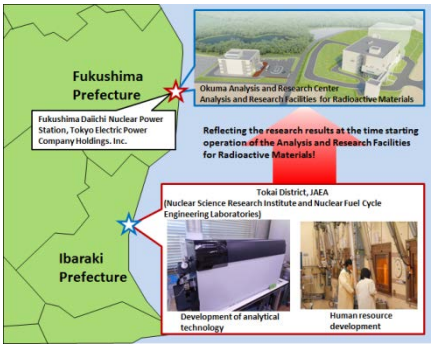
Towards the analysis of radioactive waste and fuel debris

Technological development and human resource development towards the operation start of the analysis and research facilities for radioactive materials

In order to promote the decommissioning of the Fukushima Daiichi Nuclear Power Station (1F), Tokyo Electric Power Company Holdings. Inc., the important subject is to establish safe storage method and treatment/disposal method for radioactive wastes and fuel debris. For solving this subject, it is required to clarify the species and amount of radioactive materials in wastes and fuel debris.



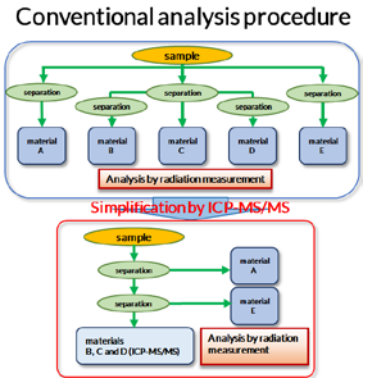
Activities towards the operation.

The Okuma Analysis and Research Center, Japan Atomic Energy Agency (JAEA), is now preparing the analysis and research facilities for radioactive materials at the adjacent area of the 1F in Okuma Town. In these facilities, radioactive materials such as rubbles and incinerated ash produced by the accident of 1F and fuel debris will be analyzed. For these analyses, the long-time analysis procedure and high analytical skill will be required.

Therefore, towards the operation start of the facilities, the development of efficient analytical technology and the training of analytical engineers are being conducted in Tokai District, Ibaraki Prefecture.

■ Development of efficient analytical technology towards the operation of the analysis and research facilities for radioactive materials

The wastes produced by the accident of 1F contain various kinds of radioactive materials, and their properties are diversified. In addition, it is needed to analyze large amount of samples to establish the methods for the storage, treatment and disposal of the wastes. In order to contribute to the smooth decommissioning of 1F, it is required to rapidly analyze these samples. However, there is a problem that the process and operation of the conventional analytical methods are so complex that the analysis is liable to last long time. For these reasons, we are developing a technology concerning the simplification of analytical methods and the automization of analytical procedures using latest analytical instruments.

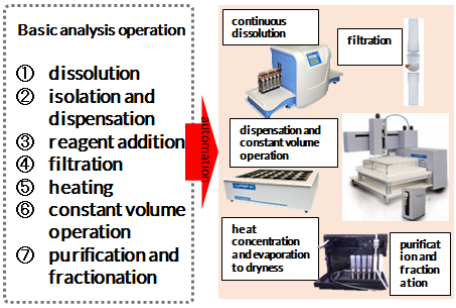


Simplification of analytical methods by Inductively Coupled Plasma Mass Spectrometry equipped with Tandem Mass Spectrometer (ICP-MS/MS).

■ Simplification of analytical methods by latest instruments

In conventional analytical methods, the species and amount of radioactive materials are determined by measuring the radiation emitted from the samples. However, when a sample contains many kinds of radioactive materials, the accurate measurements are sometimes not possible because it is difficult to distinguish the radiation from the materials to be measured from the other radiation. For this reason, it is required to separate the materials to be measured from the other materials by chemical procedure in advance. However, there is a problem that time for the chemical procedure becomes longer with the increase in the number of materials to be separated. This was the main factor that the time for the analysis became long.

Under these circumstances, an “Inductively Coupled Plasma Mass Spectrometry (ICP-MS)” that can measure the amount of radioactive materials without measuring the radiation is recently used for reducing the time for the analysis. In the ICP-MS, the sample is ionized in the instrument, and the amount is determined by counting the number of elements. Thereby, the separation procedure that had been



Technological development of automization of analytical procedures.

required in the conventional method can be omitted, so the time for the analysis can be considerably reduced. However, there is a disadvantage in ICP-MS that it is impossible to separate ions that have the same mass.

For solving this problem, an ICP-MS equipped with a Tandem Mass Spectrometer (ICP-MS/MS) has recently been developed. In order to conduct efficient analysis, we planned to introduce ICP-MS/MS in the analysis and research facilities for radioactive materials. We are now aiming for the simplification of analytical method while investigating the most appropriate measurement condition by extracting radioactive materials that can be applicable to the ICP-MS/MS.

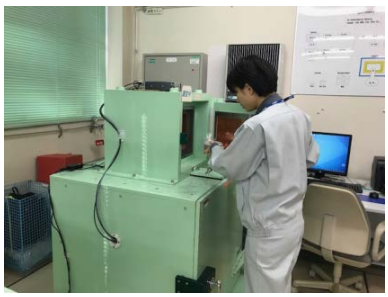
■ Development of automatic technology for analysis operation

In the analysis at the facilities, it is supposed that the pre-treatment procedure for the measurements such as chemical separation will be conducted for many samples in parallel. However, it is worried about that the working load on the analytical engineers will become larger with the increase in the number of samples. To solve this problem, we are investigating the automization of the basic procedures among the series of pre-treatments for measurements, such as dissolution, isolation and dispensation of samples.

From the investigation so far, it was clarified that the precision of the measurements by automated method is comparable to that of the manual measurements by skilled analysts. Based on these results, it is expected that the automization will be effective also in the pre-treatment procedures for measurements.

■ Human resource development towards the operation of the analysis and research facilities for radioactive materials

The Okuma Analysis and Research Center, JAEA, is conducting the training for analytical engineers towards the operation start of the analysis and research facilities for radioactive materials. The Center is dispatching young engineers to the facilities (Nuclear Science Research Institute and Nuclear Fuel Cycle Engineering Laboratories, JAEA, in Tokai District) where analytical works are mainly conducted. There, the young engineers are learning analytical technology, evaluation of analytical results and methods for handling of radioactive materials (works using glove boxes and cells). As an example, the training at the Environmental Protection Section, Radiation Protection Department, Nuclear Fuel Cycle Engineering Laboratories is reported in the followings.



Measurement of radiation

The main works of the Environmental Protection Section are to manage the liquid radioactive

waste released from the Tokai Reprocessing Plant and to monitor whether the released radioactive waste affects the surrounding environment or not. For these works, the Environmental Protection Section is analyzing the concentration of radioactivity in drainage before being released from the Tokai Reprocessing Plant and conducting environmental radiation monitoring. The obtained data are periodically reported to the government and the prefecture, and open to the general public.

The young engineers belonging to the member of the Environmental Analysis Team, the Environmental Protection Section, are conducting analysis and evaluation of radioactivity in environmental samples around the plant. The main samples are agricultural/livestock products, environmental samples on land such as soil, and marine environmental samples such as fish/shellfish, sea weed and seawater. The procedure of the work is as follows. The environmental samples are first collected, then the pre-treatments and chemical separation are conducted. After that, the radioactivity of the samples is measured by the methods depending on the radioactive materials to be measured (Germanium semiconductor detector, liquid scintillation counter, etc.). Finally, the results are evaluated and reported.

Analysis of total β-ray radiation
(filtration procedure)

One of the characteristics of the radioactive wastes at 1F is that it is not known what kinds and how much radioactive materials are contained in the samples. In order to determine the methods for storage, treatment and disposal of radioactive wastes, it is essential to analyze the species and amount of radioactive materials in the wastes. For this purpose, the young engineers will contribute to the decommissioning of 1F by learning the analytical approaches corresponding to various samples at the Environmental Protection Section.

From a young engineer working on the training

One of the trainees told the impression as follows. “The works in the training cover wide region from the collecting environmental samples to the evaluation/report of the analytical results. Furthermore, the number of radioactive materials to be analyzed is so large that I am struggling to understand and evaluate the tendency of the analytical results. I would like to become an analytical engineer who can correspond to various new, unknown “samples”. Because of that, I hope to learn in the training about not only the conventional analytical technology but also advantages/disadvantages of the respective analytical methods and the background for why the analytical method was adopted.”

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