

## 4-5 Classification of Solid Wastes as Non-radioactive Wastes\*

M. Suzuki, H. Tomioka, K. Kamike and J. Komatu  
Research Association for Nuclear Facility Decommissioning

---

### ABSTRACT

The radioactive wastes generally include nuclear fuels, materials contaminated with radioactive contaminants or neutron activation to be discarded. The solid wastes arising from the radiation control area in nuclear facilities are used to treat and stored as radioactive solid wastes at the operation of nuclear facilities in Japan. However, these wastes include many non-radioactive wastes. Especially, a large amount of wastes is expected to generate at the decommissioning of nuclear facilities in the near future. It is important to classify these wastes into non-radioactive and radioactive wastes.

The exemption or recycling criteria of radioactive solid wastes is under discussion and not decided yet in Japan. Under these circumstances, the Nuclear Safety Committee recently decided the concept on the category of non-radioactive waste for the wastes arising from decommissioning of nuclear facilities.

The concept is based on the separation and removal of the radioactively contaminated parts from radioactive solid wastes. The residual parts of these solid wastes will be treated as non-radioactive waste if no significant difference in radioactivity between the similar natural materials and materials removed the radioactive contaminants.

The paper describes the procedures of classification of solid wastes as non-radioactive wastes.

### BACKGROUND

The development and utilization of nuclear energy in Japan have been promoted since the starting of Japan Research Reactor(JRR-1) operation and more than thirty years has passed. As of January 1994, 46 nuclear power plants are operating with about 37,000 MW electricity generation in order to supply electric power to industry and the public in Japan as the most stable and secure energy.

---

\* The work is carried out under the contract of the Science and Technology Agency.

While, the decommissioning of nuclear power plants and fuel cycle facilities at the end of their lives has become an important issue. In addition, it is expected that renewal and refurbishment work will increase by the technology developments. In particular, a large amount of wastes is expected to generate at the decommissioning and renewal and refurbishment work.

The radioactive wastes generally include nuclear fuels and/or substances contaminated with radioactive contaminants or neutron activation to be discarded. In Japan, the solid wastes arising from the radiation controlled areas in nuclear facilities are used to be treated and stored as radioactive solid wastes at the operation of nuclear facilities. However, these wastes include many non-radioactive wastes. It is an inevitable matter from the economic and safety points of view to establish the effective effective waste minimization, rational treatment and disposal of dismantled wastes. Therefore, it is important to classify these wastes into non-radioactive wastes from radioactive wastes.

On the other hand, the exemption or recycling criteria of radioactive solid wastes is under discussion and not decided yet in Japan. Under these circumstances, in June, 1992, the Nuclear Safety Committee decided the concept on the category of the non-radioactive wastes for the wastes arising from decommissioning of nuclear facilities.

Based on the concept, the technically available procedures on the classification of solid wastes as non-radioactive waste have been studied and recommended.

## BASIC CONCEPT

The radioactive contamination of solid wastes from nuclear facilities is generally classified into Secondary contamination due to the adhesion and permeation of radioactive substances and activation contamination due to neutron capture.

According to the concept by the Nuclear Safety Committee, the following wastes are regarded as non-radioactive wastes.

1. In the case of Secondary contamination
  - 1) Those wastes which are apparently free from Secondary contamination due to the adhesion and permeation of radioactive substances, in the light of their history of use and their conditions of installation.
  - 2) Those wastes whose secondary contamination due to the adhesion and permeation of radioactive substances is limited and whose contaminated parts are separated and removed in the light of their history of use and their conditions of installation.
  
2. In the case of Activation contamination(Concrete waste including reinforced bars)
  - 1) Those concrete wastes which need not be taken into account the activation by neutron in the light of the structure of facilities, such

- as being sufficiently shielded by shielding materials.
- 2) Those concrete wastes for which the activation levels are calculated of no significant difference from the concrete used in non-nuclear field.
  - 3) Those concrete wastes for which the activation levels are calculated and whose significantly activated portions have been removed.

## PROCEDURES OF CLASSIFICATION

There are secondary contamination due to the adhesion and permeation of radioactive substance and activation contamination due to neutron capture in the nuclear reactor facility. Based on the concept of the Nuclear Safety Committee, we have studied the technically available procedures on the classification of solid wastes as non-radioactive wastes and have recommended the practical identification method as shown in Figure 1.

The solid wastes will be technically judged and evaluated as Non-radioactive or not in accordance with the following criteria of the judgement and evaluation.

1. The solid wastes from decommissioning of nuclear facilities are judged to be free from the radioactive substances or not by the past records and data.
2. In the case of secondary contamination, if the contaminated parts are limited, the residual parts after separation and removal of contaminated parts are regarded as non-radioactive wastes. The contaminated parts to be removed are classified into radioactive wastes. If the limitation of the contaminated parts can not be identified, the wastes are treated and stored as radioactive wastes.
3. In the case of activation contamination, if the radiation level of neutron activated wastes is equal to (or less than) natural background, the wastes can be categorized as non-radioactive wastes.

## ITEMS ON PAST RECORDS AND DATA

The items on the past records and data available to judge the solid wastes as non-radioactive wastes are based on the following:

1. Structural design feature of reactor facility ( shielding wall, trench for the contaminated water etc.)
2. Radiation control records ( routine survey data of the surface and the air in the controlled areas)
3. Operational history of the reactor
  - 1) Surface contamination measurements (Bq/cm<sup>2</sup>)
  - 2) Concentrations of radioactive substances in the air of the controlled areas (Bq/m<sup>3</sup>)
  - 3) Experience of decontamination
  - 4) Experience of accident
  - 5) Decision or release of the controlled areas

The items mentioned above are useful in judging whether the wastes from the areas being dismantled is apparently free from the radioactive substances or not. Especially, the records on the experiences of accidents or the data related to contaminations and decontaminations are important to judge and evaluate the wastes as non-contaminated wastes. Therefore, It is desirable that these records and data are reserved until the beginning of decommissioning of reactor.

## LIMITATION OF CONTAMINATED PARTS

### 1. Metal

For the metals clad or coated with some materials, the contamination of radioactive substances is limited at the surface of the materials covered. Therefore, It is easily possible for the metal to be regarded as non-radioactive waste by removing the contaminated cladding or coating materials without cross contamination.

In the case of existence of defects on the layer of the metal surface without the cladding materials, there is a strong possibility that the contaminated substances may be permeated into some depth of metal. In this case, there is a need to identify the depth of the contaminated parts. An example for settling on the limitations of the contaminated parts in the metal without the cladding materials is shown in Figure 2. In this figure, by removing the contaminated surface piece by piece from the original surface, no radioactivity was detected at a certain depth. The surface contamination level at this depth represents the lower level of detection (LLD) for 30 min. counting times, and then, the measurements for this surface were continued to increase the detection sensitivity for 1 day, 2 days, and 3 days, respectively. The results of the measurements were less than the lower level of detection without exception. Therefore, this depth is recognized as the limit of the contaminated parts in the metal. If the contaminated layers can be separated and removed without cross-contamination, the residual parts are regarded as non-radioactive wastes.

### 2. Concrete

The radioactive contaminants adhered to the surface of the concrete seem to penetrate into lower layer by the diffusion phenomenon. However, in any case the limitations of the contaminated portions in the concrete are recognized actually at the operation in the nuclear facility because the contaminated substance, at the surface if there are, are removed as soon as possible, from the point of safety control.

In Figure 3 is shown an example related to the limitation of the contaminated portions in the concrete without the coating materials. In this case, no detection was appeared at a certain depth from the surface. In common with the case of Figure 2, the measurements for the same surface at this depth were carried out for about 8 h, 20 h, 40 h and 140 h, respectively. All of the results were less than the lower level of detection. Therefore, this depth is

regarded as the limit of the contaminated portions in the concrete.

## CONCEPT ON THE CLASSIFICATION OF NON-RADIOACTIVE WASTES IN CONCRETE OF REACTOR

As the basic concept mentioned above, neutron-activated concrete wastes of which the radiation level is equal to ( or less than ) the natural background are regarded as the non-radioactive concrete wastes. The nuclides in the natural concrete consist mainly of K-40, Ra-226 and Th-232. According to the reports on the radiation levels of the natural concrete in Japan, there are considerable deviations in the background levels of the natural concrete available.

Based on the basic concept of Non-radioactive waste the classification of non-radioactive portions in the concrete can be defined as shown in Figure 4. The A point in this figure is regarded as the radiation level corresponding to be equal to the natural background. In general, the neutron-activated levels can be calculated by using the available computer cords such as ANISN, DOT3.5 and ORIGEN etc.. and then, the A point is resulted from the cross points of calculated activation values and the background level of natural concrete. As the reasonable width of the deviation in the background level, we adapted three times the standard deviation ( $3\sigma$ ) because of including approximately 99.73 % of the natural background levels within  $3\sigma$  in the natural concrete.

## FINAL SURVEY CRITERIA

The solid wastes being regarded as non-radioactive wastes should be carefully checked by the detectors available in order to reconfirm the justness of the classification we have executed .

Whether or not the wastes are clearly free from the secondary contamination or neutron-activated contamination will be checked by the direct survey method or smear method. In this case, the LLD of detectors is as followed;

For total  $\alpha$  emitters :  $\leq 0.04$  Bq/cm<sup>2</sup>  
 For total  $\beta/\gamma$  emitters :  $\leq 0.4$  Bq/cm<sup>2</sup>

The wastes of which contaminated parts or significantly activated portions are completely removed will be checked for final survey by the radioactive nuclide analysis in addition to the direct survey method or smear method. In this case, the LLD of detectors is as followed;

Representative nuclides : Co-60, Cs-137 etc.  
 Ex. For Co-60 :  $\leq 3$  Bq/Kg

It is reasonable that the final check should be carried out by surveying the representative points or several samples.

## CONCLUSIONS

The practical methods of the classification of solid wastes as non-radioactive wastes for executing the concept of non-radioactive solid wastes, are recommended.

1. The items on the pasts records and data to judge the solid wastes as non-radioactive wastes are recommended.
2. The technical criteria and procedures for judging and evaluating the solid wastes as non-radioactive wastes are recommended in the case of secondary or activation contaminations.

## ACKNOWLEDGMENTS

The authers express thanks to the members of study group on this matter and the staffs of the Nuclear Safety Bureau of the Science and Technology Agency for their works.

## REFERENCES

- [1] The Radioactive Concentration Upperbounds for the Safety Regurations on the Shallow-Land Disposal of Low-Level Solid Radioactive Wastes.( The Second Interim Report), Special Committee on the Safety Standards of Radioactive Wastes, Nuclear Safety Commission, 1992.

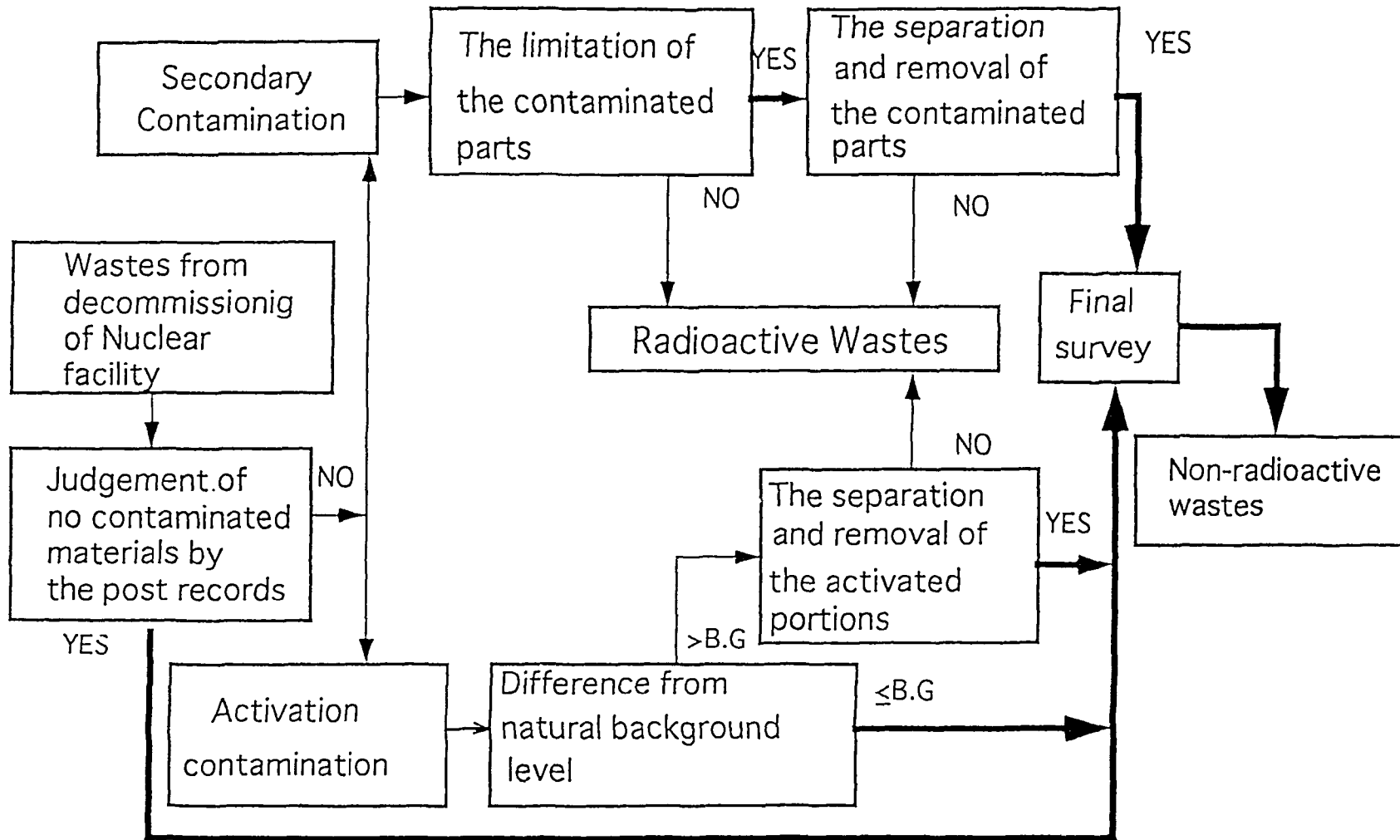


Fig.1 Procedures of Classification of Solid wastes as Non-radioactive wastes

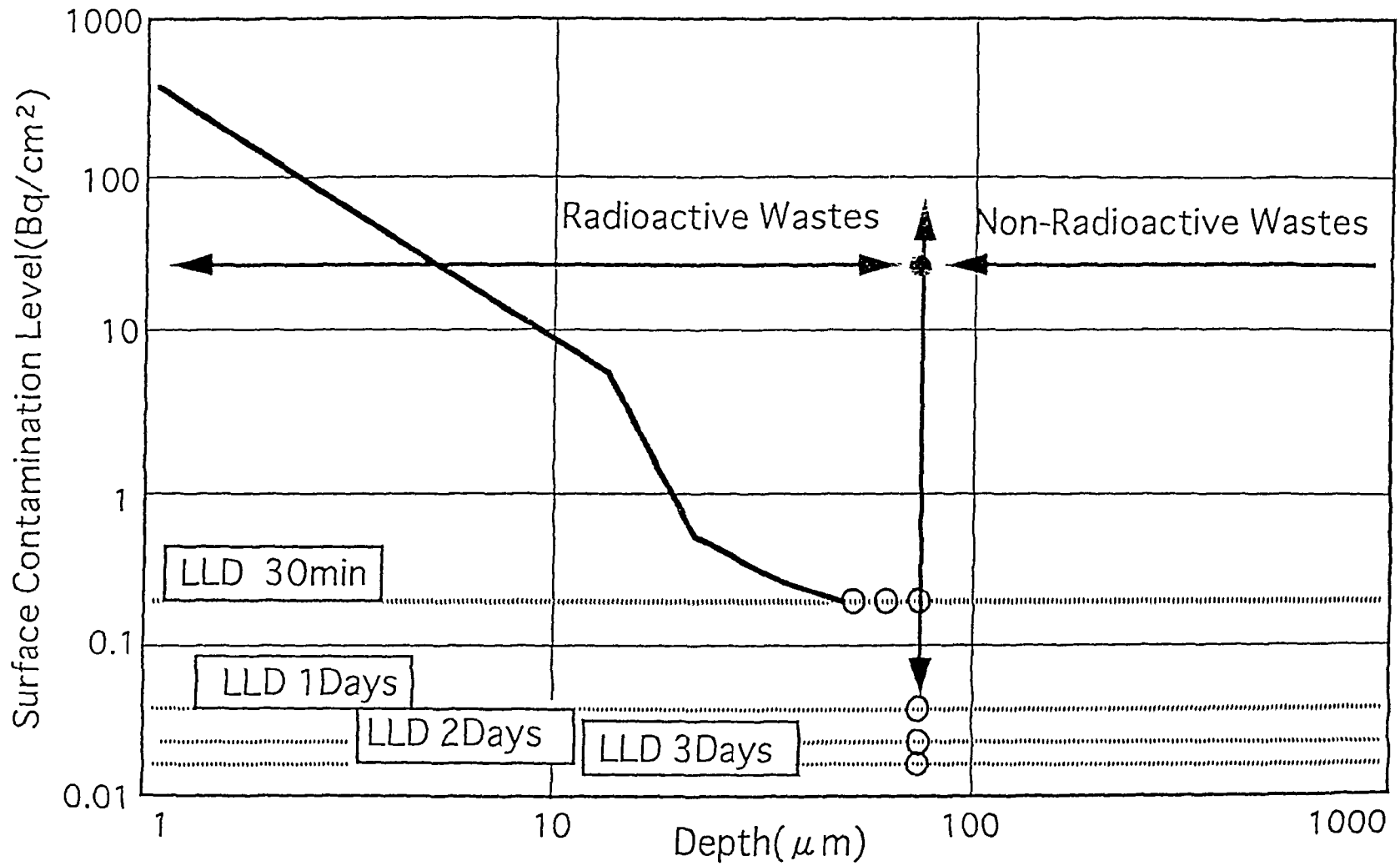


Fig.2 Limitation of the Contaminated Parts in Metal



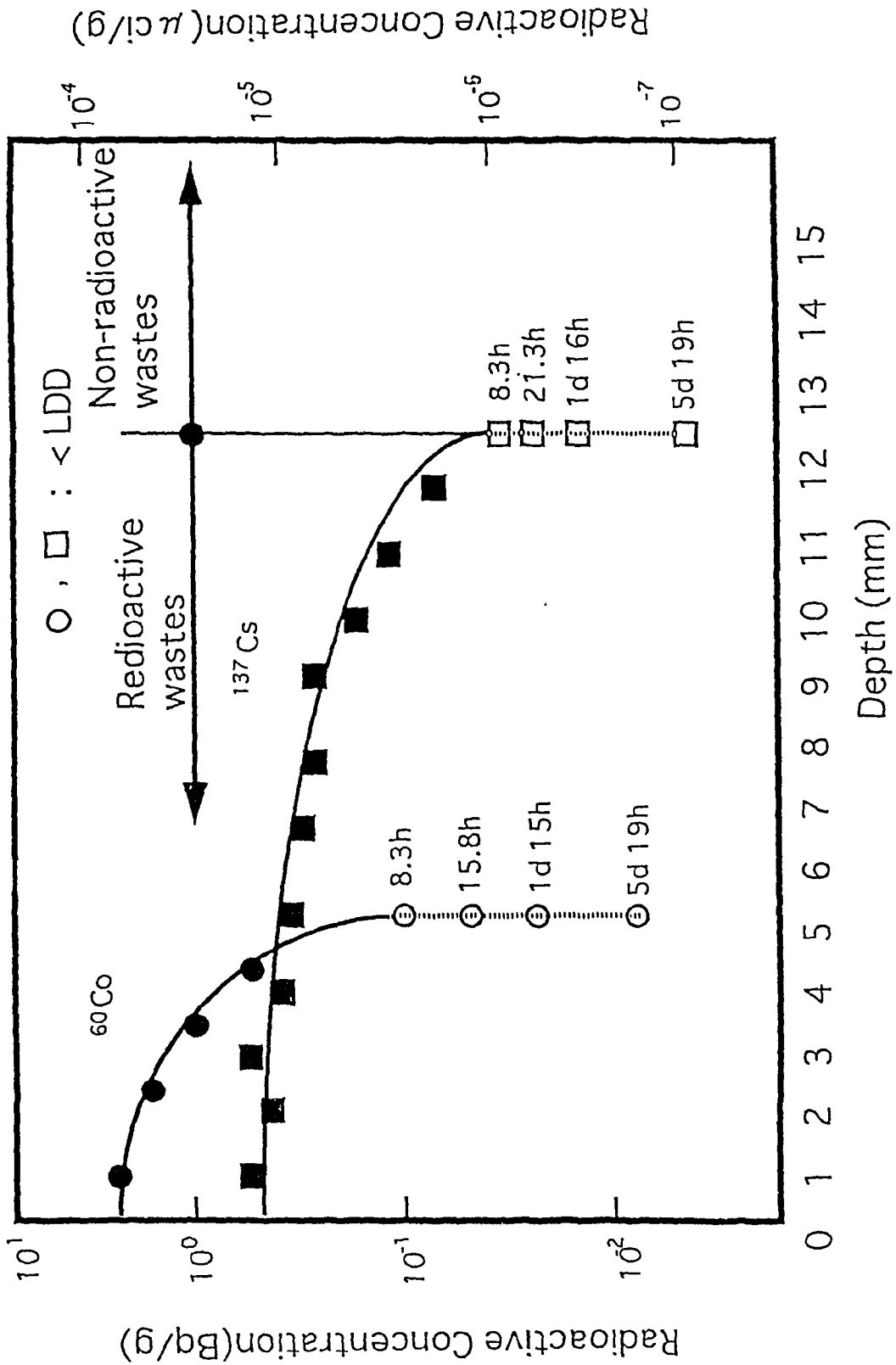


Fig.3 Limitation of the Contaminated Parts in Concrete

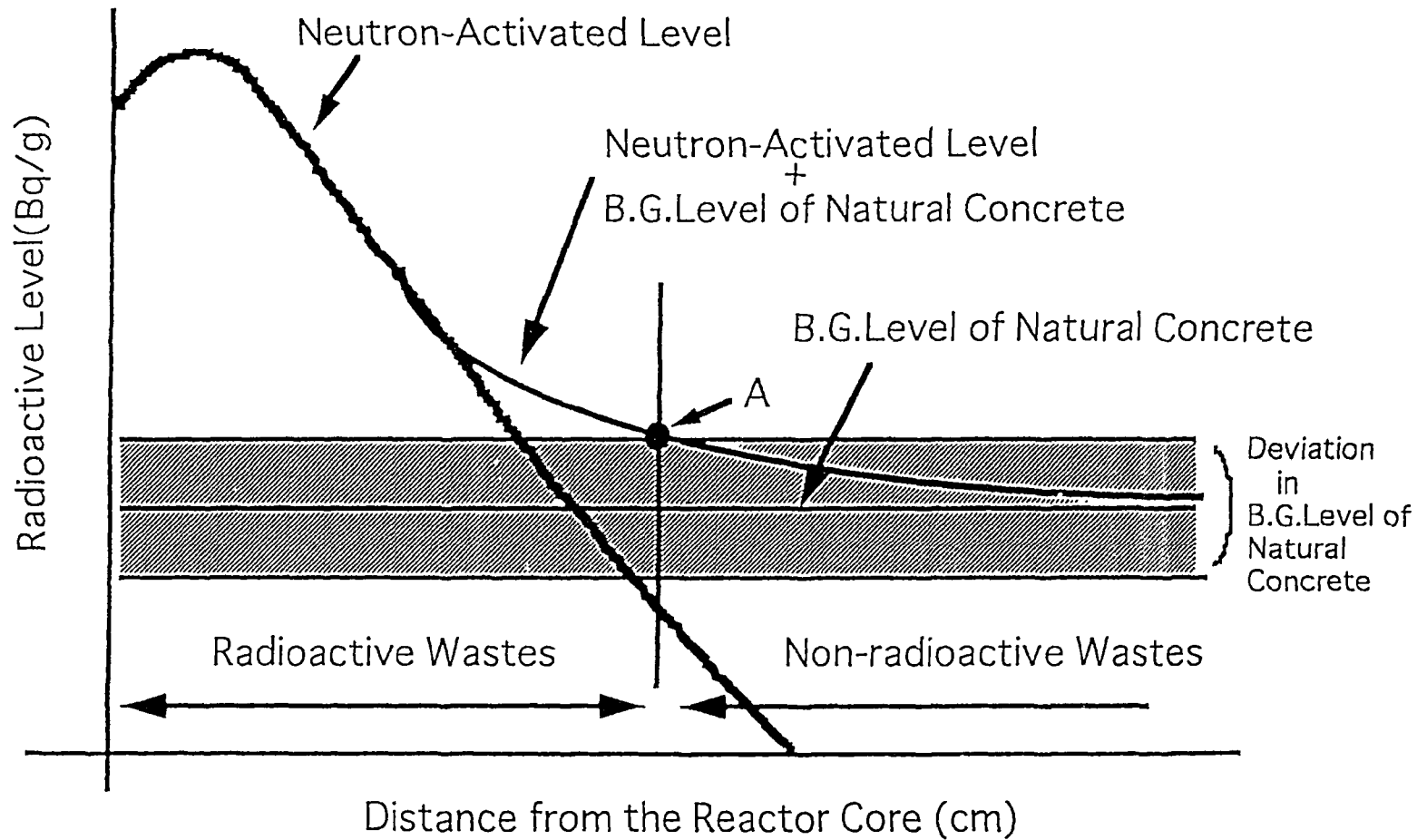


Fig.4 Concept on the Classification of Non-radioactive Portions in the Concrete of Reactor