

CONTINUING TRAINING PROGRAM IN RADIATION PROTECTION IN BIOLOGICAL RESEARCH CENTERS

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Abstract. The use of ionizing radiation in biological research has many specific characteristics. A great variety of radioisotopic techniques involve unsealed radioactive sources, and their use not only carries a risk of irradiation, but also a significant risk of contamination. Moreover, a high proportion of researchers are in training and the labor mobility rate is therefore high. Furthermore, most newly incorporated personnel have little or no previous training in radiological protection, since most academic qualifications do not include training in this discipline. In a biological research center, in addition to personnel whose work is directly associated with the radioactive facility (scientific-technical personnel, operators, supervisors), there are also groups of support personnel – maintenance and instrumentation workers, cleaners, administrative personnel, etc. – who are associated with the radioactive facility indirectly. These workers are affected by the work in the radioactive facility to varying degrees, and they therefore also require information and training in radiological protection tailored to their level of interaction with the installation. The aim of this study was to design a specific training program in radiation protection to meet the different needs of all workers in a biological research center. This program aims to ensure compliance with the relevant national legislation and to minimize the possibility of radiological incidents and accidents in this kind of center. This study has involved contributions from six nationally and internationally recognized Spanish biological research centers that have active training programs in radiation protection, and the design of the program presented here has been informed by the teaching experience of the training staff involved. The training method is based on introductory and refresher courses for personnel in direct contact with the radioactive facility and also for indirectly associated personnel. The courses will include guideline manuals (print or electronic), training through seminars or online materials, and also personnel evaluation, visits to the radioactive facility or practical training as required. The introductory courses are intended for newly incorporated personnel. The refresher courses are fundamentally designed to accommodate possible changes to national legal regulations, working conditions or the in-house radiological protection controls.

KEYWORDS: *biological research, training in radiation protection, unsealed sources.*

1. Introduction

The use of ionizing radiation in biological research has many specific characteristics that need to be taken into consideration. These arise from the use of a great variety of radioisotopic techniques involving unsealed radioactive sources, and the range of ionizing radiation-producing equipment, such as X-ray and gamma-irradiator devices. Their use not only carries a risk of irradiation but also a significant risk of contamination.

The handling of radioactive material and exposure to ionising radiation can represent a risk to the exposed workers and to the public in general.

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European Union Directives [1] and Spanish National Regulations relating to the Prevention of Risk in the Workplace [2] and the specific legislation concerning Radiological Protection [3] (RP) emphasize the fact that information and personnel training are fundamental factors for controlling risks in the workplace.

Two Spanish National Regulations (Article 21, R.D. 783/2001 [3] and Article 67, RD. 1836/1999 [4]) highlight the need to provide licensed and unlicensed personnel associated with the Radioactive Facility with basic knowledge and initial and periodic training about the rules and procedures for radiological protection, existing radiological risks, the precautions to be taken, and the importance of the rapid notification of the status of pregnant and breast-feeding women. Furthermore, the regulations governing this type of Radioactive Facility make clear the obligation to provide continuing training at least every two years.

Due to the particular characteristics of radioactive installations for biological research, and the need for specific training, proposals have been made regarding the content of the courses of specific operators in the aforementioned radioactive facilities [5]. Courses with these characteristics, approved and authorised by the Nuclear Security Council, are offered regularly [6].

In each of the biological research centers, the Radiological Protection Service, or in its absence, the Supervisor of radioactive facilities, provides training in this area. However, there are no plans for approved and authorized continuing training programs for the training that must be provided to personnel whose duties do not require them to be licensed. Nevertheless, generic radiological protection training plans have been set out [7-8-9], and the Spanish Society for Radiological Protection (SEPR) has published a specific monograph on this kind of training in different areas [10].

In this respect, to meet the training requirements of personnel in radioactive medical installations who do not need a license, a CD-ROM of a basic training guide on radiological protection, with complementary audio-visual content, has been produced in accordance with the regulations specific to this subject [11].

In preparing the training programs for radioactive facilities for biological research it is necessary to bear in mind the degree of involvement of the personnel in this type of facility [12] as well as their previous training. Therefore, two groups have been defined:

1.- Personnel directly associated with the Radioactive Installation:

- Personnel who control the radioactive installation, and users (staff): Heads of RP, Supervisors and Operators.
- Research personnel receiving training: principally predoctoral fellows, who represent the biggest group of exposed personnel. These staff are highly mobile, since they remain in the research centers for four to five years or even less while they work towards their doctoral thesis.

2.- Personnel indirectly associated with the Radioactive Installation:

This group is made up of personnel involved in research support services (e.g., maintenance, animal house, instrumentation and cleaning staff, etc.). These workers, to differing degrees, are affected by the running of the Radioactive Installation, which makes it necessary for them to receive information / training in accordance with their degree of interaction with the facilities.

Another point is that the personnel who join the centers have had little or no previous training in RP since the majority of undergraduate degree courses do not include this discipline. Therefore, a wide range of proposals have been made to incorporate specific programs of basic training in RP in diverse scientific degree courses [13].

Bearing these points in mind, the aim of this study has been to develop a continuing training program in RP specifically for biological research centers (Table 1). This program is required to fulfil the

regulations currently in force, helping to minimize the probability of incidents and radiological accidents in such facilities.

This goal has been achieved through the participation of six biological research centers at which specific training programs are currently offered. Therefore, the educational experience of the professionals who give this training has contributed to the accomplishment of the program presented here.

The aim of instigating these programs is to ensure that the exposed personnel, as well as all other personnel who carry out their duties in biological research centers, have specific training and information available that is adapted to the radiological risk that really exists in radioactive installations in this field.

Finally, it is important to bear in mind that, in addition to having continuing training plans adapted to the use of ionizing radiation, it is necessary for different institutions to establish the appropriate human and technical means by which this may be achieved.

2. Training program for personnel directly associated with the radioactive facility.

The training program developed below will be given not only to the personnel that will be directly exposed to ionizing radiation (staff or in-training personnel), but also to line managers of these personnel, despite the fact that they are not considered as exposed personnel.

2.1. Introductory training.

2.1.1. Submission of starting documentation for admission to a radioactive facility.

The need for information and training can be covered initially by the provision of summary documentation that explains the basic procedures and norms for radiation protection before staff begin their activity. The documentation can be presented to personnel as a hard or digital copy. The program should contain the following:

- Physical characteristics of ionizing radiation.
- Characteristics of commonly used radioisotopes.
- Radiobiology: interaction of radiation with tissues and the kinds of effects encountered.
- Organization in Radiation Protection.
- Duties of the holder, licensed personnel (radiation protection supervisors and operators) and exposed personnel (staff or in-training).
- Rules and procedures for the handling and internal and external transport of radioactive material.
- Classification of radiological areas.
- Authorized radioisotopes and activity limits in the radioactive facility.
- Operational surveillance program.
- Principles of radiation protection: distance, time and shielding.
- Rules related to the operator, the work area and the environment.
- Correct use of contamination monitors and personal dosimeters.
- Radioactive waste management: characterization, segregation and packaging.
- Course of action in case of surface and material contamination.
- Rules and procedures for incidents and personal accidents.
- Emergency response.

2.1.2. Guided tour of the facility.

Through this tour, the students will become familiar with the different units of the radioactive facility. They will identify the risk sources, the different danger and warning signals, and learn the access procedures, etc.

2.1.3. Test or interview.

This test allows the trainer to assess the level of knowledge acquired after reading the documentation and the guided tour. If personnel pass the examination, they will be considered suitable for work with radioactive sources.

2.1.4. Radiation protection course.

This course will develop the content included in the introductory documentation. The information and training provided in this course are more extensively reflected in the Radioactive Facility Radiation Protection Manual. In this regard, a copy of the manual must be in the custody of all laboratory heads or group leaders. Moreover, a digital copy of the course contents and the Manual should be available online to all personnel.

The frequency of the course can range from monthly to yearly. The length can be from 2 to 6 hours. Both the frequency and length will depend on the specific features and needs of each radioactive facility.

The course will consist of an audiovisual presentation (e.g. Microsoft PowerPoint®). Basic equipment will be used: seminar room, computer, projector, board.

Optionally, a self-assessment test would be held, with the aim of reinforcing uptake of the course contents by students.

2.1.5. Laboratory practical class (optional).

After the course, a laboratory practical could be included if the technical and human resources in the radioactive facility allow. In this practical training staff will put the theoretical content of the course into practice and familiarize themselves with the use of the containment, shielding, detection and waste management equipment available at the radioactive facility.

The practical training can include simulation of a labeling technique with a beta radioisotope. This would provide training in basic operations of handling, transport, storage, detection and decontamination, as well as critical phases which have a higher probability of radioactive contamination: centrifugations, hybridizations, vacuum drying, use of thermostatic baths, etc.

A standard protocol will be provided for the practical training, to be used by staff as a guideline for the procedure.

The practical training will use the standard equipment in the laboratory supplemented by the following:

- An empty vial for radioactive material.
- Fluids simulating different media and samples used in the labelling technique.
- Personal protection equipment: gown, gloves and spectacles.
- Containment equipment: trays, safety liners (plastic-backed absorbent pads), and so on.
- Shielding: front and side mobile methacrylate screens.
- Signaling tape for radioactive risk (radioactive clover).
- Shielded containers and labels for radioactive waste and labeled samples.
- Geiger-Müller Radiation detectors.

- Personal dosimeters.
- Sealed sources to practice detection of ionizing radiation.

The practical class will last for 1 or 2 hours. It can be performed in a training laboratory, if one is available, or in a conventional lab.

2.2. Continuing training.

2.2.1 Refresher seminars.

These seminars allow personnel directly associated with the radioactive facility, and who have already been trained and are accustomed to working with ionizing radiation, to renew their knowledge. These personnel update their training, taking into account changes in the radioactive facility as well as the results obtained in the degree of compliance with the rules in radiation protection.

The content of these seminars can vary considerably. The most common elements are as follows:

- Changes in national regulations related to radiation protection.
- Changes to the characteristics of the facility or its internal procedures.
- Analysis of any detected non-compliance with facility norms, as well as of incidents and accidents that might have occurred in the last period.

The frequency of the seminars should be approximately every two years. Seminars can be held with a higher frequency according to the circumstances of each facility. The seminar length should be between one and two hours.

Optionally, a self-assessment test could be held with the aim of reinforcing acquisition of course content by the student.

3. Training program for personnel indirectly associated with the Radioactive Facility.

As already indicated, although this group of personnel is not classified as exposed personnel, these people will have controlled access to areas where radioactive material is manipulated or stored. Therefore it is necessary that these personnel have the adequate information to allow them to carry out their duties while reducing the probability of exposure to a minimum. The training program developed below will be given to the personnel who carry out the activities directly as well as people in charge of every area, service or department.

3.1. Introductory training.

3.1.1. Distribution of documentation.

This group will include maintenance, cleaning, security, information systems, and administrative staff. Due to the heterogeneity in the prior training of these personnel (academic education, type of activity, previous knowledge in Radiation Protection, etc.) the information presented should be of a generic nature and be designed such that the visual aspects are strengthened (e.g. as a brochure). The information will focus in the identification of radiological risk sources. The documentation should be presented as a hard copy and it is desirable that a digital copy be available. The program should include the following content:

- Introduction to ionizing radiation and radiological risk. Differences between radiation and contamination.
- Organization of the radioactive facility. Responsibilities of different staff categories.
- Identification of risk sources : labeling, physical location, etc.
- Basic rules of access to the different RF areas.

- How to respond to emergencies, incidents and accidents.

3.1.2. Facility visit.

Through a guided tour the personnel will be familiarized with the different Radioactive Facility areas. They will identify the risk sources, different risk labels, access control measures, etc.

3.1.3. Course on the identification of radiological risk sources.

The introductory documentation will be distributed at the beginning of this course. The main goal of the course is to ensure that these personnel do not come into contact with stored radioactive material or with areas in which radioactive material has been handled. This will be achieved by teaching staff how to identify risk sources, specific labels and their meaning, the physical location of sources, the specific containers and other devices or equipment, etc., as well as training in the guidelines and regulations for working in or nearby risk areas.

The frequency of the course will depend on staff turnover in these departments. Department heads therefore need to liaise closely with the Radiation Protection Officer. The course length should be between half an hour and one hour. According to the specific characteristics of the RF, specific content could be expanded, or courses could be established for specific groups of personnel.

The course will consist of an audiovisual presentation (e.g. Microsoft PowerPoint®). Basic equipment will be used: seminar room, computer, projector, board.

3.2. Continuing training.

3.2.1 Refresher seminars.

The purpose of these seminars, as indicated in section 1.2.2, is to renew and update knowledge about Radiation Protection among staff indirectly associated with the Radioactive Facility.

As before, the content of these seminars can vary considerably. The most common elements are as follows:

- Changes to the national regulations related to Radiation Protection.
- Changes to the characteristics of the facility or its internal procedures.
- Revision of most important internal rules for Radiation Protection, with an emphasis on any recorded incidence of non-compliance.

The frequency of the seminars should be approximately every two years. Seminars can be held with a higher frequency according to the circumstances of each facility. The seminar length should be between half an hour and one hour.

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Table 1: Continuing training program in radiation protection in biological research centers.

CONTINUING TRAINING PROGRAM IN RADIATION PROTECTION IN BIOLOGICAL RESEARCH CENTERS							
Course type	Intended for...	Content	Documentation	Frequency	Length	Guided tour	Exam
SEMINARS FOR PERSONNEL DIRECTLY ASSOCIATED TO THE RADIOACTIVE FACILITY (RF)							
INTRODUCTORY	All scientific and technical personnel working with radioactive material. Attendance is mandatory	<ul style="list-style-type: none"> - Ionizing radiation (IR): physical features. - Features of radioisotopes used in research (β y γ). - Radiobiology: physiological effects of ionizing radiation. - Organization in Radiation Protection (RP). - Responsibilities: Titular, Supervisor, person in charge of authorized areas, exposed personnel. - External and internal movement of radioactive material. - Authorized isotopes and activity limits. - Radiation Protection principles: distance, time and shielding. - Manipulation norms: operator, work area and environment. - Use of contamination monitors. - Use of personal dosimeter. - Radioactive waste management: characterization, segregation, and storage - Course of action in case of surface and material contamination. - Responses to incidents and personal accidents. - Emergency response. 	RP norms and procedures (RP Manual, RF regulations, etc.)	From monthly to annual	2 - 6 hours	YES ½ hour length approx. Visit several RF areas. Identification of labeling, equipment, access control measures, etc.	YES In writing and in person, "on-line" or interview. Assessment intended to measure students' knowledge related to the most important course contents
PRACTICAL (OPTIONAL)		<ul style="list-style-type: none"> - Basic operations for handling, transport, storage, detection and decontamination. - Techniques for critical phases: centrifugation, sonication, hybridization, vacuum drying, use of baths, etc. 	Standard protocol	After introductory course	1 - 2 hours	NO	NO
REFRESHER		<ul style="list-style-type: none"> - Changes in the national regulations related to RP. - Changes in RF facilities or internal procedures. - Analysis of significant non-compliance with norms and responses to incidents or accidents. - Revision of the most significant RP regulations. 	Summary of changes or deviations	Biannual (may be held more frequent depending on circumstances)	1 - 2 hours	NO (unless required by changes to the RF)	NO
SEMINARS FOR PERSONNEL INDIRECTLY ASSOCIATED WITH THE RF							
INTRODUCTORY	Administration or other support service personnel (maintenance, cleaning, information systems, etc.) who enter or work near any RF area. Attendance is mandatory	<ul style="list-style-type: none"> - Introduction to ionizing radiation and radiological risk. - Organization of the RF . - Identification of risk sources: labeling, physical location, etc. - Basic procedures and rules in the RF. - Emergency response. 	Brochure guide for identification of risk sources	Determined by staff turnover rate	½ - 1 hour	YES ½ hour length approx. Visit several RF areas. Identification of labeling, equipment, access control measures, etc.	NO
REFRESHER		<ul style="list-style-type: none"> - Changes in the national regulations related to RP. - Changes in RF facilities or internal procedures. - Analysis of significant non-compliance with norms and responses to incidents or accidents. - Revision of the most significant RP regulations. 	Summary of changes or deviations	Biannual (may be held more frequent depending on circumstances)	½ - 1 hour	NO (unless required by changes to the RF)	NO