

APPARATUS OF INDUSTRIAL GAMMA RADIOGRAPHY IN FRANCE

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1. INTRODUCTION

Gamma radiography is a method of non-destructive testing very often used in places where the access is difficult for the inspection of the materials with thickness up to 200 mm of steel or equivalent.

It consists in carrying out a radiographic film using the gamma radiation emitted by a radionuclide.

The radioactive material is permanently enclosed in a capsule. Only sealed radioactive sources in special form are used.

At the present time, the radioelements most usually used in France are iridium 192 and Cobalt 60. Tests have begun with Selenium 75.

The use and the transport of the gamma radiography equipment are subject to:

- the general rules resulting from the regulations concerning the public and workers' protection against the dangers of the ionising radiation,
- the transport of radioactive materials,
- the special rules for using artificial radio-elements intended for industrial gamma radiography.

Several ministries or authorities are concerned in particular :

USE	TRANSPORT
⇓	⇓
GAMMAGRAPHY	PACKAGE
ΣMinistry of Employment	ΣMinistry of Finance
ΣMinistry of Health	ΣMinistry of Environment
ΣMinistry of Finance	ΣMinistry of Transport
ΣC.I.R.E.A.	ΣD.S.I.N.

2. HISTORY

Since the 50's, the production of artificial radionuclides became more and more efficient. At this time, the radiographic images were similar in term of resolution with those obtained with a x-ray generator. It quickly appeared to the operators that the use of a gamma radiography apparatus had many advantages in terms of dimension, weight, sturdiness, and easy use.

However, at that time, there was no regulation concerning the engineering of this kind of apparatus. Very often, they had no essential mechanisms for a use under the best safety conditions although the manufacturers design those with a greatest rigour.



The marketing of more and more powerful sealed radioactive sources and the development of the profession of the industrial radiologist laid down the authorities to set a strict regulation.

The first French standard concerning the manufacture of the apparatus for industrial gamma radiography appeared in 1970. Since 1974, its application was imposed by the "Commission Interministérielle des Radioéléments Artificiels (C.I.R.E.A.).

This standard laid down the use of apparatus based on the experience gathered by the users and the designers of equipments and taking into consideration the constraints met on the sites.

The number of known incidents was then strongly reduced.

However, after several years of use, we noted that this standard included some gaps and that certain types of apparatus, although in conformity, could be dangerous if they were used by an unskilled staff.

Therefore, since 1974, a new commission met in order to improve several points of this text to lead in June 1983 to a new **French standard M 60-551** which was very similar to the international standard ISO 3999 of 1977.

Let us note that they differed on the three following points :

- maximum dose equivalent rate on the external surface of the container (1mSv/h for M 60-551 instead of 2mSv/h for ISO 3999)
- tensile and crushing, bending and pressure tests for the ejection ducts and accessories of the gamma radiography apparatus no required in the ISO standard
- endurance and lock breaking tests of the container, no required in the ISO standard.



The 27th of August, 1985, the French authorities publish **the decree 85-968**.

This decree, still in force at present time, specifies the performance, design of apparatus for industrial gamma radiography, and classifies these materials as " dangerous machines ".

It is based on the requirements of standard NF M 60-551 of June 1983.

3. CONSEQUENCES OF DECREE 85-968

- checking of conformity to this decree by an independent approved laboratory to obtain a technical certificate (Visa d'Examen Technique or V.E.T.) before any sale / use of new apparatus,
- the certificate is delivered by the Ministry of Employment,
- annual maintenance by the manufacturer or importer is required,
- accompanying document required with each projector and accessories for the recording of
 - ◆ the maintenance data,
 - ◆ the operating parameters such as the number of operations carried out and working conditions (ministerial order 11octobre 1985).
- indications of secured position of source holder and shutter on the projector (green – red –yellow) required,
- 1989 was the deadline to stop using the apparatus which were not in conformity (decrees of October 1985).

4. APPARATUS USED IN FRANCE

Nowadays, a few hundred of cameras are used on French territory, especially in the nuclear and the petrochemical fields and in civil engineering works for the examination of weldings of foundry parts and concrete structures.

Roughly fifty are loaded with Cobalt 60 sources of maximum activity of 18,5 TBq (500 Curies).



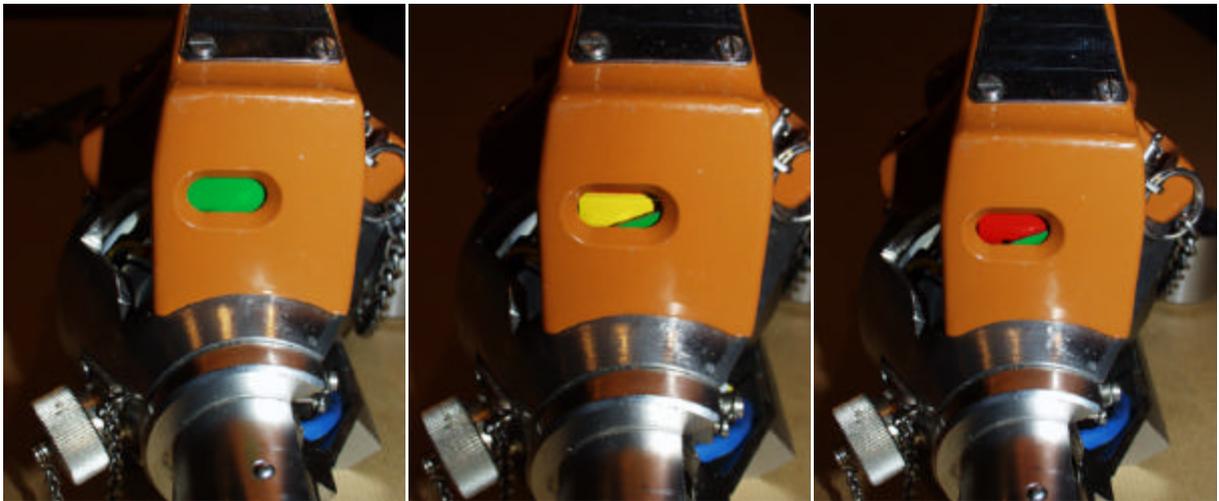
The majority of the projectors contain an Iridium 192 source of maximum activity of 4,4 TBq (120 Curies) except for very particular cases where sources of 11,10 TBq (300 Curies) are used exclusively in workshop.



A source-holder contains the sealed radioactive source in special form (double capsule).



Each projector has indications of secured position of the source holder and the shutter.



To increase the safety of the operator, with certain models of apparatus, an additional signal appears if source-holder had suddenly returned incomplete in its storage position : red with a white central point.



5. STANDARD ISO 3999-1

The required specifications for the use of an apparatus for industrial gamma radiography in France differ from the standard ISO 3999-1 mainly on :

	French regulation	ISO 3999-1
Measurement of dose equivalent rate on the external surface of the container	1 mSv/h	2 mSv/h
Indications of secured position of source-holder and shutter on the container	Required	No required
Maintenance	Required. Each year by the manufacturer or importer	According to recommendations of the manufacturer
Accompanying documents of the container and each accessory (parameters of exploitation, maintenance,..)	Required	

6. USE, and TRANSPORT

With the French regulation concerning the design and the manufacture of the apparatus, it is essential to associate the certificate for using the apparatus for industrial gamma radiography (Certificat d'Aptitude à Manipuler les Appareils de Radiographie Industrielle : C.A.M.A.R.I.) as well as the "special rules" of the "Commission Interministérielle des Radioéléments Artificiels" (C.I.R.E.A.).

The decree of 25 June 1987 lays down to each gamma radiography operator a formal and practical training in protection against radiation and on the use of the apparatus. The Ministry of Employment delivers the certificate (C.A.M.A.R.I.) after an examination of knowledge.

A preliminary agreement of the C.I.R.E.A. is necessary to be in possession and use a radioactive source.

The special C.I.R.E.A. rules specify that :

- to be used the apparatus of gamma radiography must get the technical certificate (V.E.T. - Decree 85-968),
- the source must be returned to the supplier within 10 years after the date on which the C.I.R.E.A. agreement has been granted.

The dose rate measurement for each operator (ministerial order of March 23, 1999), by holding an electronic radiation survey meter in addition to the film, completes this regulation.

For their transport, the apparatus of gamma radiography are also type B(U) packages. The new European regulation for the Safe Transport of Radioactive Materials required to update their safety files with in particular new drop tests of 9 m.

Several types of apparatus which were not in conformity with this new regulation have been destroyed since 1996.

7. CONCLUSION

This regulation makes that in France the apparatus for industrial gamma radiography properly used do not present any particular dangers for the user or his environment

However it does not permit to eliminate completely the risks from incidents linked to operating errors or losses or theft of apparatus.

Therefore, it is still necessary to increase our efforts in term of prevention in order to continue to use this method of non-destructive testing :

- Improvement of existing prevention programme for transporting and using gamma radiography apparatus,
- Sensitization and training at regular intervals, of each person using or in charge of gamma sources,
- Maintenance under quality insurance of equipment at regular intervals.

References

1. Décret n° 85-968 du 27 août 1985, Arrêtés d'octobre 1985 – Journal Officiel
2. Normes NF M 60-551, ISO 3999 – AFNOR
3. Conditions particulières d'emploi (CPE) et d'autorisation (CPA) de la C.I.R.E.A.
4. Bulletin de l'Office de Protection contre les Rayonnements Ionisants
5. IAEA Regulations for the Safe Transport of Radioactive Material
6. Accord européen relatif au transport des marchandises dangereuses par route (ADR)