Consideration About Assessment of Radiation Source Term When Decommissioning of Nuclear Power Utilization Facilities

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1. Introduction

Among the domestic nuclear power plants, Kori Unit 1 has been permanently shut down on June 18, 2017 and is in the process of decommissioning. Therefore, many organizations such as industry, research institute, educational institution are conducting research and development for decommissioning nuclear power plant, and many contents about radiation source term have been established.

But, when decommissioning nuclear power utilization facilities except for nuclear power plants, it is no certainty about the definition of radiation source term therefore it is necessary to establish

2. Assessment of Radiation Source Term of Nuclear Power Utilization Facilities

Currently, there are 8,391 licensed and reported nuclear power utilization facilities in Korea, and in this paper, when decommissioning nuclear power plants, radioisotope production facilities, opened radioisotope use facilities, neutron source calibration facilities, nuclear fusion research institutes and high energy linear accelerator facilities.

I will describe the considerations for assessment of radiation source term.[1]

2.1 Characteristics of Radiation Source Term by Facility

2.1.1 Nuclear Power Plants. The radiation source term for nuclear power plants is the fission products generated during the fission process and radioactivation material by the neutrons generated during the fission process.

2.1.2 Radioisotopes Production Facilities. When assessing the radiation source term in the case of decommissioning a radioisotope production facility, consideration should be given to radioactivation. And, if the produced radionuclides is a short-lived radionuclides, it can be excluded from the evaluation of the radiation source term.

Recently, cyclotrons are mainly used in the medical field. A typical nuclide production is 18F. Neutrons are generated in the course of producing the desired radioisotope by the reaction of the accelerated protons and target material. Therefore, it is necessary to consider the radioactivation of the surrounding material by the neutron when assessing the radiation source term.

Reaction formula : \(^{16}\text{O} + \frac{3}{1}\text{p} \rightarrow ^{18}\text{F} + \frac{2}{1}\text{n} \quad (1)\)

2.1.3 Opened Radioisotope Use Facilities. Open radioisotope is less use than sealed radioisotope. But, radioactive contamination occurs in open radioisotope facilities.

When the facilities are divided into a short-lived radionuclides and a long-lived radionuclides facilities, the assessment of the degree of contamination with
the long-lived radionuclides facility must be carried out.

Also, when used in combination, an assessment of contamination is essential.

Table 1. The amount of radioactivity licensed for the last four years [1]

<table>
<thead>
<tr>
<th>Classification</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opened RI</td>
<td>19,475</td>
<td>19,848</td>
<td>18,288</td>
<td>19,039</td>
</tr>
<tr>
<td>Sealed RI</td>
<td>144,737</td>
<td>145,844</td>
<td>146,531</td>
<td>191,633</td>
</tr>
<tr>
<td>Sum</td>
<td>164,212</td>
<td>165,692</td>
<td>164,819</td>
<td>210,672</td>
</tr>
</tbody>
</table>

Table 2. The amount of open radioisotope licensed by agency for the last four years [1]

<table>
<thead>
<tr>
<th>Classification</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td>3,278,087</td>
<td>3,278,111</td>
<td>28,639</td>
<td>433,396</td>
</tr>
<tr>
<td>Public</td>
<td>5,983</td>
<td>1,235</td>
<td>4,787</td>
<td>7,299</td>
</tr>
<tr>
<td>Medical attention</td>
<td>4,984,994</td>
<td>5,362,955</td>
<td>5,488,058</td>
<td>5,642,716</td>
</tr>
<tr>
<td>Education</td>
<td>1,459</td>
<td>2,084</td>
<td>2,014</td>
<td>175,874</td>
</tr>
<tr>
<td>Research</td>
<td>11,204,769</td>
<td>11,203,471</td>
<td>11,203,601</td>
<td>11,218,479</td>
</tr>
<tr>
<td>Military affairs</td>
<td>-</td>
<td>-</td>
<td>1,561,000</td>
<td>1,561,000</td>
</tr>
<tr>
<td>Sum</td>
<td>19,475,292</td>
<td>19,847,856</td>
<td>18,288,099</td>
<td>19,038,766</td>
</tr>
</tbody>
</table>

2.1.4 Neutron Source Calibration Facilities.

When decommissioning of neutron source calibration facilities, the radiation source term should be assessed taking into account the effect of radioactivation by the neutrons.

Radioactivation by neutrons is important for the neutron energy spectrum and the surrounding materials. This is because radioactivation is determined by neutron energy level and the radioactivation absorption cross section of the materials. Especially, the energy level of neutrons is a major factor because it affects the depth of the radioactivation of material.

2.1.5 Fusion Research Institute.

The Fusion Research Institute is conducting research to obtain energy using fusion reaction.

At this time, neutrons are generated.

Since these neutrons cause radioactivation, the effects of radioactivation should be considered in assessing of the radiation source term at the decommissioning of the fusion research institute. Typical fusion reactions are as follows.

Reaction formula 1 : \( ^2\text{H} + ^3\text{H} \rightarrow ^2\text{He} + ^3\text{n} \) (2)

Reaction formula 2 : \( ^2\text{H} + ^3\text{H} \rightarrow ^2\text{He} + ^3\text{n} \) (3)

2.1.6 High Energy Linear Accelerator Facilities.

Photons with high energy generate neutrons through photonuclear reaction with materials. Therefore, the effect of radioactivation by neutrons must be taken into consideration in the decommissioning of high energy linear accelerators.

3. Conclusion

Domestic nuclear power utilization facilities have steadily increased over the past years. So, the number of decommissioning nuclear power utilization facilities is expected to be higher than in the past. Therefore, procedures related to decommissioning nuclear power utilization facilities should be established. In addition, decommissioning technology should be developed in consideration of facility-specific radiation source term in accordance with the characteristics of various nuclear power utilization facilities.

REFERENCES