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Safe & Secure Policy for Dismantled Wastes in Nuclear Power Plant

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Summary

Summarizing the examples of domestic and overseas radioactive wastes, it is a current situation that citizens are highly anxious about the wastes contaminated by radioactive substances even though the governmental agency tries to assure the safety of wastes including radiation and the actual concentration of radiation is the level of natural radiation or below. Among domestic nuclear power plants besides closed-down Kori Nuclear Power Plant #1, the design life of 12 plants which are 50% of 24 plants in current commercial operation shall be terminated by the year 2030. In reference to Kori #1 Nuclear Power Plant, the predicted generation of dismantled wastes shall be about 80,000 drums. If dismantled wastes would be reduced to the level of 14,500 drums through decontamination or volume reduction of dismantled wastes, the predicted generation of self disposal wastes will be 13,000tons ~ 32,750tons. By the reason of discharge from nuclear power related facility, citizens may feel repulsion about the recycling of even disposal wastes. Even though self disposal wastes are safe scientifically, the institutional improvement is required to assure citizens. The present study, as a measure for safe and secure control through an optimum treatment of dismantled wastes, proposes the improvement in 「Nuclear Safety Act」 and 「Waste Control Act」, the reinforcement of written contents of self disposal plan and hazard assessment, the addition of a process to measure radioactive concentration at final disposal, the introduction of a certification system for recycled products through self disposal wastes, and the limitation on users, and the reinforcement of traceability and information disclosure for self disposal wastes.

* Please note that this paper is designed to suggest policy implications and suggestions by summarizing some parts of "Strategies for Improving the Safety and Relief Management in the Disposal of Decommissioning Waste from Nuclear Power Plants", which is the basic research of Korea Environment Institute (KEI) and taking into further discussions.

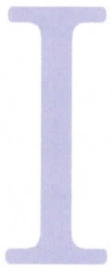
Writing

Hisun Lee

Honorary Research Fellow
Department of Living
Environment Research
leehs@kei.re.kr

Kongjang Cho

Chief Research Fellow
Department of Social
Environment Research
kjcho@kei.re.kr



Preface

As of the year 2017, there are 25 nuclear power plants in Korea. Among them, the design lifespan of 10 nuclear power plants shall be terminated within 10 years. In June 19, 2017, forty years after the first operation of Kori Nuclear Power Plant (hereinafter, 'power plant') in Korea, the power plant was permanently stopped so that the dismantlement of aged power plant became reality.¹⁾ In addition, since the launching of Moon, JaeIn government in May, 2017, Mr. President pledged a road map of a withdrawal plan for power plants such as a complete shutdown of new power plant, a nullification of construction plan, an immediate closure of a power plant with the termination of design lifespan, and a closure of Wolsong #1 Nuclear Power Plant to have promoted its policy.²⁾ As the dismantlement of power plants has become reality by the termination of lifespan of aged power plants and the policy promotion for withdrawal plan, the social and economic cost has emerged as an issue for a permanent disposal of wastes from the power plant, a safety problem, and a cost for dismantlement.

As seen from controversial cases in relation to asphalt and concrete wastes at Nowon-gu and Seocho-gu in Seoul and Uiwang-si in Gyeonggi-do, although the radiation concentration of asphalt and concrete wastes was in the lowest level,³⁾ citizens have responded sensitively to the concentration of radiation since the accident of Fuku Shima, Japan. In the mean time, if the dismantlement of power plants starts accelerating, a concentrated generation

1) KBS NEWS (2017.6.19), "Permanent Shutdown of First Kori No.1 Nuclear Power Plant in Korea", Search Date: 2017.6.22.

2) Democratic Party of Korea (2017), p.259; Chosun Ilbo (2017.10.24).

3) Dong-a Ilbo (2011.11.2); Seoul Shinmun (2012.2.24); Yonhap News (2012.11.5).

of self disposable wastes is expected in short period, which wastes are available for landfill, incineration and recycling like general wastes. However, in such a situation that citizens reacted sensitively even when a small amount of radiation is included in asphalt and concrete wastes, the control system for wastes in the current law is insufficient to assure citizens regarding wastes generated during the dismantlement process of power plants.

Dismantled waste during the dismantlement of power plant can be classified to a radioactive waste generated within the radiation control zone and a general waste (non-radioactive) generated beside the radiation control zone. As the general wastes generated besides the radiation control zone are considered as the waste uncontaminated with radiation, they are currently in the process of a disposal through landfill, incineration and recycling like general wastes. In addition, dismantled wastes are classified to a radioactive waste which corresponds to high-level, mid-level, low-level, and extreme low-level wastes and a self disposal waste with lower or no radiation concentration. It requires a separate control over the radioactive wastes as a waste including radiation above a certain standard concentration. The self disposal waste satisfies the level below the allowable concentration of self disposal, which can be treated through landfill, incineration and recycling. Generally, above 80% of wastes generated during the dismantlement of a power plant has either low level of radiation or no radiation, so that they are self disposable waste which can be treated through landfill, incineration and recycling like general wastes. Mid-level, low-level, and extreme low-level radioactive wastes shall be expected to become 20% level.⁴⁾

Although the Nuclear Safety and Security Commission has a right of the self disposal for wastes scheduled to be generated at the dismantlement of power plants, they are negligent in preparation for it. In addition, although it is possible to process the self disposal waste for general waste, there is no mention in the relevant laws by the Ministry of Environment about possible self disposal wastes among radioactive wastes such as 「Wastes Control

4) Japanese Atomic Power Company, “対象物と排出量”, Search Date: 2017.8.31.

Act」, 「Resource Circulation Basic Act」.⁵⁾

Through the above examined current status, there exist two issues of ‘safety’ and ‘security’ in relation to dismantled nuclear wastes. ‘Safety’ means a condition without any worry of any risk or accident.⁶⁾ The safe condition has a countermeasure set to prevent human from harm even there exists a condition without any risk or a cause for risk. It means such confirmed fact. ‘Security’ means a condition with a comfortable mind throwing off every worry.⁷⁾ Namely, the safety means a scientific and objective condition. The security means a subjective and emotional condition. Even scientists say it is safe, residents may not feel secure. On the other hand, even residents feel secure, it is not scientifically safe. Accordingly, it is the time for necessary policy measure to harmonize the scientific safety with the security of residents’ subjective judgment.

5) NLIC, “Waste Control Act”, “Framework Act on Resource Circulation”.

6) NAVER Encyclopedia, “Safety”, Search Date: 2017.10.11.

7) NAVER Dictionary, “Security”, Search Date: 2017.9.15.

I

Permanent Shutdown & Dismantled Status of Domestic & Overseas Nuclear Power Plants

〈Table 1〉 shows the current status of permanent shutdown of world nuclear power plants and the past dismantlement experiences for each country. The U.S holds the most nuclear power plants with 34 plants for permanent shutdown, and U.K, Germany, Japan and France have more than 10 power plants for permanent shutdown.

Table 1. Number of World Nuclear Power Plants for Permanent Shutdown & Past Dismantlement Experiences

Countries	Plants for Permanent Shutdown	Dismantlement Experiences
U.S	34	○
U.K	30	×
Germany	28	○
Japan	17	○
France	12	×
Canada	6	×
Russia	6	×
Sweden	5	×
Bulgaria	4	×
Italy	4	×
Ukraina	4	×
Slovakia	3	×
Spain	3	×
Lithuania	2	×
Armenia	1	×
Belgium	1	×
Kazakhstan	1	×
Republic of Korea	1	×
Netherlands	1	×
Swiss	1	×
Total	164	-

Source: Reorganized from IAEA PRIS, "Permanent Shutdown Reactors By Country", Search Date: 2017.10.11; KAIF, "Current State of Nuclear Power Worldwide", Search Date: 2017.10.11.

〈Table 2〉 shows the domestic power plants which reach their lifespan by the year 2030. Besides Kori #1 Nuclear Power Plant, the lifespan of 12 plants which are 50% out of 24 plants in current commercial operation are scheduled to be terminated within the year 2030.

Table 2. Nuclear Power Plant Reaching Their Lifespan by the Year 2030

Classification	Location	Commercial Operation Date	Design Lifespan (Years)	Design Lifespan Termination Date
Kori #1	Jangan-eup, Kijang-gun, Busan	1978.4.29	30	2017.6.18. (extended 10 years)
Wolseong #1	Yangnam-myeon, Gyeongju-si, Gyeongbuk	1983.4.22	30	2022.11.20. (extended 10 years)
Kori #2	Jangan-eup, Kijang-gun, Busan	1983.7.25	40	2023.8.9
Kori #3	Jangan-eup, Kijang-gun, Busan	1985.9.30	40	2024.9.28
Kori #4	Jangan-eup, Kijang-gun, Busan	1986.4.29	40	2025.8.6
Hanbit #1	Hongnong-eup, Yonggwang-gun, Jeonnam	1986.8.25	40	2025.12.22
Hanbit #2	Hongnong-eup, Yonggwang-gun, Jeonnam	1987.6.10	40	2026.9.11
Wolseong #2	Yangnam-myeon, Gyeongju-si, Gyeongbuk	1997.7.1	30	2026.11.1
Hanul #1	Buk-myeon, Uljin-gun, Gyeongbuk	1988.9.10	40	2027.12.22
Wolseong #3	Yangnam-myeon, Gyeongju-si, Gyeongbuk	1998.7.1	30	2027.12.29
Hanul #2	Buk-myeon, Uljin-gun, Gyeongbuk	1989.9.30	40	2028.12.28
Wolseong #4	Yangnam-myeon, Gyeongju-si, Gyeongbuk	1999.10.1	40	2029.2.7

Source: Reorganized from MOTIE (2016), p.201.

In 2015, the Korea Hydro & Nuclear Power (KHNP) estimated the cost to dismantle a power plant would be about 634.7 billion won. However, if the dismantlement began, the increase in the cost would be unavoidable due to the management and treatment cost for radioactive waste and nuclear fuel after its use. It was estimated that the actual close-down cost for a power plant would reach 1 billion won. As shown in the <Table 2>, there are 12 domestic power plants which are waiting for the dismantlement by the year 2030 due to their termination of design lifespan. It is expected the market scale will reach 12 billion won for the dismantlement of domestic power plants for 10 years.⁸⁾

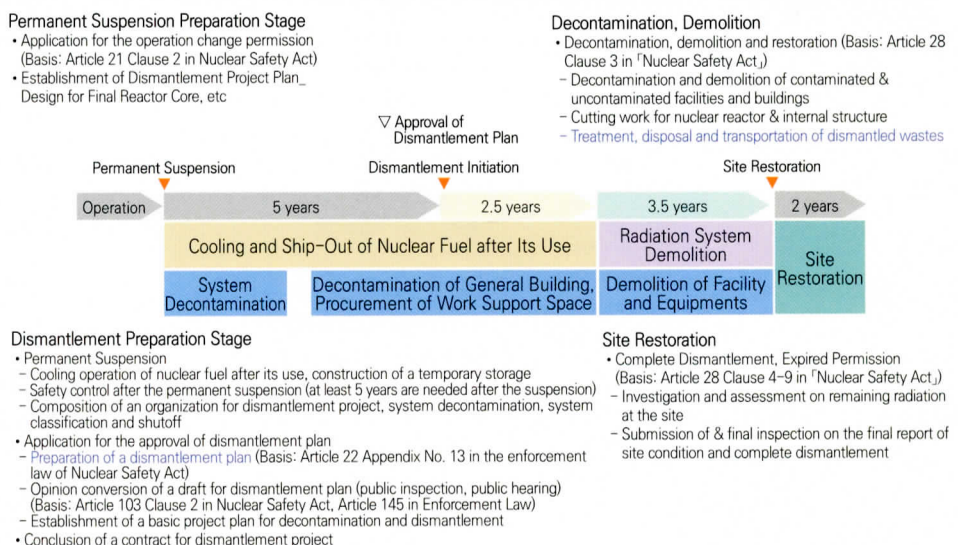
8) Busan Ilbo (2017.6.14).

III

Outline for Dismantlement of Nuclear Power Plants⁹⁾

The dismantlement is every activity to permanently stop the operation of facilities in a power plant and either demolish relevant facilities and sites or remove the radioactive contamination to eliminate it from the application target for restriction. It will be implemented by applying a technology suitable for the characteristic of dismantlement target and a condition for each country. The legal definition is the administrative and technical activity to clear the safety control restriction on the facilities in the power plant. Its administrative definition is the common physical and chemical activity to isolate fully the facilities in permanently shutdown power plant in order to prevent humans and environment from hazard. The (Figure 1) shows the general implementation for the dismantlement of power plant.

Figure 1. Implementation for Dismantlement of Nuclear Power Plant



Source: Reorganized from KHNP (2017.6).

9) MOTIE (2016), pp.242-243; KHNP (2017.6).

IV Classification Standard & Generation Prospect of Dismantled Wastes

The radioactive waste is classified to high level, mid level, and low level according to the heat generation and the radiation concentration and the mid to low level wastes to extreme low level, low level, and mid level according to the Article 3 No. 2014-3 in the notice of NSSC (『Classification of Radioactive Waste and Regulations Regarding Standards for Self-Disposal』) as shown in the <Table 3>.

Table 3. Classification Standard for Domestic Radioactive Wastes

Waste Categories	Classification Standard
High Level Waste	Among radioactive wastes, the radiation concentration and heat generation of wastes are above the value designated by the NSSC (Hereinafter "The Commission") according to the Article 3 in 『NSSC Installation & Operation Act』
Mid Level Waste	Among mid to low level radioactive wastes, the radiation concentration is above the limit 1) in the low level radioactive wastes.
Low Level Waste	Among low to mid level radioactive wastes, the radiation concentration is 100 times and above the allowable concentration 2) for self disposal and below the limited value of radiation concentration in the low level radioactive wastes
Extreme Low Level Waste	Among low to mid level radioactive wastes, the radiation concentration is above the allowable concentration for self disposal and below 100 times the allowable concentration

Source: NLFC, "Classification of Radioactive Waste and Regulations Regarding Standards for Self-Disposal", Search Date: 2017.9.15.

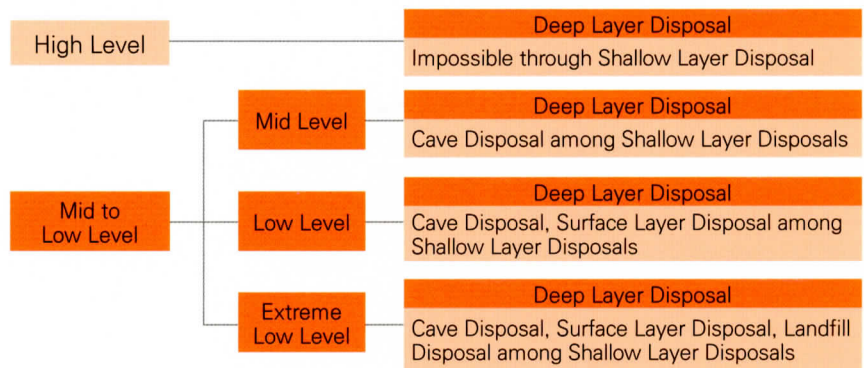
In reference to the Plant, the estimated generation of dismantled wastes is about 80,000 drum.¹⁰⁾ According to the data by the KHNP (2017.6), it is scheduled to reduce dismantled wastes to the level of 14,500 drums through decontamination or volume reduction. Therefore, the estimated generation of self disposal wastes for each unit will be 65,500 drums. If the weight of 200L drum would be 200kg~500kg, the waste would be 13,000 to 32,750 tons.

10) KHNP (2017.6).

V Disposal Plan for Dismantled Wastes

As dismantled wastes are included in the radioactive waste, another separate disposal plan has not been established, so that they are treated by the same method as radioactive waste. As of the year 2017, all facilities for the disposal of radioactive wastes in Korea are disposed in the cave with the disposal facility for low to mid level radioactive wastes located at Gyeongju. Currently, a surface layer disposal facility is under construction and a landfill type disposal facility is in the middle of a construction plan. The disposal method for radioactive waste is classified as shown in the <Figure 2>. Currently, Korea has been implementing a cave disposal type for the disposal of low to mid level wastes(applied like as to low level, mid level and extreme low level wastes).

Figure 2. Disposal Method for Radioactive Wastes



Source: KHNP (2017.6).

The amount of radioactive wastes generated during the operation and dismantlement of power plants is estimated to be 522,000 drums. The first stage radioactive waste facility at Gyeongju is in the scale of 100,000 drums. The second stage Gyeongju radioactive wastes facility currently in construction is 125,000 drums, which are in the scale of total 225,000. It is the capacity to process about 62% of dismantled wastes generated at the application of decontamination or volume reduction and about 11% of dismantled wastes generated without decontamination or volume reduction. If dismantlement is proceeded by considering new power plant (undecided), it seems that the time for the radioactive wastes facility to be filled up due to the dismantled wastes out of 36 power plants shall be the dismantlement of 22 power plants after decontamination or volume reduction and the dismantlement of 3 power plants without decontamination or volume reduction. At the time when the dismantlement of power plant is not fully in action, the capacity of the facilities may have room, but it seems there is no countermeasure against the variables of operation stop due to accident and nuclear withdrawal policy.

VI Examples of Anxious Residents about Domestic & Overseas Radioactive Wastes

1. Controversy of Some Radioactive Substances above Self Disposal Standard Contained inside Asphalt (Nowon-gu, Seoul)

According to the report about the radioactive substances contained in the asphalt concrete wastes of Wolgye-dong, Nowon-gu after the analysis on the specimen collected from the onsite, the amount and concentration of asphalt and concrete wastes was the treatment target by 「Nuclear Power Safety Act」 and 「Radioactive Wastes Control Act」, which was demolished for reconstruction. It was presumed to be contaminated by the radiation through some import materials such as iron bar used for asphalt road construction.¹¹⁾

The level of radiation emitted from asphalt concrete wastes was lower than the level taken once with X-ray, but there was a significant anxiety such as a rumor about the cancer development in a resident. As shown in <Table 4>, there was a laryngeal cancer in the position between the Korea Institute of Nuclear Safety (KINS) and citizens even for the concentration of the same radiation.

11) Yonhap News (2011.11.2).

Table 4. Different Positions by Stakeholders out of Onsite Survey Result

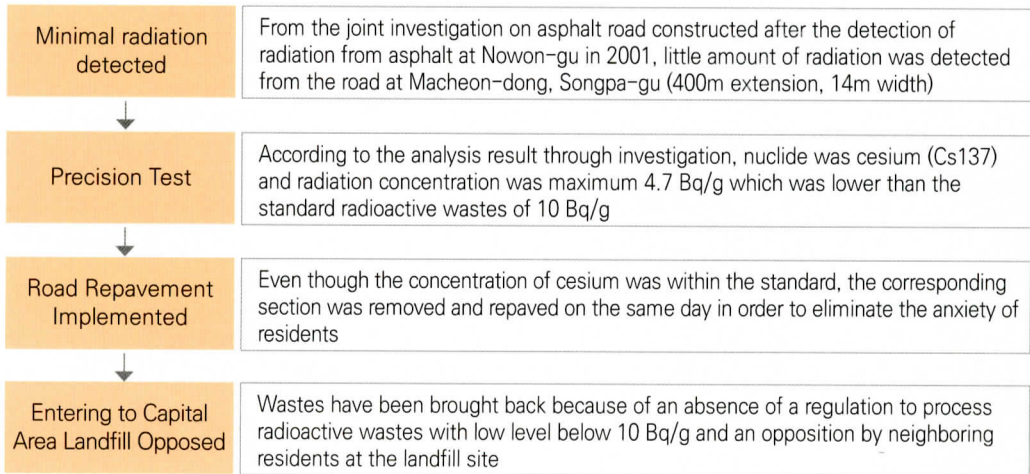
KINS	Citizens (Childsave, KFEM etc.)
<ul style="list-style-type: none"> · As the amount of radiation was minimal, it is not a level to evacuate or control residents. · Even a person stands at the corresponding location for one hour daily for one year, it is the numerical value around 50% of annual allowable radiation. · Considering accumulated radiation exposure is 0.5Sv for significant clinical symptom, it is less hazardous amount. 	<ul style="list-style-type: none"> · “Cesium is highly dangerous radioactive substance, so that it is just the elaboration to say, ‘not harmful on human body’.” · “It is only possible to say not harmful if its amount is 0mSv. The government is distorting the fact. They should say, ‘less harmful’.” · As residential area is where many children and youth pass by, they are affected by radioactive substances above 8 times more than adults. · The government insists “controlling the use of the section contaminated by radioactive substances and removing contaminated asphalt quickly.”

Source: Reorganized from Yonhap News (2011.11.2); Chosun Ilbo (2011.11.8).

2. Controversy of Radioactive Substances Contained inside Asphalt below Self Disposal Standard (Songpa-gu, Seoul)

〈Figure 3〉 shows the arrangement for the cases of Songpa-gu where radiation was detected from the result of joint investigation after the incident of Nowon-gu. After the detection of radiation from asphalt road at Macheon-dong, Songpa-gu the precision test result showed below the restriction standard. But the government removed asphalt concrete in the corresponding section and implemented a new pavement in order to relieve the anxiety of residents.¹²⁾ Residents around the landfill sites in the capital area opposed the landfill for above asphalt concrete wastes at the landfill sites around the capital area even it was below the level of self disposal. According to the safety confirmation by the NSSC, a necessity of regulation has emerged for radioactive asphalt concrete to be processed as general wastes.¹³⁾

12) Seoul Shinmun (2012.2.24).
 13) Kukmin Ilbo (2012.5.31).

Figure 3. The example of Songpa-gu, Seoul

Source: Reorganized from Seoul Shimun (2012.12.6); Kukmin Ilbo (2012.5.31)

3. Controversy regarding Utilization of Non Radioactive Wastes for the Basic Materials for Road Pavement (Uiwang-si, Gyeonggido)

Some medias reported that Uiwang, Pocheon and other cities in Gyeonggido utilized 1,702 tons of wastes among 1,735 tons generated from the dismantlement of a nuclear power reactor for 4 times of study by The KAERI (Korea Academic Energy Research Institute) from 2005 to 2009, excluding 33 tons of landfill.¹⁴⁾ Regarding this, residents insisted a complete removal of wastes through the excavation of the road, saying “it is not a matter of high or low value of radiation but the use of radioactive wastes itself is the problem which have been used for the road in front of school where students are studying and the area around apartments”. Under the presence of a company for onsite measurement on radiation and a person for onsite verification and confirmation of aggregates, the KAERI, residents and representatives of apartments at Naeson 1 & 2

14) Seoul Shinmun (2012.10.16).

dongs, media and broadcasting companies, from the result of excavation of the concrete at four sections of underground work by the KEPCO at Naeson-dong, it was confirmed that general mixed aggregates had been used not the non radioactive circulated aggregates.¹⁵⁾

4. Controversy of Illegal Disposal of Radioactive Wastes by KAERI (Daejeon Metropolitan City)

According to the NSCC (chairman Kim YongHwan), from the result of a special inspection on the actual control over radioactive wastes by three facilities in KAERI including the nuclear fuel material research building and the inflammable wastes treatment facility from last November until recent month, 24 violations were confirmed additionally. Specifically, these are '13 cases of illegal disposal of radioactive wastes', '3 cases of using decontamination, fusion and incineration facilities with the violation of permission condition', and '8 cases of the manipulation and commission of critical records such as a surveillance record for exhaust system'.¹⁶⁾

Major violations of radiation are the illegal disposal by mixing with general concrete wastes after the decontamination experiment of concrete wastes or the illegal discharge of liquified radiation wastes gathered in the remover of hazardous gas through the rain drainage pipe, and the illegal selling of several machineries used inside the radiation control zone. Besides these, regarding the use of decontamination, fusion, and incineration facilities, there was a violation of permission condition in the facility with permission for uranium decontamination such as a decontamination of other wastes including cesium and cobalt or a decontamination of wastes including uranium above permissible amount. Such violations were uncovered as either modification or manipulation of measured records by the radioactivity monitor at exhaust system and

15) OhmyNews (2012.11.6).

16) Nocut News (2017.4.20).

the reduction or omission of incinerated records at the inflammable waste treatment facility.¹⁷⁾

The NSCC implemented an assessment on the effect of radiation through the analysis on specimen targeting entire violation by KAERI. From its result, the NSCC confirmed that the self disposal or discharge control by KAERI was below the standard and evaluated that the effect of radiation on external environment was insignificant.

5. Controversy of Utilization of Decontaminated Soil in Fuku Shima

If the concentration of radioactive substances in the wastes discharged during the resolution and decontamination (removal of radiation contamination) for the explosion of Fuku Shima Nuclear Power Plant had been below a certain standard, a plan was announced to use them for construction materials of road, etc.¹⁸⁾

In this announcement, it has been determined that decontaminated wastes such as soil be used for the embankment for the constructions of road and railroad, the creation of sea wall and forest for prevention, and the construction materials for waste disposal plant. The concentration of radioactive substances in the waste available for each purpose has been subdivided into the range of 5,000~8,000Bq/kg.

Recycling was possible in the past when the concentration of radiation in the wastes out of the nuclear power related facilities was below 100Bq/kg. However, it has been determined that even though the concentration of cesium would exceed 100Bq/kg, it would be available to reuse if it is below 6,000Bq/kg as actions are implemented to reduce the exposed radiation by covering it with concrete. In addition, as for environmental concern, a policy has been set up to overlay 10cm to 1m with soil or concrete by each location where to use wastes for construction materials in order to

17) Nocut News (2017.4.20).

18) News 1(2016.6.7).

prevent the leak of decontaminated wastes or the additional exposure of radiation.¹⁹⁾

However, civil groups raised a question about the policy, 'soil or concrete shall be overlaid above 10cm to 1m according to the location where to use wastes for construction materials', as in the regulation based on 「Nuclear Power Reactor Restriction Act」, the recycling standard is 100Bq/kg for concrete or metal which has been generated by the dismantlement of power plant and decontaminated soil is above the recycling standard.²⁰⁾

The civil groups claimed that there existed much possibility of contamination in the structural materials in the public projects even though the contamination of underground water was unavoidable around a control type disposal plant; and that there was a concern of mass discharge to the midst of environment by heavy rain, natural disaster, and erosion. In addition, they raised their voices of criticism claiming that during the construction, there existed a possibility of radiation exposure to workers and pedestrians; and that it was the policy to have citizens of Japan including children being exposed to the radiation.

19) Yonhap News (2016.6.27).

20) FoE Japan (2017.6.21).

VII Workshop Result of Control Measure for Dismantled Wastes in Nuclear Power Plants

It is mandatory to safely control wastes including radiation. It is also judged necessary to have a policy to control wastes safely and assure citizens who feel anxiety. The first stage workshop was held for stakeholders to survey the awareness of the dismantled wastes from the power plant by citizens. After the workshop for stakeholders, the second stage workshop was held for professionals to prepare a measure for the safe and secure control over dismantled wastes from the power plant based on the survey result of the awareness by citizens.

1. Workshop for Stakeholders

The workshop for stakeholders was proceeded with the order of the primary survey through questionnaires, the lecture and Q & A, the secondary survey through questionnaires, the appreciation and discussion targeting graduate school students, housewives, civil groups, and professionals. The workshop for stakeholders carried out the primary survey on the awareness of citizens in a condition without previous information about dismantled wastes from the power plant; and provided the information of a current status of power plant, the major dismantlement process, the classification and disposal method of radioactive wastes, the difficulty in the construction of a radiation disposal plant. The secondary survey through questionnaires was

carried out to analyze the awareness change by citizens after the delivery of information, and the survey through questionnaires was implemented with the same contents in the primary survey. Appreciation and discussion were the time to share the contents of the workshop where professionals discussed the usual anxiety of power plants by citizens and the policy measure to assure citizens.

The survey through questionnaires consisted of questions about the understanding of a classification and disposal method for dismantled wastes from the power plant; the recycling and disposal of self disposal wastes (wastes with the concentration of radiation below $10\mu\text{Sv}/\text{year}$ among wastes generated in the radiation control zone in the power plant site); and the recycling and disposal of wastes (non radioactive wastes) generated outside of the radiation control zone at the power plant site.

Comparing the primary survey with the secondary survey, the awareness by most citizens of recycling and disposal of wastes (non radioactive wastes) generated outside of the radiation control zone at the power plant site was changed to the awareness of possible recycling after lectures and discussion. However, they recognized the landfill, incineration and recycling of self disposal wastes to be the same as those of radioactive waste, and thought negative of the same treatment through landfill, incineration and recycling as for general wastes.

The opinions of general citizens regarding the disposal of self disposal wastes were categorized to a concern for self disposal concentration standard and radiation, a treatment measure for self disposal wastes, and the necessity of specific presentation of examples. The <Table 5> shows the detail opinions for each category regarding the control and disposal method for self disposal wastes.

Table 5. Detail Opinions for Each Category regarding the Control & Disposal Method for Self Disposal Wastes

Categories	Detail Opinions
Opinions about Radiation in Reference to the Concentration of Self Disposal	<ul style="list-style-type: none"> · Consented on the recycling of self disposal wastes, but there existed a concern of an effect according to the exposure frequency of even small amount of radiation. · It is expected to have difficulty in the treatment because of the generation of mass self disposal wastes. According to the amount of wastes with a little radioactive substances, the effect of radioactive substances must be considered by gross weight. · Considering the situation at the time of setting the self disposal standard, the concentration was not harmful on human body. Yet, if the power plants would be dismantled continuously and most wastes be utilized for our daily life, the frequency of exposure to radiation would increase, which will accumulate radiation to cause danger. · Numerical values are not reliable.
Treatment Measure for Self Disposal Wastes	<ul style="list-style-type: none"> · As there exists a possibility of a little amount of radiation included in the wastes, the waste treatment is necessary at the radiation disposal plant. · Instead of recycling self disposal wastes, a measure should be considered with the methods of landfill and incineration (Landfill inside power plant site). · After the self treatment at the area of generation, it is necessary to review the direction either to landfill at the corresponding site or to construct a separate self disposal wastes plant. · As the half life of radiation is less than 10 years, it is initially necessary to review a measure to lower the radiation through landfill, etc and utilize it in a safe condition. · If it is necessary for recycling, wastes shall be utilized inside the power plant. · It seems that a measure is necessary to recycle wastes for the item with low average exposure frequency to all citizens. · The landfill of self disposal wastes at the power plant site could be felt as demanding additional burden to neighboring residents (Also there is a tendency to say easily as we do not actually reside). · The method of recycling seems for everyone to share risk and burden fairly in a certain aspect. It seems better if a sticker is attached after enforcing more strengthened law than current level and an opportunity of selection is given to consumers.
Necessity of Presenting Specific Examples	<ul style="list-style-type: none"> · An education is necessary to see the level of radiation concentration of self disposal wastes compared to other general wastes. · It is necessary either to compare with daily life wastes or to present specifically about diseases by numerical values and cases of generating side effect for people who are not familiar with numerical values and technical terminologies. · It is necessary to disclose definite information about the effect of self disposal wastes. · Types and cases of self disposal wastes should be specified in detail. · It is necessary to present in detail the information about types and generated amount of self disposal wastes. · It seems that data should be provided which have been compared with other wastes including the contents of exposure frequency for the acceptability by citizens. · As there is a low possibility of realizing the treatment by landfill or by sending wastes to the space in the economical aspect, it is necessary to provide the specific information by the government in order to improve the awareness of citizens.

Source: Prepared by the author.

The opinions of safety control and disposal method for general wastes (non radioactive wastes) can be classified to a measure to treat general wastes (non radioactive wastes), a concern at recycling general wastes (non radioactive wastes), and the necessity of information disclosure. Every citizen had a position for the necessity of definite information disclosure of self disposal wastes and general wastes (non radioactive wastes). If it is true that general wastes (non radioactive wastes) have low radiation, they gave such an opinion that it is not necessary to treat wastes at the radiation disposal plant. However, some gave an opinion of inevitable anxiety if general wastes would be utilized for recycled products, which wastes are generated inside the power plant site in the region where they are residing. Therefore, in the position of citizens, it is necessary to disclose definite information such as not harmful on human body or safe. So that, they had an opinion of a necessity of more strengthened control system than current laws. The <Table 6> shows the detail opinion about the control and disposal method of general wastes (non radioactive wastes).

Table 6. Detail Opinions per Category about Control and Disposal Method of General Wastes (Non Radioactive Wastes)

Categories	Detail Opinions
Treatment Measure for General Wastes (Non Radioactive Wastes)	<ul style="list-style-type: none"> · It seems that general wastes may be treated equivalently as the general control over wastes if it is confirmed of low radiation in general wastes. · It seems that if they are classified to general wastes, it is not necessary to process them at the radioactive wastes disposal plant. · There is a concern of several side effects if recycling is permitted officially in a situation of very poor control over self disposal wastes. · It seems fine to recycle general wastes (non radioactive wastes). · If it is not possible and unnecessary to treat general wastes at the radioactive wastes disposal plant, it is proper to utilize them where citizens are not exposed directly or indirectly to the radiation at most.
Concern at Recycling General Wastes (Non Radioactive Wastes)	<ul style="list-style-type: none"> · It seems that residents would feel anxiety if recycled products are being utilized in the region where they are residing. · It seems that neighboring people would suffer inconvenience due to secondary hazardous substances out of the recycling process even though it is good to recycle wastes.

Categories	Detail Opinions
Necessity of Information Disclosure	<ul style="list-style-type: none"> · In the position of citizens, they require of a definite information, so that it is desirable to install separate items in general wastes under the 「Waste Control Act」 and inform them. · It is necessary to provide the information with a level of understanding by citizens including residents regarding the waste treatment. · It is necessary to consider general and daily life self disposals and business site wastes comprehensively. · It is necessary to promote unfamiliar terminologies of self disposal waste and general waste (non radioactive waste).

Source: Prepared by the author.

2. Workshop for Professionals

The workshop for professionals was held to reflect the survey on literatures and the result from the workshop for stakeholders: request professionals to verify the measure prepared for the safe and secure control over dismantled wastes of the power plants; and prepare additional control measures. All professionals agreed on the matters of citizens' anxiety and on the position of researchers who claimed the more strengthened disposal method for self disposal wastes. There are total 4 major opinions discussed additionally at the professional workshop.

First, in the current 「Nuclear Safety Act」, the cooperative system is insufficient by the Nuclear Safety and Security Commission (NSSC) and the Ministry of Environment (MOE). As a role of the Ministry of Environment is necessary for any wastes, participants gave an opinion such that it is necessary to prepare a system for NSSC and MOE to cooperate through previous laws rather than to make a new law.

Secondly, regarding the system for the self disposal of radioactive wastes, if it is judged to be lower than allowable concentration for self disposal after the measurement of radiation by current business operator, participants gave an opinion of necessary reinforcement for possible self disposal. For example, in case of the treatment of designated wastes, total two times of measurement on hazardous substances shall be implemented when a business operator discharges designated wastes and when wastes

enter the disposal plant for designated wastes. Therefore, the radiation concentration should be also equally measured twice for the self disposal wastes as for the designated wastes, and more reinforced system than current self disposal system should be introduced. Namely, participants gave an opinion of measuring each radiation concentration when the business operator discharges self disposal wastes and when self disposal wastes enter the disposal plant.

Thirdly, if most dismantled wastes are concrete, they will be crushed and used for aggregates by the same way in construction wastes. As the self disposal wastes could be either radioactive wastes or general wastes under the current system of 「Nuclear Safety Act」 and 「Waste Control Act」, there exists a blind spot in the management. Therefore, if the power plant plans to process radioactive wastes by the same method as for the construction wastes, it is necessary to disclose the information about treatment method and to trace recycled products.

Lastly, if the wastes were generated from the power plant, repulsive feeling by citizens would be severe even though the radiation concentration is low. Therefore, the participants have a position for necessary review on the disposal method such as safe landfill at the place isolated from human life rather than to proceed with the disposal of self disposal wastes through landfill, incineration and recycling. As there are also diverse types of self disposal wastes, considering the generation source of self disposal wastes, it is necessary to review the different disposal method by type. If the power plant should recycle self disposal wastes inevitably, they should put an effort to prevent wastes from entering citizens' life by presenting a limitation on users in the laws; and consider the introduction of a history system for recycled products in order to secure the reliability.

VIII

Closing Remarks

Summarizing the examples of domestic and overseas radioactive wastes, even though the governmental agency assures the safety of wastes which include radiation and an actual radiation concentration is the level of natural radiation or below, citizens still feel high anxiety of the wastes contaminated by radioactive substances. The government and relevant nuclear power agency insist that as most wastes contain radiation below the self disposal concentration standard, they are not in the level of hazard on human body; that there is rarely a risk of radiation exposure as the wastes above the specific level of concentration are controlled by installing a safety facility. However, citizens or civil groups of interest react so sensitively that even there is a person who usually carries the portable radiation detector. They believed that the claim of non hazard on human body only corresponds to when wastes do not contain radiation at all which is 0mSv. They also believed that even when the radiation was below the self disposal level, it was considered to be unsafe waste. It is possible to confirm that the analysis by personnels in the government and relevant nuclear power agency is clearly different from the analysis by citizens or civil groups on the same concentration standard.

By the reason of a discharge of self disposal wastes from nuclear power related facilities, citizens may feel repulsion for

recycling, so that the system improvement is required to assure citizens even though self disposal wastes are safe scientifically. In order to assure citizens, education or promotion activity is judged mandatory by producing data for terminologies of easy understanding by citizens. In addition, as the current information disclosure regarding radiation is not transparent besides the daily life radiation concentration, it is judged necessary to prepare a specific measure to disclose the information about the entire process of dismantlement of power plant and the disposal path of dismantled wastes.

Participants in the workshop proposed a measure for the safe and secure control over dismantled wastes of power plants to assure citizens as well as their safety by identifying status and problems of a control system over domestic self disposal wastes and deducing the implication. There are total 5 measures for the safe and secure control over the dismantled wastes of power plants: the amendment in 「Nuclear Safety Act」 and 「Waste Control Act」, the reinforcement of written contents and hazard assessment in the self disposal plan, the addition of the measuring process for radiation concentration at final disposal, the introduction of a certification system for recycled products out of self disposal wastes, the limitation on users, and the reinforcement of traceability and information disclosure of self disposal wastes.

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KEI ENVIRONMENT FORUM



8F-11F, Bldg B, 370 Sicheong-daero, Sejong, 30147, Republic of Korea
TEL +82-44-415-7777 FAX +82-44-415-7799 www.kei.re.kr

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