[SE1-OR-2] Safety of Nuclear Facilities on the Korean Peninsula

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Full Summary

Panelists of this session mainly talked about the implication of nuclear facility safety in Korea after the unfortunate event in Fukushima. Three Korean panelists represented insights of R&D Sector (KAERI), International Organization (IAEA) and Domestic regulatory body (KINS), respectively. One Japanese panelist was there to provide the detail and sequence of Fukushima accident.

Session started with the introduction of the session itself and panelists. Prof. Chang from KAIST, who acted as the moderator during the session, started the session by raising a question "What kind of knowledge is necessary to enhance the nuclear safety?" to Dr. Baek from KAERI. Dr. Baek started his remark by stating the goal of nuclear safety: it is to protect individual, society and environment from nuclear facility. He further elaborated that during the Fukushima accident Japan was able to protect the individual but emergency response team didn't do a good job in protecting society and environment from the accident. There are two levels of safety; (1) minimum required level and (2) desirable safety level. The minimum required level is the regulatory requirements. The regulatory requirements for the nuclear power plants are basically not to introduce significant additional risk to public due to nuclear energy and the risk from the nuclear energy source should be comparable to the other energy sources. The desired level is higher than the minimum level and it is bound by available technologies. The minimum required level is well satisfied in Korea, however further improvement is necessary to satisfy the desired safety level. To reach the desired safety level in Korea we need to focus on the following items: Strengthening awareness of man-made hazard, Mitigation of severe accident, Preparedness of accident response, Clear and transparent communication during event of crisis. The terminology of "severe accident" is defined when the nuclear reactor core is severely damaged or degraded, and it is not part of the "design basis accident." The design basis accident is postulated for the nuclear power plant for construction and operation licenses which sets the limit of nuclear power plant.

The R&D areas which can further improve the nuclear facility safety level are:

(1) Designing advanced reactors with higher level of safety
(2) High level of knowledge of nuclear safety
(3) Revise design base for natural hazard and man-made hazard
(4) Understanding of cooling mechanism
(5) Detailed explanation for Severe Accident propagation
(6) Safety issues of long term operation of nuclear power plant
(7) Radioactive dispersion and health effect.

He concluded his remark that the design and decision should be based on knowledge not emotion. Furthermore, he stressed that accident should be prevented at all costs and mitigation comes after we did our best to prevent the accident.

The second panelist Prof. Yoichi mainly focused on the Fukushima accident itself and lessons learned from it. The sequence of the accident is as follows. 9.0 Magnitude earthquake initially struck the Fukushima Daichi plant, which is a boiling water reactor type designed for magnitude of 8.5 earthquake. The offsite power was lost and three out of six Fukushima nuclear power plants operating at full power at that time were successful to shut down. When a nuclear reactor is successfully shut down, the next crucial step is to provide long term reliable cooling to the reactor core which generates heat due to daughter nuclide from the fission which under goes decay process. This is done by emergency diesel generator, which provides electricity to essential equipments for the decay heat removal system. The Fukushima nuclear power plant emergency diesel generator operated successfully for a while. However, due to unprecedented Tsunami, which the height was 15m at the time, swept the Fukushima nuclear power plant resulting in total loss of emergency diesel generator due to flooding. The design basis for the Fukushima nuclear power plant is 6m Tsunami. After the loss of emergency diesel generator, battery replaced the generator's role to sustain the cooling function of the nuclear power plant. Unfortunately, the purpose of the battery is only to buy some time to repair or replace the emergency diesel generator to restore the long term reliable decay heat cooling. This meant that before the battery was depleted, Japanese had to fix or provide alternative power source on site, which was not possible due to damaged infrastructure of Japan at the time. After the battery was depleted, the reactor core could not be successfully cooled down, which resulted in large amount of reactor core degradation, i.e. Severe accident. When the core degrades substantially, the cladding material zirconium reacts with high temperature steam generating hydrogen. The generated hydrogen from degraded core diffused or transported to the reactor containment building and was accumulated until it reached the concentration to explode. Prof. Yoichi posed that the Fukushima accident does not involve any casualty due to radiation exposure, which is contrast to the Chernobyl accident. He thinks that the Fukushima accident has far less impact on the environment than the Chernobyl accident. However, the Fukushima accident is considered as a major "social" accident. Due to the accident, many livelihood and day to day life near the Fukushima site were destroyed. Peoples who evacuated from the site are still suffering in the refugee camp and so forth. He further said that the Fukushima accident began with lesser impact than the Three Mile Island accident but eventually reached the level of the Chernobyl accident due to large amount of radio-isotope release. However, the reason why he thinks the Fukushima accident has far less implication than the Chernobyl accident is because only short half life radioisotopes were released which means that the radiation due to the release only affects the surrounding environment within limited amount of time, and this is not true for the Chernobyl accident. He also mentioned another current widely discussed issue about whether if the power plant reached the criticality again or not after the shutdown. If the criticality re-occurred this means that we can't say the reactor was safely shut down. However, he claims that as it can be seen from the Three Mile Accident, once the borated water is introduced to the core, which is the case for the Fukushima accident as well, the core cannot reach the criticality again. The lessons learned as well as future work to be done identified by Prof. Yoichi are: clean-up issue of polluted water and soil, severe accident management has to be revised, the inherent safety features have to be checked, reactor parameters should be measured at all costs. He closed his summary by notifying the audience that information regarding the accident will be opened to the international community with transparency.

The third panelist from IAEA, Dr. Kang, added the discussion of lessons learned from the Fukushima accident that can be directly applicable to a Korean nuclear facility. He mentioned that the current good operating history does not always promise the safety of a nuclear facility. For example the unplanned nuclear power plant shut down per year is 0.2 times for Japan, which is one of the best records around the world. Korea holds 0.3 times per year. He briefly summarized the Fukushima accident as an accident that evolved from the loss of offsite power accident, which is a design-basis accident, to the total station black out scenario, which became a sever accident. He then explained two different types of accident management. One is the on-site emergency management and the other is the off-site emergency management. The on-site emergency management team is consisted of group of engineers and workers on the nuclear power plant site. For instance, in the Fukushima nuclear power plant, currently 4,000 workers are involved along with 200 engineers divided into 15 groups looking at different aspects of the accident. The off-site management team seats on the Tokyo Electric Power Company Head office which governs and makes major decision what to do at on-site. He further explained that who is making what kind of decision was not clear for the Fukushima accident, in other words, the off-site management was not transparent. He gave out some examples that the IAEA requested important information to NISA, Japanese regulatory body, multiple times but no answer returned back from them during the accident.

Moreover, NISA even sent out wrong information which damaged their credibility further. He especially emphasized that the off-site emergency management has to be reviewed since the communication between different stake holders and chain of command was not well organized in the Fukushima accident. He also stressed that accurate radiation measurement outside the nuclear power plant has to take place even during a severe condition. Finally, he ended his statement by saying that the communication with public during this type of event cannot be overlooked at any cost.

The fourth panelist, Dr. Lee, summarized the Korean response to the Fukushima accident to demonstrate how the safety of Korean nuclear facility is managed. After the Fukushima accident, Korea operated an emergency response team 24 hours a day to check and monitor the Korean border regarding dispersion of radioisotopes from the Fukushima accident, to constantly review information released to public and to respond to public needs. He also further discussed that the recent investigation initiated by the president of South Korea concluded that all nuclear facilities in Korea are safe for expected earthquake and Tsunami around Korean peninsula. Finally he summarized the identified points raised by other panelists which can improve the safety of nuclear facility in Korea. He further argued that international credibility of Korean nuclear facility safety has to be improved in the future by learning lessons from the Fukushima accident.

A few questions were raised from the audience. The first question involved the on-site spent fuel storage in Korea. Since unit 4 in Fukushima Daichi site had major problem with not with the reactor but with the liquid pool spent fuel storage area, an audience asked the question if Korea is reviewing the current practice due to the Fukushima accident. Prof. Chang and Prof. Yoichi answered to this question. Prof. Chang mentioned that spent fuel generated from CANDU type reactor are not stored in a liquid pool rather they are stored in dry casks. Prof. Yoichi further discussed that the hydrogen explosion in Unit 4 Fukushima Daichi site did not occur due to the spent fuel but it actually occurred due to hydrogen migration from Unit 3 after Unit 3 experienced explosion. Another question was regarding if there is collaboration between Korea, Japan and China like in European Union. Dr. Kang and Prof. Chang responded to the question. They both stressed that Korea, Japan and China are very different in how they regulate their nuclear power plants unlike EU. Therefore, the regional collaboration cannot take the same form as EU. However, in the future three Asian countries will communicate with each other to enhance the nuclear safety furthermore. Two more questions followed by. The next question was about asking for examples of passive safety system. Dr. Baek answered the question. He briefly mentioned the design of APR+ which is the upgraded design of APR1400. APR+ is a Korean advanced light water reactor with a few added passive safety systems to APR1400 design. The most significant passive safety system is the auxiliary feedwater system to the secondary side. By utilizing natural circulation and isolation condenser APR+ now has a passive means to supply feedwater to the steam generator. This means that the decay heat from the primary side can be successfully removed by passive system during most of the accidents without loss of coolant event. The last question in the session was about if the emergency diesel generator in the Fukushima site had been survived, would the accident sequence be any different? Prof. Yoichi, Dr. Baek and Dr. Kang answered to the question. They all agreed that if the emergency diesel generator survived flooding due to Tsunami, the core wouldn't experience severe degradation that resulted in hydrogen explosion. However, since many supporting systems and essential equipments were damaged during Tsunami as well, it would not have been that easy to manage such crisis even the emergency diesel generator was alive.

The session concluded with Prof. Chang's statement that accident should be always prevented as much as possible before we think about the mitigation strategy. Therefore, many future R&D efforts should focus on this part. Prof. Yoichi added that information about the Fukushima accident will be opened to public and international community with transparency so that many useful insights and learned lessons can be shared.