

(Draft)

## PRESENT SITUATION AND TRENDS OF NUCLEAR POWER IN JAPAN AFTER THE FUKUSHIMA ACCIDENT

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### ABSTRACT

This article illustrates extensive reformation of the government and the nuclear industry in Japan after the Fukushima accident to drastically restructure nuclear safety securing framework based on the lessons from the accident. The article covers broader aspects of changes such as governmental reorganization, new laws and standards, and initiatives of the industry. Most of all, important topic of this article is foundation of Japan Nuclear Safety Institute (JANSI) as the self-regulating organization and the powerful safety driver of the industry.

### **1. Fukushima Daiichi accident**

#### **1.1 Earthquake and tsunami caused nuclear disaster**

The great east Japan earthquake of M.9.0 occurred on March 11, 2011. All the plants of Fukushima Daiichi Nuclear Power station shut down automatically. But the earthquake stopped outside power supply and although emergency generators started, the tsunami caused by the earthquake damaged the emergency generators and power supply system of the reactors. The loss of cooling system caused core meltdown and resulted in hydrogen explosions. Nuclear materials were released to the atmosphere. On the other hand, Nuclear Power Stations of Fukushima Daini, Onagawa, Tokai Daini, which are located in north east pacific side, were assailed by the tsunami, but survived without major damages to the plants.

#### **1.2 Impact of the accident**

People within a radius of 20 km and in other designated areas were evacuated and people in a radius of 20-30 km areas were advised to voluntarily evacuate. Though

substantial decontamination has been carried out since the accident and evacuation areas have been gradually reduced, still 85,000 people are living outside of their home town. The government is extensively conducting decontamination and reestablishment of infrastructure and promoting the return of resident people to their home town and restoration of the industry including agriculture and fishery.

## **2. Present situation of Fukushima Daiichi**

### **2.1 Decontamination and Management of contaminated water**

Tokyo Electric Power Company (TEPCO), the owner of Fukushima Daiichi NPS, is conducting removal and decontamination of radioactive materials in the site. The site radiation dose has been decreased. Radiation doses in almost all of the area of the site are under 5 $\mu$ SV/h except the area very close to the reactor units. TEPCO installed the seaside impermeable wall and has prevented release of radioactive materials to the sea. The concentration of radioactive materials outside the port is substantially below regulation limit. In addition, TEPCO installed frozen soil wall barriers around the reactors to block the flow of underground water.

### **2.2 Decommissioning**

The Fukushima Daiichi Unit 1 through 4 damaged by the accident will be decommissioned. TEPCO, the government and related organizations are implementing decommissioning work. Detailed situations of the plants are being investigated and the decommissioning plan including the methods for removal of the fuel debris and other radioactive materials are studied. The decommissioning is targeted to complete in 30 to 40 years.

## **3. Reform of regulatory organization**

### **3.1 Reorganization and establishment of the Nuclear Regulation Authority**

The investigation reports and studies on the Fukushima Accident indicated failures in nuclear safety systems, procedures and standards in Japan. Japanese Government reorganized nuclear regulatory organizations and established the Nuclear Regulation Authority (NRA) in 2012 as independent commission body, clearly separated from the Ministry of Economy, Trade and Industry (METI) that has also promoted the nuclear energy. Also various regulating functions regarding nuclear safety, security, safeguards, radiation monitoring and radioisotopes in other Ministries were integrated into NRA.

## **4. New safety standards**

#### **4.1 Amendments to Nuclear Regulation Act**

New Nuclear Regulation Act was promulgated in 2012 and put into effect in 2013. New regulation substantially considers natural disaster, terrorism and other criminal acts. The regulation also legally requests measures severe accidents. Back-fitting rule of latest regulations to licensed reactors has been articulated. The regulations which had been described in separated laws such as operation of commercial power plants were integrated into new nuclear regulation act.

#### **4.2 Basic policy of new requirements**

New requirements place emphasis on Defense-in-Depth concept and request multi-layered protective measures where each layer has capability to secure its objective independent from other layers. SSCs should be reinforced to eliminate long time shared use of passive components. More intensive approaches have been introduced in assessment of earthquake and tsunami. Also former “redundancy centered” approaches have been shifted to “diversity and independence” of countermeasures.

#### **4.3 Severe accident**

Upgraded countermeasures against severe accident and terrorism are one of the most significant changes of new requirements. Multi-layered protection has been taken for prevention of core damages, maintaining containment integrity, controlled release by venting and suppression of radioactive materials dispersion. Specialized safety facility against intentional aircraft crash has also been introduced.

### **5. Nuclear Policy of Japan**

Japanese government formulated *The Long-term Energy Supply and Demand Outlook* in July 2014. The share of nuclear energy in the total electric power generation in Japan is expected to be 20 - 22% in 2030. The share will be dropped from the 30%, the figure before the Fukushima accident. Japanese government has made clear that the government keeps nuclear energy as an important base load power source.

### **6. Present situation of Nuclear Power in Japan**

#### **6.1 NPPs submitting application for conformity to new standards**

Of all 57 units of nuclear power plants in Japan (including 6 units of Fukushima Daiichi), 26 units have submitted applications to NRA for conformity to new standards. 14 units including 6 of Fukushima Daiichi have been decided to be decommissioned. Other

plants are being reviewed for their future.

## **6.2 Restarts of NPPs**

Of the applicants, 5 units have received approval from NRA and restarted operation so far, although 2 of the 5 units, Takahama Units 3 & 4 stopped operation in March, 2016 due to the injunction by Otsu district court.

## **6.3 Challenges to restarts**

Although some nuclear power plants have resumed operation, the pace of the restart seems slow and not steady. There are several challenges to the restart of nuclear power plants. The review by NRA is time consuming process than expected. At present applications by 18 units are still under review. It is difficult for the utilities to foresee the timing of approval. Political risk is other challenge to the utilities. Many opinion polls show that more than half of the people in Japan are negative to nuclear power. Two governors having negative stances to nuclear power have been elected in 2016 in prefectures where nuclear power stations are located. Other challenges are lawsuits. As already indicated, Takahama Units 3 and 4 were stopped by the injunction by Otsu district court. Many nuclear power plants are objectives of lawsuits by anti-nuclear groups. Decisions of local courts may be reversed at high courts or the Supreme Court, but still operation of nuclear power plants is under legal risk.

## **7. Self-safety-improvement activities of the Nuclear Industry**

### **7.1 JANSI as self-regulating organization**

The regulatory requirements to the nuclear power plants have been greatly intensified. However, in addition to satisfying regulatory requirements, the industry has recognized pursuing excellence and continuously improving safety are essential to secure safety of nuclear power plants, considering potential great risk of nuclear energy. The industry with its whole consensus organized the Japan Nuclear Safety Institute (JANSI) as self-regulating organization in November, 2012. To ensure the Japanese nuclear industry pursues the world's highest level of safety, "Untiring Pursuit of the Highest Standards of Excellence," JANSI drives forward nuclear operators' voluntary and continuous safety enhancement activities

### **7.2 JANSI's activities**

JANSI's main activities consist of the following 3 areas.

- Evaluate, propose and recommend safety improvement measures, and provide

support to secure of safety and improvement for future such as safety system improvement program

- Evaluate nuclear facilities, make proposals and recommendations, and provide support to secure of safety and improvement for present such as nuclear facility peer review program
- Basic activities to support the above two pillar activities such as operating experience information analysis, human resource development, etc.

### **7.3 Assessment and support to enhance nuclear safety**

JANSI assesses the management and design of safety-critical equipment of nuclear operators and provides evaluations, proposal and/or recommendations as well as assists in improving safety measures in many areas including risk management, safety enhancement for severe accident prevention and fire protection.

Peer review is one of the most important activities of JANSI. Peer review is a voluntary safety improvement activity to pursue excellence by identifying strength and weakness of plants through on-site observation and interviews.

Support to restart of nuclear power plants is another important area. With cooperation of nuclear operators, JANSI reviews start-up readiness of each plant and support in various areas such as sharing of experience of the plants that have already started.

WANO also conducts peer reviews and pre-start up reviews. Therefore JANSI closely cooperates with WANO-Tokyo Center. An example is mutual participations of evaluators in each peer review.

### **7.4 Support Program**

To maintain and strengthen the support to the nuclear operators, JANSI has allocated senior representatives as a contact point with each nuclear power station. JANSI also provides assistance to the nuclear operators' safety culture assessment and safety culture fostering activities. JANSI holds lectures, training, and other program on safety culture at the sites.

### **7.5 Other basic areas**

JANSI provides the Japanese nuclear operators with various information and programs to assist their safety improvement. JANSI provides operating experience (OE)

information from domestic and overseas nuclear power plants. OE information and analyses results are registered on the Nuclear Information Archives (NUCIA), a database accessible to nuclear operators.

JANSI conducts human resource development program for the nuclear operators. Major program is a series of leadership trainings for utility members of various management levels from the top executives, CEOs, to frontline supervisors. Reflecting on the Fukushima Daiichi accident, JANSI promotes strong leadership of nuclear operators' management with an awareness of risks inherent to nuclear energy. JANSI emphasizes particularly leadership under the crisis of extreme conditions.

## **8. Conclusion**

After the Fukushima accident, Japanese government drastically reorganized nuclear regulatory organization and established new Nuclear Regulation Authority and significantly amended the nuclear regulation act and safety requirements based on the lessons from the accident.

The utilities have upgraded the safety measures of the nuclear power plants and also the utilities are making every effort to restart nuclear power plants. Some Nuclear Plants have resumed the operation, but there still remain challenges to the restarts.

The nuclear industry in Japan established JANSI as the self-regulating organization to secure and to continuously improve safety of the nuclear power plants. JANSI conducts safety assessment and support to the utilities to continuously enhance nuclear safety not only to satisfy nuclear regulations but also to pursue excellence in nuclear safety.