

# Spanish inventory of industrial gamma radiography apparatus and monitoring for radiation devices attending to their special characteristics.

Laura Urteaga García; Belén Tamayo Tamayo; Blanca Alfonso Nicolás; Emilia Rodrigo Gonzalez; Dolores Aguado Molina; Sofía Suarez Carrillo

NUCLEAR SECURITY COUNCIL  
C/ Justo Dorado, 11 - 28040 – Madrid (Spain)

## 1. Abstract

The practice of the industrial gamma radiography where portable or mobile apparatus are used, supposes a considerable radiological risk.

From the point of view of the gamma radiography apparatus and monitoring for radiation devices used in these operations, it is necessary to consider:

- These apparatus must be designed to allow the controlled use of gamma radiation emitted by a sealed radioactive source for industrial radiography purposes in order that persons will be safeguarded when the apparatus is used in conformity with the regulations in force regarding radiation protection. International Standard ISO 3999 (1977) “Apparatus for gamma radiography” establishes the security requirements that must be considered in their construction. ISO 3999-1 (2000) has increased the requirements of security of these apparatus, in order to reduce the operational incidents.
- This Nuclear Safety Council demands that during the use of these apparatus, each professionally exposed worker will have to carry: a gamma survey meter, a thermoluminescent dosimeter (TLD) and a direct reading dosimeter, better if it has an acoustic alarm.

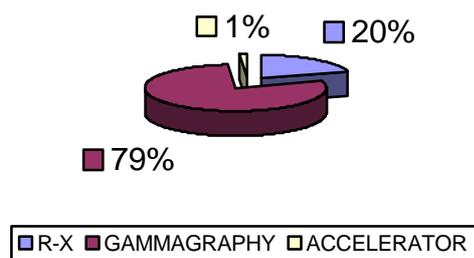
The enclosure of this paper will be to present the actual Spanish stock-taking of the apparatus refereed based on their characteristics.

## 2. INTRODUCTION

At present in Spain the 15% of the industrial radioactive installations are dedicated to the industrial radiography. For the purpose of this paper we are going to consider as industrial radiography intallations those that use gammagraphy apparatus or those that use X-Ray generators or accelerators with the same purpose that the gammagraphy apparatus.

As it is observed in the following graphic, the most used technique in Spain is the gammagraphy (79%), followed by X-Ray (20%) and of the accelerators (1%) .

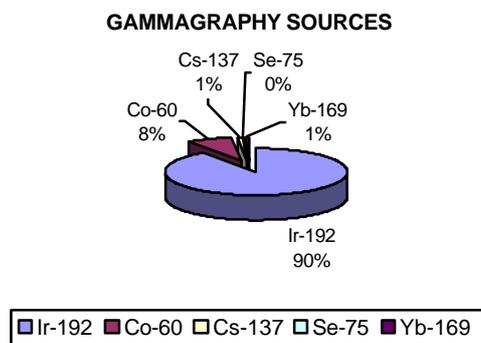
INDUSTRIAL RADIOGRAPHY TECHNICS



### 3. RADIOACTIVE SOURCES FOR GAMMAGRAPHY

The source more used in gammagraphy apparatus is the Iridium-192 (90%), followed by Cobalt-60 (8%). Also are used sources of Yterbium-169, Cesium-137 and Selenium-75, not exceeding in total a 2%.

In this inventory have not been considered the sources of Cs-137 that incorporate the devices used as instruments of control for gammagraphy apparatus type "Crawler" because not are used directly in the execution of the radiography.



The maximum activities authorized for these sources are as follows:

SOURCE	Ir-192	Co-60	Cs-137	Se-75	Yb-169
<b>Max. Activity (TBq)</b>	5	7,4	$1,85 \cdot 10^{-2}$	3	0,3
<b>Max. Activity (Ci)</b>	135	200	0,5	80	8

The maximum activity authorized of Iridium-192 sources is 5 TBq (135 Ci), although no more than 3 TBq (80 Ci) are generally used.

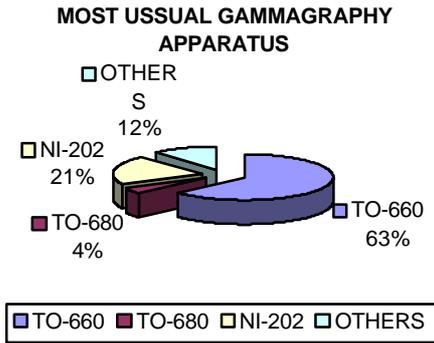
The sources of Selenium-75 have begun to be used recently in Spain and although its use represents less than the 1%, lately several requests for new apparatus have been presented that incorporate them, though these apparatus in most cases have not come to be acquired, because of it, is foreseeable that in a future go increasing the use of this source.

In Spain not sources are manufactured to incorporate in gammagraphy apparatus being carried out only the change of the sources exhausted by the news. The supply of these sources is carried out through the companies authorized for commercialization of this apparatus.

### 4. STOCK-TAKING OF GAMMAGRAPHY EQUIPMENT IN SPAIN

From the point of view of the gamma radiography apparatus and monitoring for radiation devices used in these operations, it is necessary to consider that these apparatus must be designed to allow the controlled use of gamma radiation emitted by a sealed radioactive source for industrial radiography purposes in order that persons will be safeguarded when the apparatus is used in conformity with the regulations in force regarding radiation protection International Standard ISO 3999 (1977) "Apparatus for gamma radiography" established the security requirements that must be considered in their construction. ISO-3999-1 (2000) has increased the requirements of security of these apparatus, in order to reduce the operational incidents.

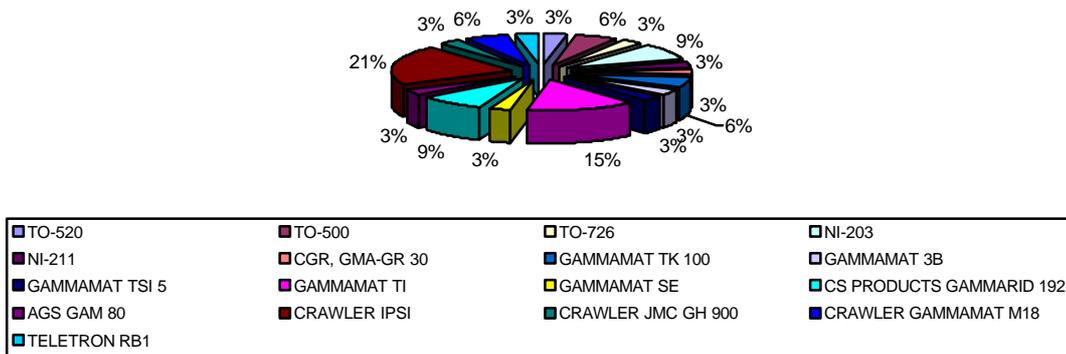
In Spain 21 different models of gammagraphy apparatus are used, but the most extended are the models TO-660 (63%), and NI-202 (21%), both with sources of Iridium-192. All the apparatus that are used in Spain are of importing, except Nuclear Ibérica (NI) apparatus, that of national production, but that so stopped manufacturing in the year 1995 although its use continues just as itself reflects in the next graphic.



Among the ones that incorporate sources of Cobalt-60 (used generally in bunker) the most used is TO-680.

The 12% remainder of the inventory of these apparatus, corresponds with the other 17 models distributed according to is observed in the next figure, being the most representative the Crawler IPSI IRIS (20%) and the Gammamat TI (14%).

### OTHERS GAMMAGRAPHY APPARATUS

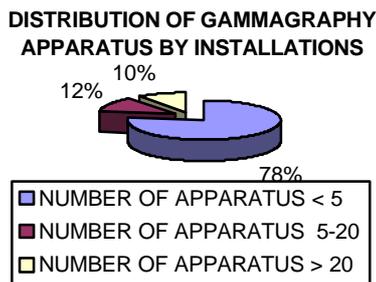


For execution of gammagraphies in pipes so much equipment are being used with manual remote control as equipment type Crawler.

Regarding the total of gammagraphy apparatus only a 3% are of design type Crawler, although also are being used conventional gammagraphy containers using a programmable mobile carriage type "Crawler". In Spain there is only a company that design programmable mobile carriage type "Crawler" to use with conventional gammagraphy containers in in agreement with ISO-3999-1 (2000).

As it is observed in the following graphic the distribution of the apparatus in the installations is the following one:

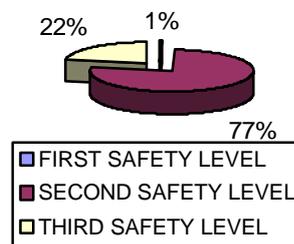
- . 10% of installations with more of 20 apparatus each one.
- . 12% of installations with a number of apparatus among 5 –20.
- . 78% of installations with less than 5 apparatus.



From the point of view of the security in the design of these apparatus, we are going to classify them in three levels of security:

- In a first level we have all those apparatus that comply with, according to certificate, the standard ISO 3999-1 (2000) or equivalent standard, and therefore count on the highest requirements of security in its design. These apparatus represent less than 1 % of the inventory.
- In a second level we will include those apparatus that can certify fulfillment with the standard ISO 3999 (1977) or equivalent, or those other that still without arranging of this certificate incorporate an additional blockade of security in the ring selector (LOCK position) agree to it indicated in that norm. Inside this group we find a 77% of the inventory.
- A third level for those apparatus that don't comply with the standard ISO 3999 and don't incorporate the LOCK position. These apparatus represent a 22% of the inventory.

**DISTRIBUTION OF GAMMAGRAPHY APPARATUS BY SAFETY LEVEL**



### **RADIOLOGICAL SURVEY DEVICES AND DIRECT READING DOSIMETERS (DRD)**

The use of gammagraphy apparatus supposes a radiological risk in normal operation, therefore the workers should arrange of some adequate devices for the measurement of the environmental radiation and personal dosimeters (TLD and DRD), as well as the appropriate devices of protection to the job to carry out.

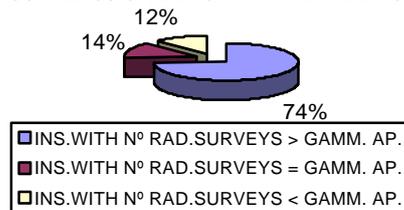
The Guide 5.14 "Security and radiological requisites in the industrial gamma radiography facilities" (Nuclear Safety Council - 1998), include the characteristics that should have the devices for the measurement of the radiation and the personal dosimeters of direct reading (DRD).

The radiological survey devices must be capable to detect and meter gamma and X-ray radiation. It should have a response appropriate for range from 0 to 10 mSv /h, and a continue to indicate "full scale" at dose rates within the range 10 to 1000 mSv/h.

The number of survey meters in each installation of gammagraphy should be agree to the type of activity (enclosure or mobile) and number of apparatus.

As it is observed in the next graphic, in a 74 % of the Spanish gammagraphic installations the number of radiation surveys is over than gammagraphy apparatus, in a 14 % is equal, and in a 12 % is lower.

**INSTALLATIONS WITH A NUMBER OF RADIATION SURVEYS / GAMMAGRAPHY APPARATUS**



During each radiographic operation, when the operator enter shall be provided with a survey meter, TLD and DRD. When the radiographic operation is in an enclosed facility, in the entry to room shielding must be a fixed survey meter.

In the storage facilities, when gammagraphy apparatus are stored, must be a survey meter.

The personal dosimeters of direct reading (DRD) must be capable to detect and meter gamma and X-ray radiation within the range 0,01 to 100 mSv, with audible warning signals. Pen-dosimeters are not accepted as DRD.

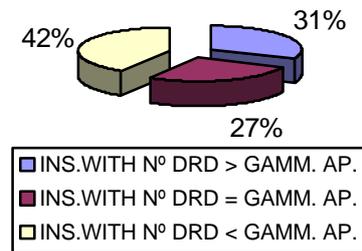
The majority of survey meters used in Spain are agree to the characteristics previously exposed, and usually the problems found in their use, according to the analysis performed after the occurrence of incidents, are because a bad use of them or badly operation of the survey, since they are not calibrated with the periodicity recommended.

In the past were used only pen-dosimeters as DRD. Actually the pen-dosimeters are being substituted gradually by other dosimeters that comply with the requirements described previously, being currently the percentages of pen-dosimeters represents around a 18 % of the total of DRD.

Nevertheless still enough of the dosimeters used have not an acoustic alarm.

As it is observed in the next graphic, in a 31 % of the Spanish gammagraphic installations the number of DRD is over than gammagraphy apparatus, in a 27 % is equal, and in a 42 % is lower.

**INSTALLATIONS WITH N° OF DRD /  
GAMMAGRAPHY APPARATUS**



## 5. CONCLUSIONES

For the operations of industrial gammagraphy, normally of mobile form and using radioactive sources of high activity, to avoid unnecessary expositions is very important: to arrange of good operational procedures, the correct use of the protection equipment and the good state of operation of the survey meters and dosimeters.

The majority of gammagraphic apparatus that there are in Spain not comply with any version of the standard ISO-3999 relative to the requirements of design of these apparatus.

Therefore the first action to should be is the progressive change of those apparatus that not arrange neither of the certificate ISO-3999 or equivalent, neither incorporate an additional blockade of security in the ring selector (LOCK position) by new apparatus that comply with the standard ISO-3999-1 (2000).

With the purpose of reducing the dose received in the operations of gammagraphy into pipes, these operations should be carried out with equipment type "Crawler", that comply with the requirements established in the standard ISO 3999-1 (2000) for these equipment.

Therefore, it's very important that the gammagraphic installations have an adequate number of radiation surveys and DRD, that comply with the requirements previously indicated.

The DRD type pen-dosimeters should progressive change by others that comply with the requirements indicated in the Nuclear Safety Guide: 5.14.

## REFERENCES

- [1] Actions adopted by the Spanish competent authority to improve the radiological protection in industrial radiography series. F. Zamora. Spanish Nuclear Safety Council.
- [2] Evolución de la dosimetría en gammagrafía industrial. Comparación con los límites recogidos en la Directiva 96/29 de Euratom. Belén Tamayo; Laura Urteaga; Blanca Alfonso. Spanish Nuclear Safety Council.
- [3] Plan de actuación para las instalaciones de gammagrafía. Sofía Suarez. Manuel Rodriguez. Spanish Nuclear Safety Council
- [4] Real Decreto 1836/1999, de 3 de diciembre, por el que se aprueba el Reglamento sobre instalaciones nucleares y radiactivas.
- [5] Real Decreto 783/2001, de 6 de julio, por el que se aprueba el Reglamento sobre protección sanitaria contra radiaciones ionizantes.
- [6] Safety Guide nº 5.14 issued in Spain by the Nuclear Safety Council: Security and Radiological requirements in the industrial gamma radiography facilities.