P3

Study on Maintenance, Recycle, and Radioactive Waste Management of Fusion Reactor
Part V : Decommissioning and radioactive waste management
核融合炉に関する検討
5．廃止措置と放射性廃棄物管理

Satoshi Yanagihara
柳原　敏

University of Fukui, Research Institute of Nuclear Engineering
3-9-1 Bunkyo, Fukui-shi, Fukui-ken, 910-8507, Japan
福井大学　附属国際原子力工学研究所　〒910-8507　福井市文京3丁目9番1号

Nuclear facilities including fusion reactors produce radioactive waste in operation and decommissioning. It will be therefore necessary to make clear characteristics on radioactive waste arising from fusion reactors as same as nuclear power plants. Based on the Japanese study on decommissioning and radioactive waste management conducted in terms of nuclear power plants, a discussion has started to characterize the radioactive waste arising from decommissioning of fusion reactors. The difference on waste arising between nuclear power plants and fusion reactors is briefly discussed at the beginning of the study.

1. Introduction

Since starting peaceful use of nuclear energy after World War II, a number of nuclear facilities for civilian use including nuclear power plants have been constructed in the world. There are more than 430 nuclear power plants (NPPs) operating in the world. Nuclear facilities must be managed in a safe and efficient manner throughout their life cycle from designing through operation to decommissioning stages. Decommissioning is the final stage of the plant life cycle, and it is often considered as less important since it does not produce any values from the activities such as decontamination and dismantling. However, the nuclear facilities ceased their operation should not be abandoned; the site should be cleaned up to make use for other objectives or continued use for nuclear energy. In terms of developing fusion energy, it must be of importance to characterize the plant life cycle before starting construction of the facility for energy production. Waste management is a key issue in the plant life cycle. During the operation of fusion reactor, some radioactive waste will generate in various states, and a large amount of radioactive wastes will be generated from decommissioning of the facility. The study on waste arising from decommissioning is inevitable in research and development of fusion energy.

2. Decommissioning of nuclear facilities

Decommissioning activities include planning, project management, facility characterization, decontamination, dismantling, final radiation survey, and so on. These activities should be carried out to achieve reduction in radiological hazards on the basis of planning and assessment to ensure safety. De-licensing is the final outcome of these decommissioning activities. As the remarkable characteristics, decommissioning of nuclear power plants and fusion reactors will result in the generation of large amount of radioactive waste with differing types in relatively short periods.

2. Regulation of nuclear facilities

Decommissioning NPPs is basically regulated by the nuclear reactor regulation law which was issued 1957. A new regulatory frame for decommissioning has legislated by amending the law, which brought into effect in December, 2005. The decommissioning phase is separated from operational phase. In addition, clearance system is established for effective recycling of the materials arising from decommissioning.

To date, various experimental fusion facilities have been constructed under safety regulations; the construction and operation are basically regulated by the other law than the nuclear reactor regulation law as long as no nuclear fuel materials are handled in the facility. The law applied in most case is the law concerning the prevention from radiation hazards due to radio-isotopes and others. However, it may be practicable to study the waste arising from fusion reactors by assuming the same frame on NPPs, even though a new regulation for

fusion reactors will be prepared in the future. Here we will discuss the waste management on fusion reactors in the same frame as regulating NPPs.

3. Policy of radioactive waste management

National policy on radioactive waste management is described in the framework for nuclear energy policy by atomic energy commission (2005).

The four principles on treatment and disposal of radioactive waste are described in the framework;

- Liability of generators,
- Minimization of radioactive waste,
- Rational treatment and disposal, and
- Implementation based on mutual understanding with public.

The policy also states as follows; important is appropriate classifications of the wastes based on the recognition of that the waste may include materials with such characteristics as that it takes an extraordinary long time for the radioactivity to decrease to insignificant levels. As for the wastes from research and development facilities, trans-uranium and uranium waste, discussion on safety regulations has been undertaken step by step. Concerned parties should work on the implementation of disposal in line with the progress on the preparations for the safety regulations.

On the basis of the statement, efforts have been made to build regulatory regime on disposal of radioactive wastes

4. Radioactive waste disposal

Waste disposal forms are classified into two types; disposal with institutional control for very low level, low level and intermediate level wastes, and geological disposal for high level and trans-uranium wastes.

Basically, the waste will be disposed of in deeper with increasing their radioactive risk. The wastes will be disposed of in different types of repository depending on radioactivity levels and its characteristics as follows.

Very low level waste (VLLW): The wastes will be disposed of in simple near surface repository without engineering barriers so called trench type facility. The upper limits of activity concentration (Bq/t) are 1.0×10^{10} for ^{60}Co, 1.0×10^{7} for ^{90}Sr, 1.0×10^{8} for ^{137}Cs.

Low level waste (LLW): The wastes will be disposed of in near surface repository with engineering barrier so called concrete pit type facility. The upper limits of activity concentration (Bq/t) are 1.0×10^{11} for ^{14}C, 1.0×10^{15} for ^{60}Co, 1.0×10^{13} for ^{63}Ni, 1.0×10^{13} for ^{90}Sr, 1.0×10^{9} for ^{99}Tc, 1.0×10^{14} for ^{137}Cs, 1.0×10^{10} for all alpha nuclides.

Intermediate level waste(ILW): The wastes will be disposed of in sub-surface disposal repository 50 to 100 meters below from the surface. The upper limits of activity concentration (Bq/t) are 1.0×10^{16} for ^{14}C, 1.0×10^{13} for ^{36}Cl, 1.0×10^{14} for ^{99}Tc, 1.0×10^{12} for ^{129}I, 1.0×10^{11} for all alpha nuclides.

As for the high-level waste, vitrified canisters will be disposed of with some trans-uranium waste in a geological repository more than 300 meters below the surface. A disposal business has progress for the low-level radioactive waste in the Rokkasho low level radioactive waste disposal center since 1992.

5. Waste arising from decommissioning

The decommissioning cost regarding 1100 MW class NPPs was studied by a government committee; it showed the characteristics of wastes arising from decommissioning. On the other hand, dismantling and disposal scenario of ITER was studied; the waste arising was estimated assuming 30 years cooling period after ceased operation [1]. Both results are shown as follows.

ITER
ILW: 7700 t, LLW: 9000 t, VLW: 3200 t
BWR
ILW: 100 t, LLW: 2000 t, VLLW: 10,000 t
PWR
ILW: 200 t, LLW: 3000 t, VLLW: 3,000 t

A large amount of intermediate level wastes will be generated from decommissioning of ITER, while a dominant waste class arising from BWR/PWR is very low level; it is about 70 times of the wastes arising from BWR. This might cause higher cost of waste management of ITER than that of nuclear power plants.

6. Future perspective

It will be necessary to study more precisely on the waste to characterize the waste management and decommissioning of fusion reactors. This will be done in parallel with the study on new regulatory frame for fusion reactors.

Reference

[1] S. Kakudate; Journal of Plasma and Fusion Research, Vol. 87 Supplement, February(2011)