[SE3-OR-2] Spent Nuclear Fuel Issues in Korea

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Full Summary

The spent nuclear fuel is one of the key issues that has to be resolved for nuclear energy to be sustainable. This session's main focus was to discuss how Korea would like to deal with increasing spent nuclear fuel and at the same time to emphasize how international collaboration regarding this issue is relevant.

The session started with the statement from a panelist, Dr. Hwang from KAERI. He began his speech by saying that even other countries, such as Italy, has given up the nuclear option, it is not practical in Korea. Like many other products and technologies, electricity has become essential part of the human society, and it is impossible for Korean to imagine world without cheap electricity. Moreover, Dr. Hwang argued that Korean thinks electricity bill as taxes, which means that Korean thinks electricity is not something that you buy from the market but instead something that is so essential the price of electricity feels like taxes. This reflects how cheap and reliable electricity generation is very important to Korea. Korea has looked at various renewable energy supplies including solar, wind and hydro, but none of them came close to nuclear option in terms of economy. Current Korean nuclear program is very cost-effective. However, to make nuclear energy sustainable and secured, the spent nuclear fuel issue has to be resolved. In other words, Korea requires a spent fuel ultimate solution. Without a practical and final solution of spent fuel, the nuclear energy solution cannot be sustainable. As part of this ultimate solution, Korea has to develop a spent fuel recycling technology. However, this recycling technology should be very resistant to proliferation and at the same time it should be affordable. The background of Korean R&D on pyro-processing is thus straightforward. Korea wants to develop a highly non-proliferative and economic spent fuel recycling technology to have nuclear energy as a sustainable and secured energy source. Dr. Hwang also stressed that not only technology development is important but also communication between experts and public is important. He concluded his remark by stressing three points for communication; "Scientific evidence" which demonstrates the reliability and feasibility of advanced reactor concept that can reuse recycled spent nuclear fuel, "authenticity" which justifies the spent nuclear fuel recycling and make the whole process transparent, and finally "fairness" which is required when experts are to compare many other spent fuel management options to each other.

The second panelist, Prof. Jorshan Choi, first summarized the situation in Korea why spent fuel issue has to be resolved soon. 21 nuclear power plants are operating in Korea and except for 4 CANDU type reactors, which the spent fuel can be stored in dry cask, 17 Pressurized Water Reactors (PWR) are all generating spent nuclear fuels even at this moment. Furthermore, the amount of produced spent fuel will be increasing in Korea, since Korean nuclear sector is expanding; 8 more PWR type nuclear reactors are planned or under construction. So far, the recycling of spent nuclear fuel relied on chemical reprocessing process called PUREX. Plutonium and uranium recovered from the reprocessing process are all re-used in light water reactor systems in the form of MOX fuel. This technology is an old technology and the proliferation issue is quite salient with this method. Therefore, the necessity of better recycling technology development to resolve issues in Korea with spent nuclear fuel is self-evident. Prof. Choi mentioned two reasons why Korea should develop the recycling technology: The first reason is that Korea is becoming a world leader of nuclear technology since Korea is building more nuclear reactors domestically and it is even exporting the technology to other countries. Therefore, Korea has to take responsibility on spent fuel issue and has to become one of world standards. The second reason is that only 0.5% of total spent fuel requires long term attention thus separating these 0.5% makes sense for reducing the volume and the cost for managing the nuclear waste. The 0.5% problematic isotopes are I-131, Tc-99, Cs and Sr. The first two radioisotopes are toxic and the last two isotopes are mainly responsible for long term decay heat. If the heat generating isotopes are part of the nuclear waste, securing reliable ultimate heat sink for very long time becomes very difficult task. Therefore, once the toxic or long term heat generating radio-isotopes were removed from the spent fuel through a process like pyro-processing the spent nuclear fuel issue becomes easier to handle. Even a solution like deep-bore hole storage can be a viable option if the fast reactor technology is not available to reuse separated plutonium or uranium. He summarized his talk by saying that pyro-processing can successfully separate this small amount of radioisotopes responsible for long term management with limited proliferation issues compared to the other existing technologies, and therefore in order to resolve spent nuclear fuel issue in Korea and elsewhere it is pertinent to develop the technology.

The third panelist, Mr. Pomper, focused on the political side of Korea developing the spent fuel recycling technology. Historically, managing spent nuclear fuel involved multi-national participation. The primary reason is because as more countries are involved, more transparency is promised. Korea spent nuclear fuel management also involves multinational effort. This is because Korea has to consider relationship with other surrounding countries, especially Korea-US relationship. Recent issue with revising Korea-US nuclear agreement is that Korea wants to develop spent nuclear fuel recycling technology while US wants to discourage such effort. This is because US views pyro-process as a reprocessing technology which cannot be free from nuclear material proliferation issues. In other words, US is never

supportive of reprocessing technology and therefore US is not supportive of pyro-processing as well. However, Korea has a growing domestic problem to deal with spent nuclear fuel issue since the nuclear fleet is expanding more as discussed by other panelists. He suggested four potential solutions to the spent nuclear fuel problem:

(1) Interim storage overseas without reprocessing – There was a discussion about transporting the spent nuclear fuel to a remote place such as Mongolia from Taiwan or Korea. After the spent nuclear fuel cools down in remote place interim storage it is transported back to the origin and goes to the ultimate final storage area. However, this plan was never realized or discussed seriously. But there is always a possibility to send the spent nuclear fuel to elsewhere to resolve the issue.
(2) Storage of high level waste after it was reprocessed from a country with reprocessing capability – UAE case can fall into this category. Since UAE receives nuclear fuel from US and after it is burned in nuclear power plant, the spent nuclear fuel is shipped back to US or transported to France for reprocessing. However, this solution is not an option for Korea since no neighboring country would like to take the spent nuclear fuel and coming up with secured transportation is very difficult task as well.
(3) Utilize more non-proliferative and advanced reprocessing technology – This approach is developing an advanced fuel cycle technology. However, this option takes very long time compared to the required time to deal with spent nuclear fuel issue.
(4) Try to setup a multi-national demonstration facility in Korea and build interim storage nearby – The last option is to build a demonstration facility that utilize pyro-processing with multi-national participation and construct an interim storage nearby to transport and store the spent nuclear fuel.

After Mr. Pomper's talk there was an active discussion on this issue. The first question from the audiences was about storing reprocessed nuclear materials. Since fast reactor technology is not mature enough, the audience wanted to know if it is possible to store plutonium or uranium above ground just like what the United Kingdom or France is doing. Dr. Hwang and Prof. Choi answered to this question. Dr. Hwang first answered that he is more of a direct disposal person rather than a recycling reprocessed fuel person. But, the problem with the direct disposal is that it cannot be the final solution. Direct disposal can be a working platform. In Korea, early introduction of spent fuel storage and expanding nuclear fleet at the same time are two main nuclear policies. But, in order to reduce the spent fuel volume and lowering the level of radiation and toxicity the final solution should include reprocessing. Korean R&D effort is to develop an advanced fuel cycle with advanced nuclear reactor technology. He understands that there are some technical problems with Sodium-cooled fast reactor. Japanese already spent 100 Billion USD and French, US fast reactors spent similar order of money but they all failed to commercialize the technology so far. However, he thinks

that Korean learned lessons from others and Korean can build cheaper and safer fast reactor from learned lessons. He also emphasized that Korea will be transparent during the whole process, and in the mean time deep bore hole repository can be also another option. Prof. Choi added to the discussion by stating that the fast reactor technology is not a mature technology. Thus, R&D efforts are needed especially to manage the doubling time of plutonium production in the fast reactor better than the current situation.

The second question was regarding the current Korea-US relation and agreement on the nuclear sector. Dr. Hwang and Mr. Pomper answered to the question. Dr. Hwang first said that US first recommendation is constructing an interim storage for the spent nuclear fuel. However, US is also focusing on the development of advanced fuel cycle as a part of the R&D effort. He further stressed that pyro-processing technology development in Korea is not an effort trying to resolve the spent nuclear fuel problem by tomorrow. It is rather a long term effort to draw the final and ultimate solution to the problem. Mr. Pomper further argued that pyro-processing and fast reactor technology is one of the many options. There are more options to resolve the spent nuclear fuel issue and Korea has to take cautious steps to resolve the issue by carefully considering other options.

The next question was about the effect of Fukushima accident on Korean nuclear industry as well as the change in opinion in Korean public towards the nuclear issues such as spent nuclear fuel storage. Dr. Hwang started his answer by reassuring that Korea will never give up nuclear option regardless of other issues such Fukushima accident and Korean knows that. The spent nuclear fuel issue has to be dealt and he thinks that pyro-processing offers an option that can have significant implication on environment. He further discussed that each country has its own way to deal with the spent nuclear fuel issue and it is never too much to emphasize the importance of the communication internationally and domestically.

This was followed by a comment from audiences to Mr. Pomper's statement. The first two options that Mr. Pomper has mentioned are nowhere close to the real solution. Sending the spent nuclear fuel to other countries is highly improbable and they don't even have to be mentioned as alternatives to resolve the spent nuclear fuel issue. Recently Korea-US agreed upon to perform a feasibility study on pyro-processing. Pyro-processing has many advantages compared to old technologies and therefore Korean thinks that pyro-processing can be an ultimate solution to the growing spent nuclear fuel problem. However, Mr. Pomper argued back that US wants to discourage Korea from developing pyro-process technology through Korea-US feasibility study, not to encourage it. Therefore, the purpose of joint feasibility study is different between the two nations.

One audience commented on Prof. Choi statement. The audience agreed that Korea is playing a major role as a nuclear technology exporter but that cannot be the reason why Korea should develop reprocessing technology since we don't want the reprocessing technology to spread around the world. Prof. Choi agreed on his point by clarifying that his original intention was to stress that the nuclear technology customer should have spent fuel solution when they import the technology. Korea should be able to provide options for it. But this does not necessarily mean that Korea should export reprocessing technology to customers. The follow up comment to the last comment was that the reason why many countries do not embark on the reprocessing is because of the high price. If Korea makes the process too cheap then all countries will try to do the reprocessing which is not an ideal situation.

The next question was about the spent nuclear fuel self-protection capability. The spent nuclear fuel is usually recognized to have self protection capability from the proliferators due to high radiation level. However, recent studies performed by Oak Ridge National Laboratory shows that spent nuclear fuel looses this capability after short period time. The audience posed the question to the panelist that what should we do with the spent fuel that does not have self-protecting capability? Dr. Hwang discussed that that is the reason why a lot of R&D efforts are needed. The self-protection capability of spent nuclear fuel is not a reliable technical solution. He further argued that we should rather rely on safety culture by building it with emphasizing 3S: Safety, Security and Safeguard to protect the spent nuclear fuel from potential proliferators.

The last question in the session was asking if the reprocessing technology can be a part of export package, for instance a deal with Korea-UAE. Dr. Hwang clarified that Pryo-processing is a R&D effort. It has nothing to do with UAE or commercial sector so far. Korea will try to be the nuclear leader and Korea will try to develop a solution. However, the R&D effort of pyro-processing is for the long term solution.