# Safety Guide nº 5.14 issued in Spain by the Nuclear Safety Council: Security and Radiological requirements in the industrial gamma radiography facilities.

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## PREFACE

Radioactive facilities where industrial gamma radiography apparatus are used require an Operating Permit in accordance to the Spanish regulations. In order to get authorized the licensee has to release a set of documents; among them two of the most important attending to radiological safety, are the "Operating Organization Manual" and the "Emergency Plan". The fulfillment of these documents is essential to get, from the radiological point of view, the optimal conditions for the running of the installation.

The Regulation 96/29 on Sanitary Protection against the Ionizing Radiations, transposition of Directives 80/836/EURATOM and 84/467/EURATOM, provides certain targets to be reached and a set of radioactive protection measures, applied, in general terms, to this kind of installations. The experience gathered on the running of these especially radioactive risky installations demands special attention to the fulfillment of the safety and radiological protection measures.

The Nuclear Safety Council issued in 1998 the safety guide 5.14, in order to help licensees to fulfill the safety and radiological requirements, as well to became a guideline in the writing of mandatory documents, specially those referring to the "Operating Organization Manual" and the "Emergency Plan", where procedures for safe operation of this kind of equipments are described.

## SCOPE

This guide applies to radioactive facilities, at which are used or stored industrial gamma radiography apparatus.

The requirements for the issuance of an Operating Permit of these facilities are set forth in the Spanish legislation by:

- Law of Nuclear Safety Council Creation
- Decree of Nuclear and Radioactive Facilities, where there are established the type of authorisations that must obtain the same ones and the documents that they must present for its obtaining
- Decree of sanitary Protection against the Ionizing Radiations provides the standars of radiological protection
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Furthemore, the Operating Permit of the radioactive installation is subjeted to fulfilment certain specified conditions.

## GUIDE'S CONTENTS

1) Requirements for industrial gamma radiography apparatus and sources
2) Requirements for radiography in enclosed installation and requirements for gammagraphy equipment storage
3) Periodic checking and maintenance for gamma radiography apparatus, ancillary and safety equipment
4) Recommendations for use of device detecting and measuring ionizing radiation (gamma survey meters and personal dosimeters with Thermoluminiscent Dosimeters (TLD) and Direct Reading Dosimeters (DRD)) and protecting against ionizing radiation.

5) Criteria to apply for the optimization of the radiological protection (Criteria ALARA)
6) Medical Surveillance
7) Personnel requirements and training for workers operating radiography apparatus
8) Operations Records and periodic reports to the CSN.
9) Documents " Operating Organization Manual " and "Emergency Plan"

**REQUIREMENTS FOR INDUSTRIAL GAMMA RADIOGRAPHY APPARATUS AND SOURCES**

For the purposes of this guide an apparatus for industrial gamma radiography includes an exposure container, a source assembly, a remote control, and a projection sheath, or, the self propelled intra-tubular gamma radiography apparatus (pipe-line crawler) and the control source in order to control gammagrafic source from outside the pipe. This control source which normally consist of a low activity (Cs-137) sealed source mounted in a hand-held device and collimated.

Requirements for the apparatus:

- It is desirable certificate of conformity to show compliance with ISO 3999 or equivalent standard .
- Certificate of prototype approval issued by competent authority
- Certificate of apparatus quality control , issued by the apparatus manufacturer.
- Sealed source included in the apparatus is conforming to the apparatus design.
- Each exposure container shall be marked with:
  - . The basic ionizing radiation symbol and the word "RADIACTIVO" complying with UNE-73302
  - . The maximum rating of the exposure container for the intended radionuclide(s) in Becquerels (Bq)
  - . The exposure container manufacture's name, the model number and serial number of the device. In addition, the exposure container displays a durable fireproof label or tag bearing information about radioactive source contained in the exposure device.
- Exposures containers are often designed as transport packages and are tested and certified to Type B standards. In this case is necessary to provide the correspondent certificate, and where applicable, the Spanish validation of this certificate.

Requirements for the source:

- Design in compliance with ISO 2919 or equivalent standard, and its classification according to ISO for industrial gammagraphy or higher.
- Certificate of source activity and leakage issued by source's manufacturer.
- It is desirable the approval certificate of source satisfying the requirements for special form radioactive material defined for transportation purpose.

**FACILITIES REQUIREMENTS:**

For the purpose of this guide we consider:

- Enclosures facilities where the gammagraphy apparatus has been placed in a shielded exposure room those outsiders them cannot enter, and this apparatus operating into
- Storage facilities where a shielded room is devoted only to store a gammagraphy apparatus .

In the Operating Permit conditions the facilities type is specified .

**Enclosures facilities**:

- The gammagraphy apparatus must be controlled outside the room. The control unit and remote control of the gammagraphy apparatus must be located in a place where one can easily see the access door.
- Shielding design will consider the maximum operating parameters, the direction of useful beam, the leakage radiation, the scattered radiation, and special points where leakage radiation may exits , as points with pipework ducts or fasterner penetrations (for example, screws), and around doors and windows. Outside place to enclosure will classify "monitored area" or "access free" in accordance with the Regulation on Sanitary Protection against the Ionizing Radiations for these areas. If the outside

place to enclosure is out titular ´s facility property only is possible to classify the area out the enclosure as access free and the dose rate in the outside surface enclosure shall not exceed 2,5 μSv/h.

- Doors to the exposure room must be lockable. If apparatus for gamma radiography are used in the exposure room, the doors to the room must be provided with an interlock that prevents entry into the room during exposure. At least one door must be of such design that it can always be opened from the inside the room. Its interlocks should remain so while the operator at the control exposes the primary beam.
- The enclosed facility shall be labeled with a radiation warning sign. On the outside, there shall be a clearly visible warning red light, which is lit during exposure. The light must be accompanied with an explanatory text.
- Failure of any single component shall not result in the failure of more than one of the required safety interlocks.
- Furthermore in big enclosures facilities is convenient to install acoustic warning signals while source is exposed.
- Into the exposure room must be a suitable fixed monitor placed at the room entry. It´s interlocked with the access door such that personnel cannot enter unless the source is safely shielded and normal (background) radiation dose rates exist. The same fixed monitor also triggers visible and audible alarm signals. Such a system does no obviate the need to use a portable survey meter when entering a shielded enclosure.
- If the radiographic sources are stored in the shielded enclosures, it may be necessary to designate this shielded enclosure as permanently controlled areas even while no radiography is being carried out.

The safety system specified above may be of design different than described provided it offers a equivalent level of safety.

**Storage facilities:**

- The door must to be kept locked, and the key for the storage facility and exposure device control must to be held only by authorised personnel.
- Entrance doors leading to the storage room shall have a label conforming the area classification in the decree on Sanitary Protection against the Ionizing Radiations and a standard sign warning againts ionising radiation complying to UNE 73-302.
- When it's possible the storage room should be placed in basements, preferable in a zone classified as for industrial use.
- The access to the storage room must be exclusive to the facility.
- The storage room should be built with non-flammable material. Fire extenuators must be avilable.
- The dose rate at accessible places outside a permanent storage room shall not exceed 2,5 μSv/h.
- Permanent workplaces must´n be located into the room's storage
- Into this room or nearness must´n be performances with explosion or fire risk neither radioactive material storage together with explosives or highly inflammable material.
- Storage of industrial gammagraphy apparatus in motor vehicles is generally prohibited..

**CHECKING AND MAINTENANCE OF EQUIPMENT**

The items of a gamma radiography apparatus specified bellow -intended for use in connection with gamma radiography - shall be submitted for periodic checking and service.

- Source holders
- Exposure containers and remote control cables and sheaths
- The projection sheaths

In the case of Crawler equipment, in those items that not be it of application the requirements described subsequently must be check according to the manufacturer equipment recommendations .

1. **Source holder**:

The source shall not leak. Leak test should be carried out frequently over sealed sources in use with the periodicity stabilised in permit condition for operating to the radioactive installation and according to the recommendations of Spanish Nuclear Safety Council guide nº 5.3 and the results given in a leak test certificate. This work shall only be performed by companies being licensed to perform such work.

**2. Exposure containers and remote control cables and sheaths:**

We distinguish between checks performed to the equipment in use by companies being licensed to perform such work which release an check certificate, and the checks performed by the license. The checking shall be carried out with the frequency established in the condition of the operation permit for the radioactive facility.

When performed by specifically licensed companies the following aspects should be include in the scope of the checks:

- The container and remote control state. The container and the source plate shall be marked. The marking plate shall be legible and firmly attached, the container shall not show any signs of external damage that can affect the functioning or the shielding properties and shall be complete; the connections to the projection sheath and the remote control cable and sheath shall be clean an undamaged; the connector on the back of the source holder shall be undamaged and clean and shall have the correct dimensions; the remote control shall not have damage strands; the cable shall not be bent, and it shall be clean, properly lubricated and free room corrosion , and the connecting device shall be undamaged and have the correct dimensions.
- The shutter or locking mechanism shall not show signs of external damage and they shall function faultlessly. The colour codings or other markings on the shutter or locking mechanism shall be clean, undamaged and easily seen.
- The source holder shall not be contaminated. A wipe test shall be made to verify this.
- Dose rate around the container shall be in concordance with the specified dose rate manufactures

The periodic checking performance by the license must be included in the installation radiactive "Operating Organization Manual".

**3. The projection sheaths:**

The inner face of the projection sheath shall be undamaged and clean. These checks can be performed by the operator according with the "Operating Organization Manual".

**RADIOLOGICAL SURVEY DEVICES AND RADIOLOGICAL PROTECTION EQUIPMENT.**

For the purpose of this guide the radiological survey devices are the personal monitoring (thermoluminescent dosimeters- TLD- and direct reading dosimeters- DRD) and the workplace monitoring (dose-rate meters).

Each worker who act as a radiographer or assistant radiographer shall wear, on the trunk of the body, a combination of appropriate direct reading dosimeter and a thermoluniniscent dosimeter. Such devices are not a substitute for radiation survey meters.

Each TLD must be assigned to and worn by only one individual.

The TLD shall be provided and processed by a laboratory or company that has been authorized by Spanish Nuclear Safety Council. The frequency of TLD replacement must´n exceed one month and must be replaced always after a radiological incident.

All exposed proffesionaly workers must have a dosimetric history where the results of TLD measurements are recorded over all his work live.

When the worker professionally exposed performs works in controlled area of an nuclear or radiactive installation, of other company that he belongs, he should have assigned an individual document of radiological protection (Carné Radiológico) that should be fulfilment and brought up to date by the company of gammagraphy worker belongs. This document should contain the aspects that are defined in the article 7 of the R.D. 413/1977 upon operational protection of external workers with risk of exposition to ionizing radiations because intervention in controlled areas.

A sufficient number of suitable direct-reading dosimeters are provided in the installation to comply with the requirement "each radiographer and assistant radiographer working with gammagrapy apparatus wear a suitable direct-reading dosimeter".

The characteristics required for this device are:

- It must be capable to detect and meter gamma and X-ray radiation, it should have a response appropriate for the kind of radiation being measured and it should be in good working condition.
- It must have a range from 0,01 mSv to 100 mSv for photons
- Furthemore it is desireable to have an audible warning signals or, if the performance are in noisily places, a warning lighting signals .

Pen dosimeters are not accepted as DRD.

This devices must be periodically checked and calibrated. The frequency for the checking is stablished by the manufacturer or, in default, one time per year and always after a repair. The calibrating must be carried out by a certified company by the Metrology System in Spain, and the frequency is stablished by the Meter laboratory or, in default, by the manufacturer.

During each radiographic operation the radiographer, shall monitor around the apparatus. This monitoring confirms the delineation of controlled and supervised areas, and indicates any failure in the control of the radiation source. Also, when the radiographic operation is in an enclosured facility, in the entry to room shielding there is a fixed survey meter. In the storage facilities, when gammagraphy apparatus are stored, must be a survey meter.

A sufficient number of suitable survey meters are provided in the installation in order to comply the requirement that described before paragraph.

The requirement for survey meter are:

- It will have a response appropriate for the type of radiation being measured
- It will be in good working condition
- It will be capable of measuring dose rates within the range 0 to 10 mSv/h
- It will continue to indicate "full scale" at dose rates within the range 10 to 1000 mSv/h
- Portability, durability in bad weather and poor conditions, reliability and use in low-light or dark environments.
- Must be formally calibrated and tested within the specified periodicity.

The survey meter must be checked and calibrated following the criteria for direct-reading dosimeters checking and calibrating.

For the purpose of this guide the protection equipment include: collimators and local shielding, temporary barriers or tapes, warning notices and signals, tables or graphics to perform dose calculation,, emergency kit, including remote source handling tools, tongs, lead tile, appropiate container for shielding the source and other ancillary equipment, such as damps and positioning aids.

**OPTIMIZATION OF THE RADIATION.**

The document "Operating Organization Manual" shall include criteria to apply for the optimisation of the radiation for the industrial gammagraphy application in order to comply the Regulation on Sanitary Protection Against the Ionizing Radiations in relation to ALARA principle. The aspects to be analysed for optimization should be:

- Reduce as possible the source exposure time by operation
- The radionuclide and the activity of the radiographic source shoud be selected such that the dose for all workers is kept ALARA, consistent with obtaining adequate diagnostic information.
- Previous to working, perform a study about the individual doses range assessments to the different types of work in order to know the radiological risk assessments and to reduce the individual doses. In the realising of this analysis are the important help the direct-reading dosimeter measures.
- Optimización of the number of persons involved in practice

- To Establish some "dose constrains", given that a systematic exposition of the workers to nearby levels of dose to the limit established would be nearby to an unacceptable situation of risk
- Incorporate programs about basic qualification in radiological protection for workers assed retraining program for the radiographer and assitant radiographer, in which the basic lines of the program be included ALARA applied to the practices.

**MEDICAL SURVEILLANCE**

The professionally exposed workers must pass a medical test in compliance with Spanish Regulation on Sanitary Protection Against the Ionizing Radiations in order to asses the health of the worker , to help in ensuring initial and continuing compatibility between the health of the workers and the condition of their work and to provide a base line of information useful in the case of accidental exposure or occupational disease.

These tests should be performed prior to the incorporation to the job and subsequently with a frecuency minimum annual or more frequently if by the state of health or the conditions of the job thus it required, or by the occurrence of some incident. In certain cases of over-exposure a special medical examination is required.

This medical surveillance should be performed by a specialized medical service, with capability officially recognized to this end, which after the tests release the corresponding certificate of aptitude, that should be recordered together with the dosimetric history of the worker.

**QUALIFICATION AND TRAINING FOR WORKERS OPERATING RADIOGRAPHY APPARATUS**

Complying with the Spanish regulations, the gammagraphy installation shall appoint a radiation protection officer to take responsibility for all relevant aspects of radiation protection. The radiation protection officer must be given the authority necessary to perform his work in a satisfactory way. The radiation protection officer shall be have a license released by the Nuclear Safety Council. Theoretical knowledge and practical experience shall be taken into consideration. Regarding theoretical knowledge the course described in other Nuclear Safety Council guide 5.12 as a minimum.

Radiographers shall have satisfactory knowledge on radiation protection fundamentals and on the proper use of all radiography equipment, which is encountered during the work. These radiographers must perform a course described in the guide nº 5.12, this, together with proper practical training, is normally considered to give sufficient competence.

Radiographer assistants must be given sufficient information on the procedures involved in the industrial radiography to be able to carry out their work satisfactorily. Work assistant doesn´t operate with the gammagraphy apparatus.

Licensee has responsibility in the qualification and training of its workers in radiological protection aspects and should stablish a program for qualification and training of gammagraphy workers in accordance with the radiological risk assess with the job including practices. Also must perform incorporate a program of periodic inspections on site over radiographer an radiographer assistant operations.

**OPERATION RECORDS BOOK AND PERIODIC REPORTS**

In compliance with the Decree of Nuclear and Radioactive Facilities an Operation Records Book must be fulfilled and periodic reports must be sent to the Nuclear Safety Council with the information about the operation the radiactive installation.

The gammagraphy facilities must fullfil a General Operation Records Book with records about apparatus displacements, sources changes, radiological surveillance dates in the enclosured facilities or in the storage facilities, safety interlocks state in the enclosured facilities where applicable, radiological incidents in the installation including incidents with personal dosimeters (loses, falling in a radiation field, incorrect storage..) and checking and maintenance over apparatus an equipment, performed both by a authorized company and by the licensee and checking and calibrations results of survey meters and the periodic leakage source test (no apply to Iridium.-192)

In addition for working on site, an Operation Records Book must be fullfiled for mobile apparatus with records concerning to the specific gammagraphic operator involved: date, place, type of gammagrapyc operation, source activity, exposure times, operator involved, incidents and the regardings of the diret-reading dosimeters.

**OPERATING ORGANIZATION MANUAL AND EMERGENCY PLAN**

Each radioactive installation will arrange of their own documents called "Regulation of Operation" and " Emergency Plan ", which should be written considering that they are directed to the operation personnel and therefore, they should be clear, concise and of easy management.

A procedure should exist that define responsabilities on the elaboration, modification and disclosure of these documents written constancy must exist that the mentioned documents have been received by all the workers professionally exposed.

The document "Regulation of Operation" should contain to the except the following sections:

- Operating organization
- Procedures operation for the apparatus considering the particularities imposed by the apparatus or to apply and the procedures for calculation of the parameters that affect to the radiological protection.
- Procedures for the control of stored apparatus.
- Procedures of radiological protection that should include the correct utilization of all radiological survey devices.
- Procedures for the optimización of the radiation protection
- Apparatus transportation procedure according to the legislation.
- Program of tests, verifications and maintenance of apparatus and ancillary and the calibration of personnel dosimeters and survey ratemeter
- Program for training and retraining of workers
- Procedure of fulfilment of Operation records book.

The document "Emergency Plan" will include the accidental situations anticipated during the storage, transportation and operation with the apparatus, as well as the procedures for actions that should be applied in each case.