

# Discussion on Radiation Safety Management in Nuclear Technology Application Activities

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**Abstract.** The paper refers to the latest radiation safety management requirements at home and abroad, and comprehensively discusses radiation safety management in nuclear technology application activities to help nuclear technology application units better establish and improve radiation safety management. The article first discusses the main radiation safety management of nuclear technology application, then further discusses the key occupational exposure and public exposure radiation safety management, and finally discusses the emergency intervention radiation safety management. At the end of the article, based on the discussion, suggestions are made for the establishment of a radiation safety management framework for nuclear technology application units.

**Keywords:** Nuclear Technology Application; Radiation Safety; Management.

## 1. Introduction

The application of nuclear technology is a major branch of the application of atomic energy, which mainly includes the application of radioisotopes and radiation devices in industry, agriculture, medicine, and science and education. Compared with nuclear energy application activities, nuclear technology applications have no large-scale health and environmental impacts, but they still cannot be ignored. In nuclear technology application activities, some units lack radiation safety management experience, making radiation safety accidents a prominent problem in this field. Therefore, it is of practical significance for nuclear technology application units to establish a complete radiation safety management framework system in strict accordance with the requirements of national laws, regulations and standards, and is also vital to the healthy development of the industry.

The paper refers to the latest radiation safety management requirements at home and abroad, and comprehensively discusses radiation safety management in nuclear technology application activities to help nuclear technology application units better establish and improve radiation safety management. The article first discusses the main radiation safety management of nuclear technology application, then further discusses the key occupational exposure and public exposure radiation safety management, and finally discusses the emergency intervention radiation safety management. At the end of the article, based on the discussion, suggestions are made for the establishment of a radiation safety management framework for nuclear technology application units.

## 2. Main Radiation Safety Management of Nuclear Technology Application

### 2.1 Government Supervision

Radiation safety supervision is a national responsibility, and my country has established a relatively complete regulatory framework. Any radiation practice activity must be confirmed by the government supervision department before it can be put into action. Of course, practical activities with low radiation risk can apply for exemption from management by regulatory authorities, and sources with low radiation risk (including radioactive materials and devices with radioactive materials, etc.) can apply to regulatory authorities for removal and control, and the level of removal and control should not be higher than Exemption level.

In nuclear technology application activities, notification, registration and licensing management must be carried out according to the radiation risk of the activity. When the exposure caused by the

activity is small or negligible, the notification procedure shall be performed after confirmation by the regulatory authority; when the inherent safety of the activity is relatively high and the operation of the source is simple and easy, the approval and registration procedures shall be performed after the verification by the regulatory authority; the radiation risk of the activity When the operation of the source is larger and the source is more complicated, the approval procedure shall be performed after confirmation by the regulatory authority.

## 2.2 Radiation Protection Requirements

(1) The principle of legitimacy in practice. After considering social, economic and other relevant factors, the practice will be justified and be dealt with and implemented only when the benefits to the exposed individual or society are sufficient to make up for the radiation hazards, they receive. This requires an analysis of the trade-off between benefits and costs in the relevant practices of the source.

(2) Principles of personal dose limitation and potential exposure risk limitation. The normal exposure received by individuals should be restricted to meet the requirements of national standards. At the same time, the potential exposure hazard received by individuals should be limited, so that this hazard and the health hazard caused by the normal dose limit are at the same level.

(3) The optimization principle of safety and protection. After considering social, economic and other factors, in order to minimize the possibility, size and number of people of exposure caused by the source, the safety and protection measures adopted should be optimized.

(4) Dose restriction and potential exposure hazard restriction. For a specific source, the limit value of exposure dose and the limit value of exposure hazard should not be greater than the value approved by the regulatory authority for the source, and not greater than the limit specified in (2). Dose constraints for the public must also take into account cumulative effects of source releases to the environment over the years so that the dose to the public in any given year does not exceed the corresponding dose limit.

## 2.3 Operation Management Requirements

(1) Safety culture. Start with the establishment of the organization system and the positive response of employees to cultivate and maintain a good safety culture. Organizational system building includes policy, organization, planning and implementation, performance measurement, review, and supervision. Employee response includes the response of decision-making, management and grassroots.

(2) Quality assurance. Formulate effective quality assurance mechanisms and procedures to provide sufficient assurance for satisfactory radiation safety management. In the latest international radiation safety standards, the concept of "management system" has been used to replace the concept of "quality assurance", the quality assurance requirements have been integrated into the corporate management framework, and an ecological management system has been established.

(3) Human factors. Human factors are the easiest to change and the most difficult to control. Measures should be taken to minimize the possibility of human error causing incidents and accidents. Measures may include: training all management and production personnel involved in nuclear technology application activities to have the corresponding qualifications, understand and perform their duties in a correct manner in accordance with the prescribed procedures; design and develop equipment in accordance with the principles of ergonomics Operating procedures to make the operation and use of the equipment as simple as possible to reduce the possibility of misunderstandings and operating errors leading to abnormal situations; provide defense-in-depth management measures to detect, correct and compensate for accidental exposure caused by human error; Employ qualified professionals to provide guidance for the satisfactory implementation of national laws, regulations, standards and procedures.

## 2.4 Technical Requirements

(1) The principle of defense in depth. In the design, construction, operation and decommissioning of the device, according to the possibility and size of its potential exposure, multi-level safety protection measures are applied to ensure that when one level of defense measures fails, the next level of defense measures can make up for it or correct to achieve: prevent possible abnormal exposure; reduce the consequences of abnormal exposure; restore the source to a safe state after an abnormal situation occurs.

(2) Principles of good engineering practice. In the design, construction, operation, and decommissioning stages of the device, mature engineering practices that meet the requirements of national laws, regulations and standards must be adopted. For the purpose of preventing and reducing accidents and limiting exposure, sufficient safety margin should be left in engineering practice to ensure reliable operation of the source.

(3) The principle of effective physical protection. Take reliable security measures to keep the source always in a protected state to prevent theft, loss and destruction. When these abnormal situations occur, promptly notify the government supervision department to take countermeasures.

## 2.5 Safety Confirmation

(1) Safety evaluation. In the design, construction, operation and decommissioning stages of the device, the safety and protection measures of the source in practice are evaluated to analyze the abnormal exposure that may be caused by internal and external factors, to estimate the possibility and magnitude of the abnormal exposure, and to evaluate the security measures the quality and completeness of the product. Safety evaluation includes third-party evaluation and self-evaluation.

(2) Monitoring and verification. Procedures should be established and appropriate equipment should be provided to monitor the parameters required for safety and protection to verify whether the source's safety level meets the requirements of national standards. The monitoring equipment should be regularly maintained and verified, and the verification should be traceable to the national benchmark measurement standards.

## 3. Occupational Radiation Safety Management

(1) Creation of working conditions. Preferential treatment arrangements such as economic compensation, shortening of working hours and vacations shall not be used to replace the security measures required by national standards. Give minors and pregnant women special working conditions and treatment. Provide employees with appropriate personal protective equipment and provide guidance on complex protective equipment. When health reasons make it unsuitable to engage in radioactive work, arrangements should be made to exchange suitable positions. Occupational exposure and occupational health surveillance files should be established and maintained.

(2) Division of radiation workplaces. Radiation workplaces should be divided into control areas and supervision areas. The areas that require special safety measures and protection measures should be divided into control areas; the areas that do not require special safety measures and protection measures should be divided into supervision areas. The boundary between the control area and the supervision area shall be monitored and evaluated regularly to confirm whether it is necessary to modify the boundary range. The control area and the supervision area shall be marked with warning signs at the entrance. The control area should adopt a physical boundary, indicate the radiation level and pollution level at the entrance, and be equipped with protective facilities, supplies, and monitoring equipment.

(3) Monitoring and evaluation of occupational exposure. Individuals and workplaces should be monitored and evaluated, and the evaluation of occupational exposure should be based on personal monitoring. In personal monitoring, personnel who are often in the control area, or sometimes enter the control area and may be exposed to significant occupational exposure, or those whose

occupational exposure dose may be greater than 5mSv/a, should be personally monitored; Supervised area or staff who only occasionally enter the control area, and staff whose occupational exposure dose is expected to be within 1~5mSv/a, should be monitored personally as much as possible; for staff whose exposure dose can never be greater than 1mSv/a, generally No personal monitoring is required. In the monitoring of the workplace, the content and frequency of monitoring should be determined according to the radiation level and its changes in the workplace and the possibility and magnitude of potential exposure.

#### **4. Public Radiation Safety Management**

(1) Control of public exposure. The possibility and magnitude of exposure to the public caused by the source should be monitored and evaluated, and the normal exposure of key groups of people in the public should not exceed the prescribed limit. Without the permission of the regulatory authority, no important aspect of security may be modified. For radioactive pollution in non-open places, special containment measures must be established to prevent the pollution from spreading to areas that the public may reach. Visitors who enter the control area shall be accompanied by persons who understand the security measures of the control area and provide them with sufficient information and guidance to ensure the safety protection of the visitors and the safety protection of others.

(2) Management of radioactive waste. The radioactive waste generated in the activities should be well managed. The management of radioactive waste should include the management of waste generation, classified collection, treatment, preparation, transportation, storage and disposal. In the management process, the relationship between the management steps must also be considered, that is, the influence of the former management on the latter management.

(3) Control of the release of radioactive materials to the environment. The discharge of radioactive materials to the environment shall comply with the discharge limits stipulated by national standards and be approved by the regulatory authorities. After the discharge, the radiation impact of the discharge of radioactive materials on the environment and the public should be monitored and evaluated.

#### **5. Emergency Intervention Radiation Safety Management**

(1) Emergency plan. The possible emergency intervention situations in the evaluation activities shall be analyzed and an appropriate emergency plan shall be formulated. The emergency plan should include reporting procedures, emergency responsibilities, incident types, protective action intervention levels, emergency supplies, emergency support, emergency termination criteria, etc.

(2) Reporting requirements. It should be reported to relevant intervention organizations and regulatory authorities in a timely manner. The content of the report includes: current situation and development trends; measures taken to protect workers and the public; exposures that have been caused and may be expected to be caused. Intervention organizations may be government public service departments such as environmental protection, public security, medical care, etc., and supervision departments are government administrative agencies corresponding to the intervention organizations.

(3) Monitoring and evaluation of emergency intervention. During and after the emergency intervention, the monitoring of the accident site, emergency personnel, and the public should be strengthened to provide support for emergency intervention actions and evaluate the impact on the staff, the public, and the environment after the accident.

(4) Protection of emergency intervention personnel. After considering the comprehensive consideration of health protection and social and economic factors, emergency intervention is justified when the benefits are expected to outweigh the disadvantages. If the dose level received by emergency personnel is close to or is expected to be close to a significant deterministic effect, the protective action taken is always justified. In an emergency, under normal circumstances, the dose

received by emergency personnel should not exceed the national limit of 50mSv. Under special circumstances, the above national limit can be exceeded. Such special circumstances include: to save lives or avoid serious injury; to avoid major damage Group exposure; to prevent catastrophic consequences. In addition, after weighing the benefits and costs, emergency intervention actions should be optimized, and appropriate adjustments should be made according to changes in the actual situation during the emergency process.

## 6. Suggestions

Although radiation safety management in nuclear technology application activities is not as deep as nuclear energy application, it is similar in breadth. It requires nuclear technology application units to respond from the top to the bottom from the decision-making level, the management level to the grassroots level. In order to systematically establish a radiation safety management framework, it is recommended that nuclear technology application units start from the following points:

(1) Clearly declare the radiation safety policy of the nuclear technology application unit, and put radiation safety at the highest priority;

(2) Establish a sound radiation safety management organization, and be equipped with qualified professionals;

(3) Identify the national laws, regulations and standards related to the unit's nuclear technology application projects, and formulate a complete management system in accordance with the requirements of national laws, regulations and standards, and implement the radiation safety responsibilities of management personnel at all levels;

(4) Establish and implement complete inspection and review procedures, verify and evaluate the effectiveness and suitability of the implementation of the system, and provide in-depth experience feedback in a timely manner when problems are found;

(5) In practice, per severely cultivate a nuclear safety culture for employees.

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