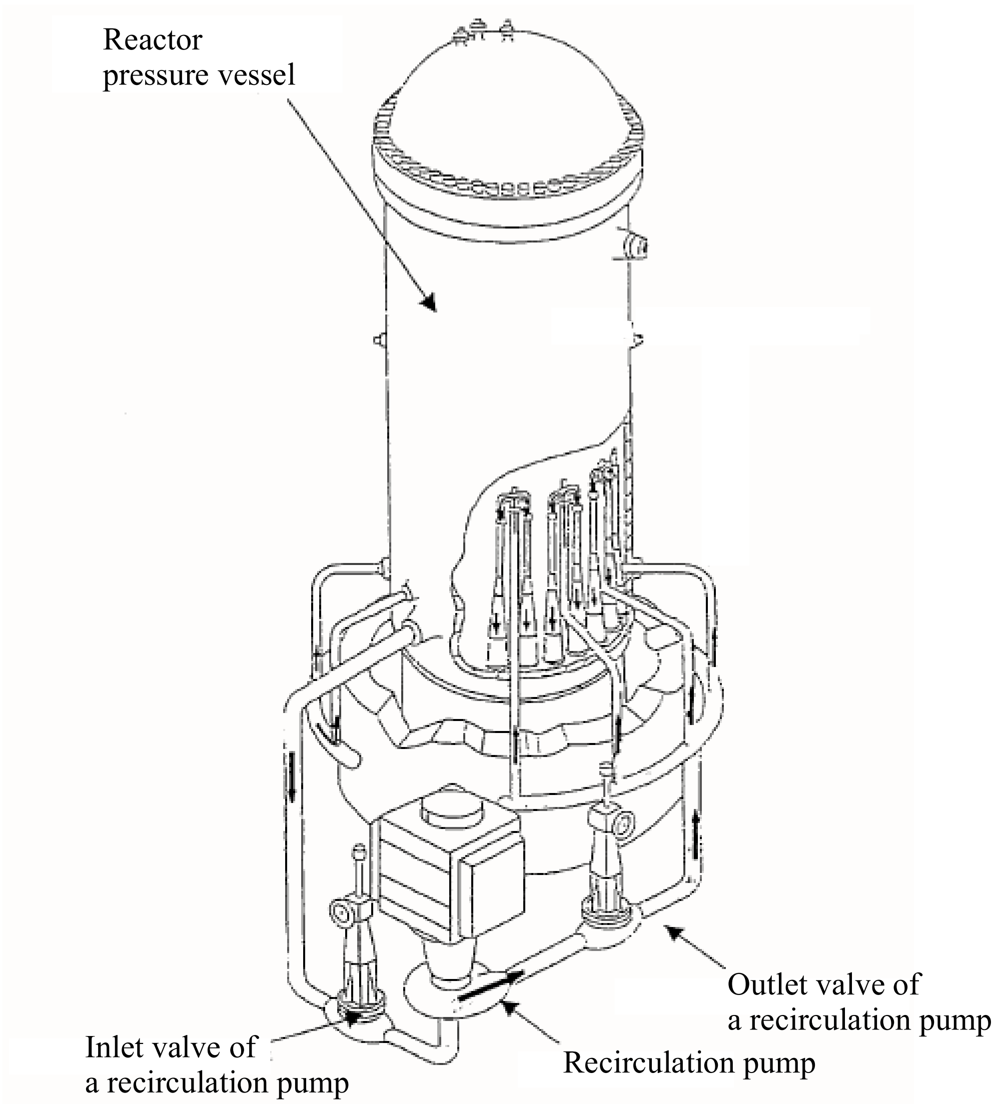

Fig. 2 Structure of a Primary Loop Recirculation System.

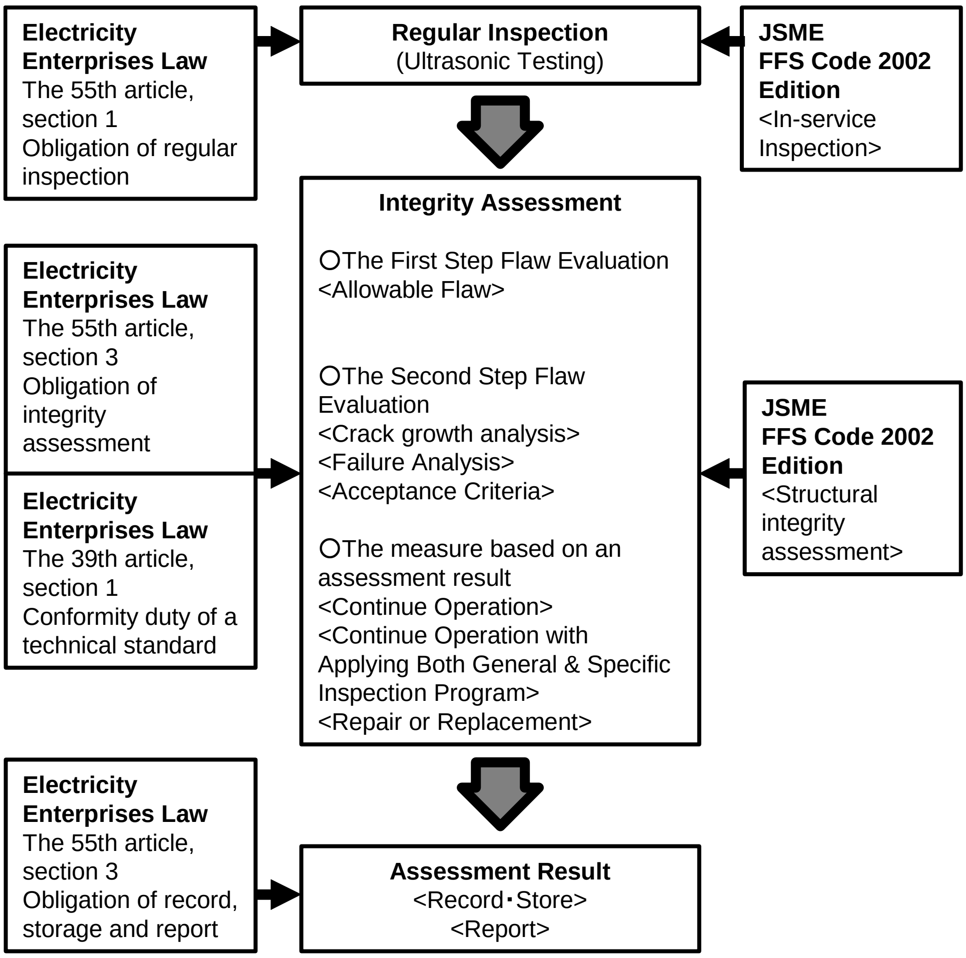

Fig. 3 Integrity Evaluation System for Nuclear Power Plants.