Activities regulated by ASN

Chapter 10

Industrial, research and veterinary uses and source security

Industry, research, and also a large number of other sectors have for a long time been using sources of ionising radiation for a wide variety of applications and in a large number of locations. The purpose of the radiation protection regulations currently in force is to check that the safety of workers, the public and the environment is ensured. This protection includes source management, monitoring of the conditions in which sources are held, used and disposed of, from fabrication through to end-of-life. It also involves increasing the monitoring of the main stakeholders, the source manufacturers and suppliers, and enhancing their accountability.

The regulatory framework governing nuclear activities in France has undergone major changes and been tightened over the last few years. It falls within the scope of the Labour Code and the Public Health Code, and orients the regulation activities for which ASN is responsible.

The radiation sources used are either radionuclides, primarily artificial, in sealed or unsealed sources, or electrical devices generating ionising radiation. The applications presented in this chapter concern the manufacture and distribution of sources, industrial, research and veterinary uses (medical activities being presented in chapter 9) and activities not covered by the basic nuclear installations system (these are presented in chapters 12, 13 and 14). All other applications however, including those carried out within installations classified on environmental protection grounds (ICPEs), are concerned.

1 INDUSTRIAL, RESEARCH AND VETERINARY USES OF RADIOACTIVE SOURCES

1|1 Sealed radioactive sources

The main uses of sealed radioactive sources (sources whose structure or packaging, in normal use, prevents any dispersal of radioactive substances into the environment) are described below.

1|1|1 Industrial irradiation

Industrial irradiation is used for sterilising medical equipment, pharmaceutical or cosmetic products and for the conservation of foodstuffs. It is also a means of voluntarily modifying the properties of materials, for example, to harden polymers.

These consumer product irradiation techniques can be authorised because, after being treated, these products display no residual artificial radioactivity (the products are sterilised by passing through radiation without themselves being "activated" by the treatment). Industrial irradiators often use cobalt 60 sources, whose activity can be very high and exceed 250,000 terabecquerels (TBq). Some of these installations are classified as BNIs (see chapter 14).

1|1|2 Non-destructive testing

Gamma radiography is a non-destructive testing technique using radioactive sources, which is able to assess homogeneity defects in materials. It is frequently used to check weld beads. This technique primarily uses sources of iridium-192, cobalt-60 and, more recently, selenium-75, whose activity can reach about twenty terabecquerels at the most. A gamma radiography device is usually a mobile device which can be moved from one worksite to another. It consists primarily of:
– a source applicator, used as a storage container when the source is not in use;
– a guide tube, end-piece and remote-control for moving the source between the applicator and the object to be inspected, while protecting the operator who can thus remain at a distance from the source;
– a radioactive source inserted into a source holder.

Gamma radiography devices mainly use high-level sources which can entail significant risks for the operators in the event of incorrect operation, failure to abide by radiation protection rules, or operating incidents. As such, it is an activity with high radiation protection implications that figures among ASN's inspection priorities.

Gamma radiography device on work site

UNDERSTAND

Selenium gamma radiography

The use of selenium in gamma radiography has been authorised in France since 2006. It is employed in the same devices as those operating with iridium-192, but it is little used, with only about 3% of all devices being equipped in this way. However, it can be used in place of iridium-192 in numerous industrial fields, especially in petrochemistry. With a radioactive half-life longer than that of iridium-192 (120 days as opposed to 74), the use of selenium-75 in gamma radiography offers significant radiation protection advantages: far lower dosimetry for the operators, easier intervention in the event of incidents. The equivalent dose rates close to the source are about 55 millisieverts(mSv)/h/TBq at one metre, as against 130 for iridium-192, thus considerably reducing the extent of the safety perimeters required.

1|1|3 Verification of physical parameters

The operating principle of these physical parameter verification devices is the attenuation of the signal emitted: the difference between the emitted signal and the received signal can be used to assess the information looked for.

The radionuclides most frequently used are krypton-85, caesium-137, americium-241, cobalt-60 and promethium-147. The source activity levels are between a few kilobecquerels (kBq) and a few gigabecquerels (GBq).

These sources are used for the following purposes:
– atmospheric dust measurement; the air is permanently filtered through a tape running at a controlled speed, placed between source and detector. The intensity of radiation received by the detector depends on the amount of dust on the filter, which enables this amount to be determined. The most commonly used sources are carbon-14 (activity level: 3.5 MBq) or promethium-147 (activity level: 9 MBq). These measurements are particularly used for air quality monitoring by verifying the dust content of discharges from plants;
– basis weight measurement: a beta radiation beam passes through the paper and is then received by a detector. The signal attenuation on this detector gives the paper density and thus the basis weight. The sources used are generally krypton-85, promethium-147 and americium-241 with activity levels not exceeding 3 GBq;
– measurement of a liquid level: a gamma radiation beam passes through the container of liquid. It is received by a detector positioned opposite. The signal attenuation on this detector indicates the filling level of the container and automatically triggers certain operations (stop/continue filling, alarm, etc.). The radionuclides used depend on the characteristics of the container and the content. As applicable, americium-241 (activity level: 1.7 GBq), caesium-137 – barium-137m (activity level: 37 MBq) are generally used;
– density measurement and weighing: the principle is the same as for the above two measurements. The sources used are generally americium-241 (activity level: 2 GBq), caesium-137 – barium-137m (activity level: 100 MBq) or cobalt-60 (30 GBq);
– soil density and humidity measurement (gammadensimetry) in particular in agriculture and public works. These devices operate with a pair of americium-beryllium sources and a caesium-137 source;
– logging, which enables the geological properties of the sub-soil to be examined by inserting a measurement probe comprising a source of cobalt-60, caesium-137, americium-241 or californium-252.

Level gauge

1|1|4 Neutron activation

Neutron activation consists in irradiating a sample with a flux of neutrons to activate the atoms in the sample. The number and the energy of the gamma photons emitted by the sample in response to the neutrons received are analysed. The information collected enables the concentration of atoms in the analysed material to be determined.

This technology is used in archaeology to characterise ancient objects, in geochemistry for mining prospecting and in industry (study of the composition of semiconductors, analysis of raw mixes in cement works).

Given the activation of the material analysed, this requires particular vigilance with regard to the nature of the objects analysed. Article R.1333-3 of the Public Health Code in fact prohibits the use of materials and waste originating from a nuclear activity for the manufacture of consumer goods and construction products, if they are or could be contaminated by radionuclides, including by activation (see point 3|3).

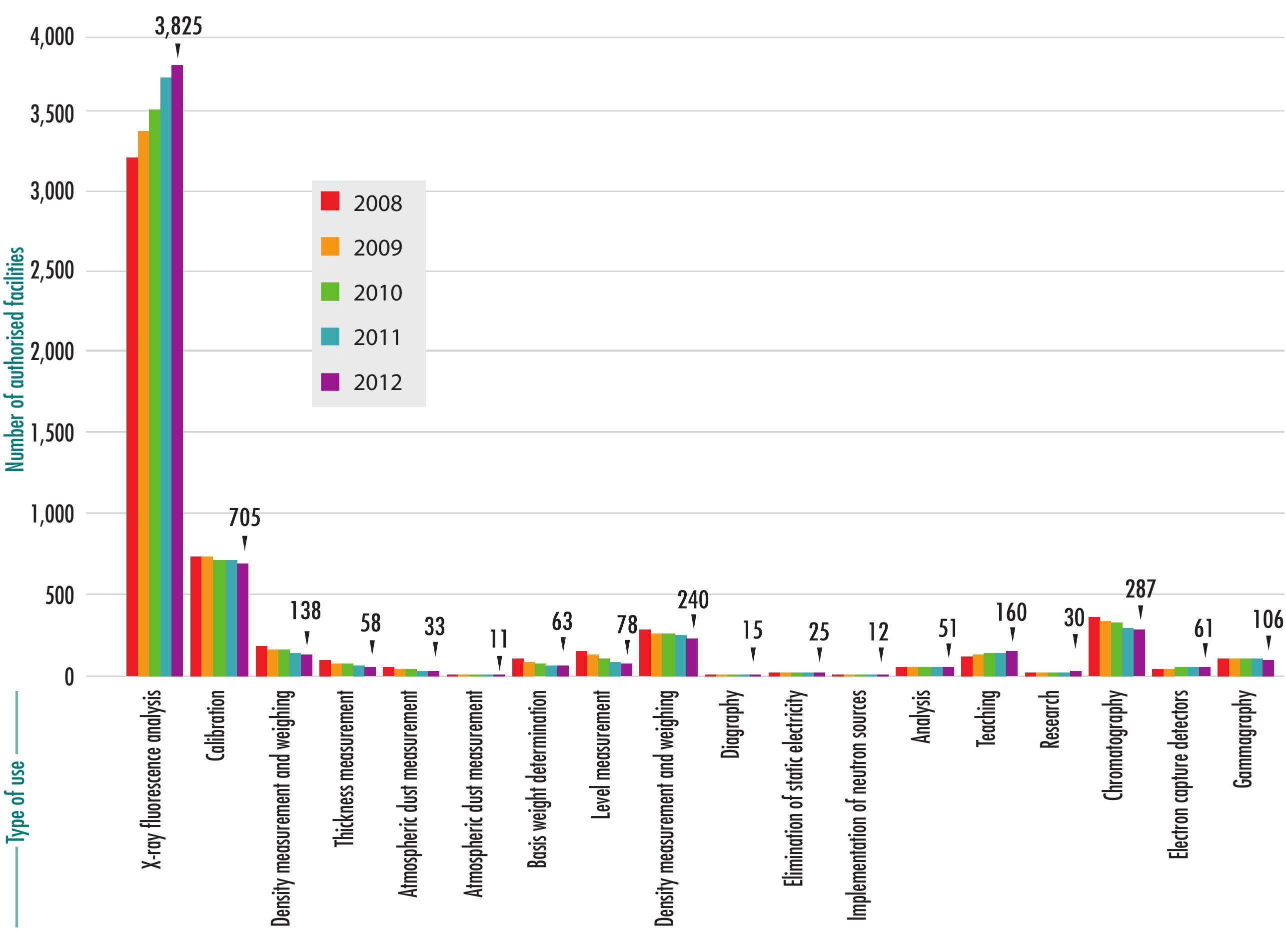
1|1|5 Other common applications

Sealed sources can also be used for:
- eliminating static electricity;
- calibrating radioactivity measurement devices (radiation metrology);
- practical teaching work concerning radioactivity phenomena;
- electron capture detectors using sources of nickel-63 in gaseous phase chromatographs. This technique can be used to detect and dose various elements;
- ion mobility spectrometry used in devices that are often portable and used to detect explosives, drugs or toxic products;
- detection using X-ray fluorescence. This technique is particularly useful in detecting lead in paint. The portable devices used today contain sources of cadmium-109 (half-life 464 days) or cobalt-57 (half-life of 270 days).

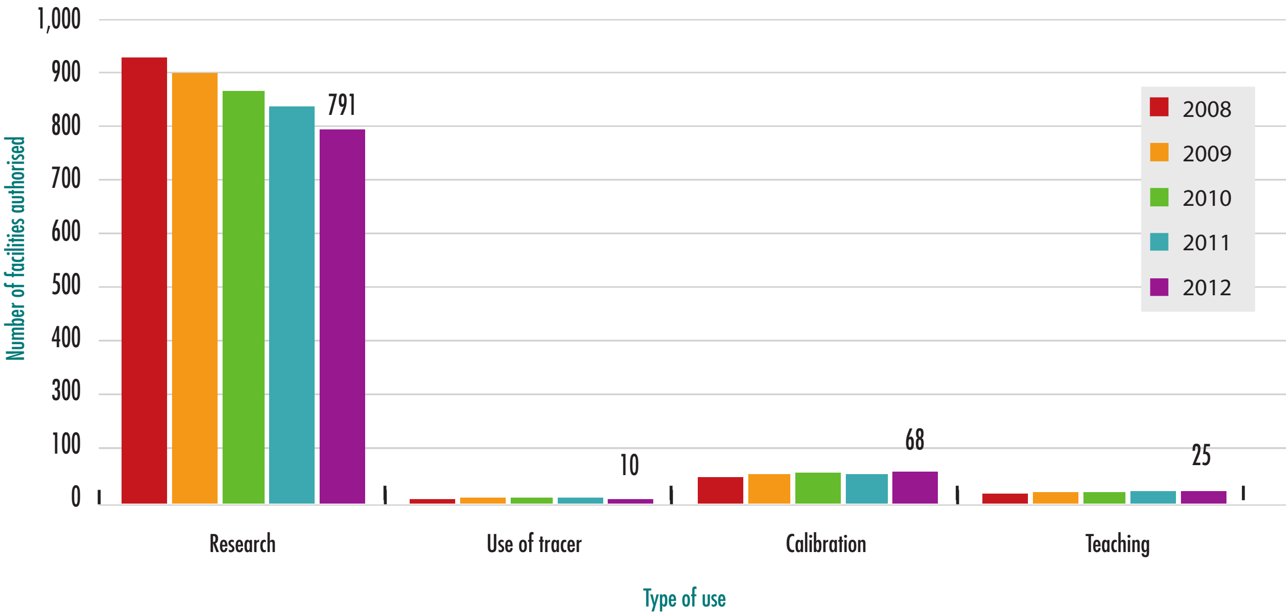
The activity of these sources can range from 400 MBq to 1,500 MBq. This technique, which uses a large number of radioactive sources in France (nearly 4,000 sources), results from a legislative measure to prevent lead poisoning in children, which requires a verification of the lead concentration in the paintwork of any residential building built before 1st January 1949, if it is to be sold or to undergo works significantly affecting the surface coatings in the common parts of the building.

Device for detecting lead in paint

Graph 1 : Use of sealed radioactive sources



Graph 2 : Use of unsealed radioactive sources



Graph 1 specifies the number of facilities authorised to use sealed radioactive sources for the applications identified. It illustrates the diversity of these applications and their development over the last five years (from 2008 to 2012).

It should be noted that a given facility may carry out several activities, and if it does, it appears in graph 1 and the following diagrams for each activity.

1|2 Unsealed radioactive sources

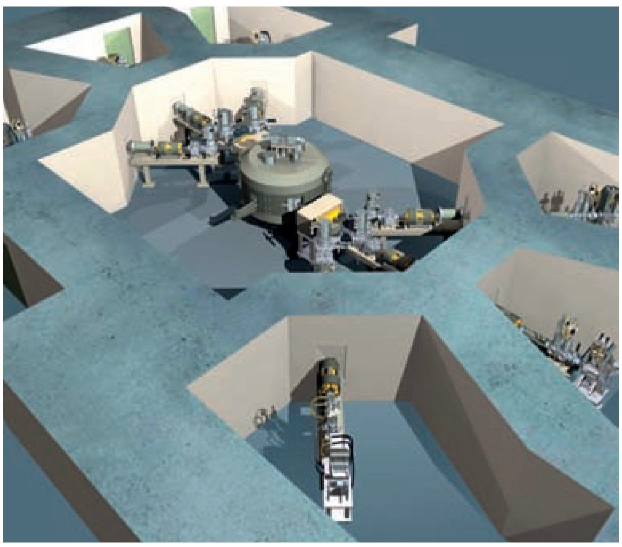
The main radionuclides used in the form of unsealed sources are phosphorus-32 or -33, carbon-14, sulphur-35, chromium-51, iodine-125 and tritium. They are in particular used in the research sector and in pharmaceutical establishments. They are thus a powerful investigative tool in cellular and molecular biology. Using radioactive tracers incorporated into molecules is common practice in biological research. There are also a number of industrial uses, for example as tracers or for calibration or teaching purposes. Unsealed sources are used as tracers for measuring wear, searching for leaks or friction spots, for building hydrodynamic models and in hydrology.

The number of facilities authorised to use unsealed sources stands at 894.

Graph 2 specifies the number of facilities authorised to use unsealed radioactive sources in the applications identified in the last five years (from 2008 to 2012).

1|3 Manufacturers and distributors of radioactive sources

ASN regulation and monitoring of suppliers of radionuclide sources or devices containing them, is crucial to ensuring the radiation protection of the future users. It is based on examining the conditions of use and guarantees the security of source movements, their traceability and the recovery and disposal of used or end-of-life sources (see point 3|2|1). Source suppliers must also play a teaching role with respect to users. It is important that their situation with regard to radiation protection rules be satisfactory and that their activities be duly covered by the license specified in Article R.1333-17 of the Public Health Code.



Computer generated image of the cyclotron installed on the Arronax research site in Nantes

In France, there are about 150 suppliers of sealed radioactive sources, or devices containing them, and of unsealed radioactive sources.

In 2012, these included 29 cyclotrons operating to produce radioactive tracers used in medical imaging (also see point 2 | 3).

UNDERSTAND

Cyclotrons

A cyclotron is a scientific instrument 1.5 to 4 metres in diameter, belonging to the particle accelerator family. The accelerated particles are mainly protons, with energy levels of up to 70 MeV. A cyclotron consists of two circular electromagnets between which there is a magnetic field and an electrical field, allowing the rotation of the particles and their acceleration at each revolution. Then, at a speed close to the speed of light, the accelerated particles "strike" a target containing an enriched fluid, which will become activated and generate radioactive isotopes.

Low and medium energy cyclotrons are primarily used in research and in the pharmaceutical industry to produce positron-emitting isotopes, such as fluorine-18 or carbon-11. The isotopes are combined with molecules of varying complexity to form radioactive tracers used in medical imaging. The best known of them is 18 FDG (fluorodesoxyglucose marked by fluorine-18), which is an industrially manufactured injectable drug, commonly used for early diagnosis of certain cancers.

2 INDUSTRIAL, RESEARCH AND VETERINARY USES OF ELECTRICAL DEVICES EMITTING IONISING RADIATION

Electrical devices emitting ionising radiation are mainly used in industrial radiography, where they are gradually replacing devices containing radioactive sources, as well as in veterinary applications. Graphs 3, 4 and 6 specify the number of facilities authorised to use electrical devices generating ionising radiation in the listed applications. They illustrate the diversity of these applications which have evolved over the last five years (from 2008 to 2012). This evolution is closely related to the regulatory changes introduced in 2002 and later in 2007, which created a new licensing or notification system for use of these devices. At present, the situation of the professionals concerned is being brought into compliance in many activity sectors, but a large number of users have not yet taken any action.

2 | 1 Industrial applications

The electrical devices emitting ionising radiation are chiefly X-ray generators. Like the devices containing radioactive sources, they are used in industry, non-destructive structural analyses (analysis techniques such as tomography, diffractometry, also called X-ray crystallography, etc.), checking the quality of weld beads or inspecting materials for fatigue (in aeronautics in particular).

The applications of these devices, which work using the principle of X-ray attenuation, include uses as industrial gauges (measurement of drum filling, thickness measurement, etc.), inspection of goods containers or luggage and also the detection of foreign bodies in foodstuffs.

The increasing number of types of device available on the market can be explained more particularly by the fact that when possible, they replace devices containing radioactive sources. The advantages of this technology are significant with regard to radiation protection, given the total absence of ionising radiation when the equipment is not in use. Their utilisation does however lead to worker exposure levels that are comparable with those resulting from the use of devices containing radioactive sources.

Radiography for checking the quality of weld beads or for the fatigue inspection of materials

These are fixed or worksite devices that use directional or panoramic beams. These devices can also be put to more specific

Baggage or cargo inspector

uses, such as radiography for restoration of musical instruments or paintings, archaeological study of mummies or analysis of fossils.

Baggage inspection

Ionising radiation is used constantly in security screening checks, whether for the systematic verification of baggage or to determine the content of suspect packages. The smallest and most widely used of these devices are installed at the screening checkpoints in airports, in museums, at the entrance to certain buildings, etc.

The devices with the largest inspection tunnel areas are used for screening large baggage items and hold baggage in airports, as well as for air freight inspections. This range of devices is supplemented by tomographs, which give a series of cross-sectional images of the object being examined.

The irradiation zone inside these appliances is sometime delimited by doors, but most often simply by one or more lead curtains.

X-ray body scanners

Interest in body scanner technologies is growing, in particular for airports, to reinforce security checks. This particular application is given for information only, since the use of X-ray scanners on people during security checks is prohibited in France (Article L. 1333-11 of the Public Health Code). The experiments being carried out in France are based on non-ionising imaging technologies (millimetre wave scanners).

Inspection of consumer goods

In the last few years the use of appliances for detecting foreign bodies in certain consumer products has developed. For example, the search for unwanted items in food products, cosmetics, etc.

X-ray diffraction analysis

X-ray diffraction appliances, which are self-shielded, are being increasingly used by research laboratories. Experimental devices used for X-ray diffraction analysis can however be built by experimenters themselves with parts obtained from various suppliers (goniometer, sample holder, tube, detector, high-voltage generator, control console, etc.)..

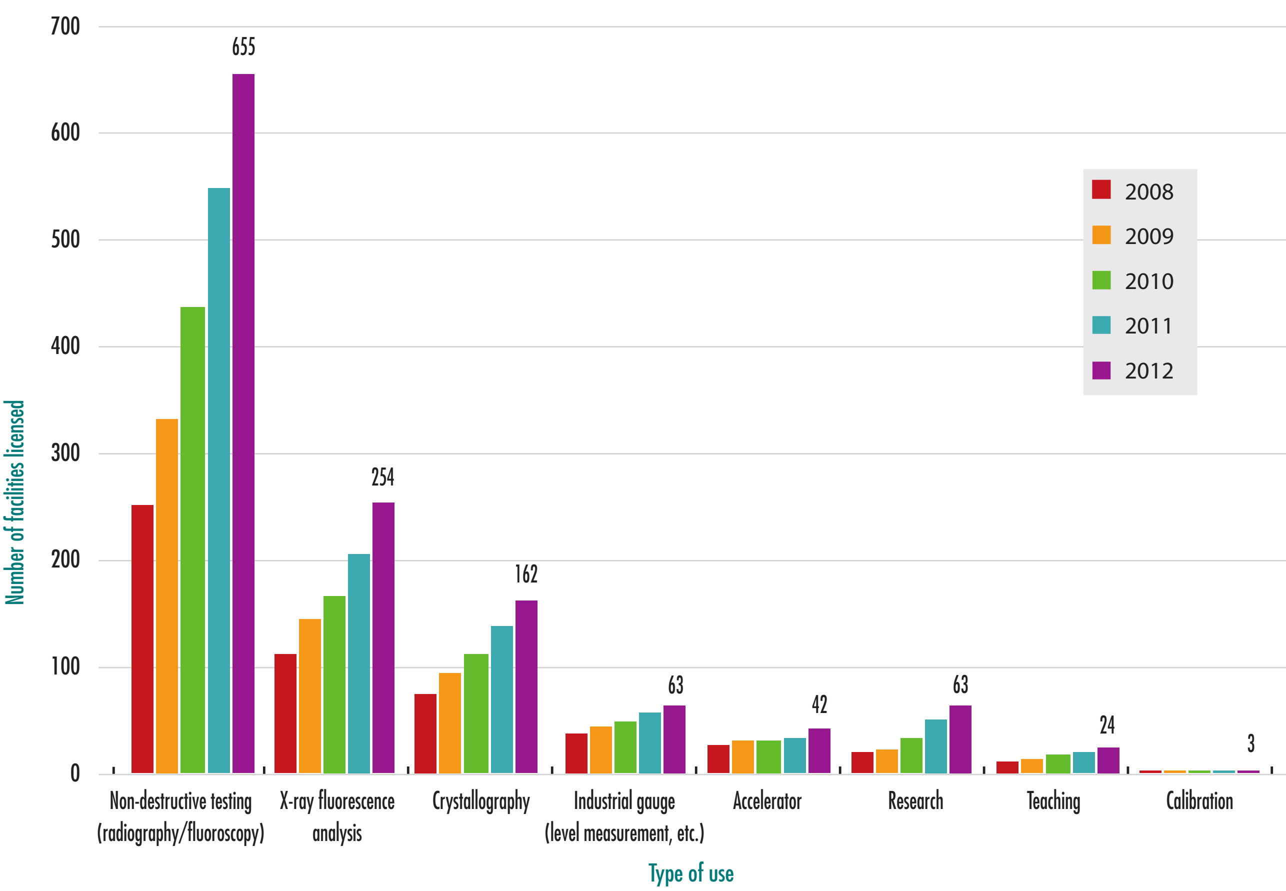
X-ray fluorescence analysis

Portable X-ray fluorescence devices are intended for the analysis of metals and alloys.

Measuring parameters

The appliances, which operate on the principle of X-ray attenuation, are used as industrial gauges for measuring fluid

Graph 3: Use of electrical devices generating ionising radiation (outside veterinary sector)



levels in cylinders or drums, for detecting leaks, for measuring thicknesses or density, etc.

Irradiation treatment

More generally used for performing irradiation, the self-protected appliances exist in several models that sometimes differ only in the size of the self-shielded chamber, while the characteristics of the X-ray generator remain the same.

2 | 2 Veterinary radiodiagnostics

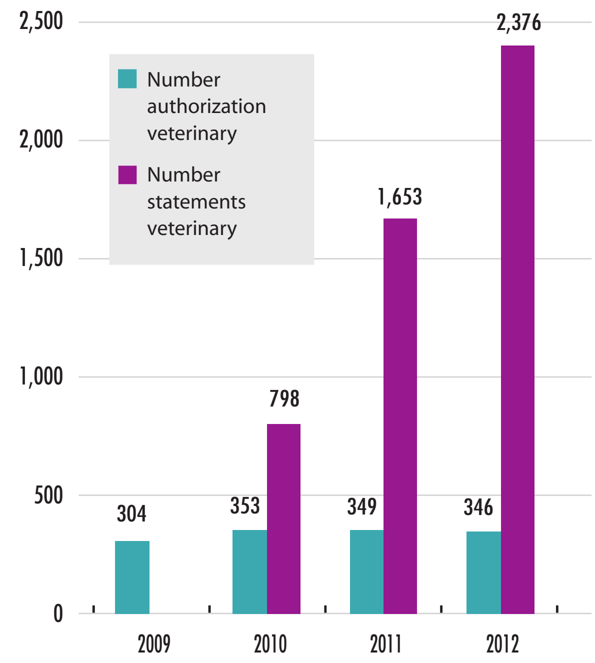
The profession counts approximately 16,000 veterinary surgeons and 14,000 non-veterinary employees. Veterinary surgeons use radiodiagnostic devices in a context similar to that of the devices used in human medicine. Veterinary radiodiagnostic activities essentially concern pets:
– 90% of the 5,793 veterinary structures in France have at least one radiodiagnostic device;
– ASN moreover notes an increase in the number of scanners used in veterinary applications, with about fifteen in France at present;
– other practices drawn from the medical sector have been implemented more recently. For instance, three scintigraphy centres, one brachytherapy centre and plans for several radiotherapy centres have been identified around the country.

The treatment of large animals (mainly horses) requires the use of more powerful devices installed in specially equipped premises (radiography of the pelvis, for example) and of portable X-ray generators, used either indoors – dedicated or other premises - or outside in the open air. This activity, which has significant radiation protection implications for the veterinary surgeons and the grooms, will be one of ASN's inspection priorities in 2012.

The devices used in the veterinary sector are sometimes derived from the medical sector. However, the profession is increasingly adopting new devices specially developed to meet its own specific needs.

Operator protected behind a screen, carrying out a radiographic examination of a horse inside a facility

Graph 4: Use of electrical devices generating ionising radiation for veterinary activities



2 | 3 Particle accelerators

The Public Health Code defines an accelerator as a device or installation in which electrically charged particles undergo acceleration, emitting ionising radiation at an energy level in excess of 1 megaelectronvolt (MeV).

Use of this type of device is subject to the notification or licensing regime specified in Articles L.1333-4 and R.1333-17 of the Public Health Code. When they meet the characteristics specified in Article 3 of decree 2007-830 of 11th May 2007 concerning the list of BNIs, these facilities are listed as BNIs.

Certain applications require the use of particle accelerators which produce photon or electron beams, as applicable. The inventory of particle accelerators in France, whether linear (linacs) or circular (cyclotrons – see point 1 | 3 - and synchrotrons), comprises about 50 identified installations (non-BNIs) which can be used in a wide variety of fields:
– research, which sometimes requires the coupling of several machines (accelerator, implanter, etc.);
– radiography (fixed or mobile accelerator);
– radioscopy of lorries and containers during customs checks (fixed-site or mobile accelerators);
– modification of material properties;
– sterilisation;
– conservation of foodstuffs;
– etc.

In the field of research, a number of synchrotron radiation production installations can be mentioned: the ESRF (European synchrotron radiation facility) in Grenoble, and the SOLEIL synchrotron at Gif-sur-Yvette.

Mobile linear accelerator used for inspecting loads

Road freight inspection system

2|4 Other electrical devices emitting ionising radiation

This category covers all the electrical devices emitting ionising radiation other than those mentioned above and not excluded by the license and notification exemption criteria set out in Article R. 1333-18 of the Public Health Code.

This category notably includes devices generating ionising radiation but not used for this property, such as ion implanters, electron-beam welding equipment, klystrons, certain lasers, certain electrical devices such as high-voltage fuse tests.

Recently, particle accelerator imaging systems have been used in France to combat fraud and large-scale international trafficking. This technology, which is felt by the operators to be effective, must however be used under certain conditions in order to comply with the radiation protection rules applicable to workers and the public, in particular:

– a ban on activation of construction products, consumer goods and foodstuffs as specified by Article R.1333-4 of the Public Health Code, by ensuring that the maximum energy of the particles emitted by the accelerators used rules out any risk of activation of the materials being verified;
– a ban on the use of ionising radiation on the human body for purposes other than medical. Thus, the use of ionising technologies to seek out illegal immigrants in transport vehicles is prohibited in France;
– the setting up of procedures to ensure that the checks conducted on the goods or transport vehicles do not lead to accidental exposure of workers or other individuals. During customs inspections of trucks using tomographic techniques, for example, the drivers must be kept away from the vehicle and other checks must be performed prior to irradiation to detect the presence of any illegal immigrants, in order to avoid unjustified exposure of persons during the inspection.

3 REGULATIONS APPLICABLE TO INDUSTRIAL, RESEARCH AND VETERINARY FACILITIES

The provisions of the Public Health Code relating specifically to the industrial and research applications provided for in the Public Health Code are specified in this section. The general rules are detailed in chapter 3 of this report.

3|1 The Authorities regulating the sources of ionising radiation

In application of the Public Health Code, ASN is the authority that grants the licenses and receives the notifications, in accordance with the system applicable to the nuclear activity concerned.

The Public Health Code does nevertheless provide for a series of waivers to alleviate the licensees' administrative constraints. The notification or licensing obligation does not apply to installations licensed under another system:
- for the radioactive sources held, manufactured and/or used in installations licensed under the mining system (Article 83 of the Mining Code) or in installations classified on environmental protection grounds (ICPE) which come under Articles L. 511-1 to L. 517-2 of the Environment Code, and have a licensing system, the Prefect[1] is the authority responsible for ensuring that these same licenses contain instructions relative to the radiation protection of the nuclear activities carried out on the site;
- for installations and activities relating to national defence, ASND (Defence Nuclear Safety Authority) is responsible for regulating radiation protection aspects;
- for the installations licensed under the BNI regime pursuant to Act 2006-686 of 13th June 2006 relative to transparency and security in the nuclear field (now codified in books I to V of the Environment Code by Order 2012-6 of 5th January 2012), ASN regulates, under this regime, the sources necessary for the functioning of these same installations (radioactive sources and electrical devices emitting ionising radiation). Holding and using other sources within the bounds of the BNI remain subject to licensing pursuant to Article R.1333-17 of the Public Health Code.

In no way do these waivers exempt the beneficiary from the need to comply with the requirements of the Public Health Code, in particular those concerning the acquisition and transfer of sources.

The distribution, import and export of radioactive sources, however, are not concerned by these waivers, and are subject to ASN authorisation.

Nuclear materials, for their part, are subject to specific regulations provided for in Article L. 1333-2 of the Defence Code. Application of these regulations is overseen by the Minister of Defence with regard to nuclear materials intended for defence needs, and by the Minister in charge of Energy with regard to nuclear materials intended for any other use.

3|2 Licensing and notification of ionising radiation sources used for non-medical purposes

3|2|1 Integration of the fundamental principles of radiation protection in the regulation of non-medical activities

ASN verifies application of the three major principles governing radiation protection and which are written in the Public Health Code (Article L. 1333-1), namely justification, optimisation of exposure and dose limitation (see chapter 2).

Assessment of the expected benefit of a nuclear activity and the corresponding health drawbacks may lead to prohibition of an activity for which the benefit does not seem to outweigh the risk. Either a generic prohibition is declared, or the license required on account of radiation protection is not issued or is not extended. The uses of radium for which the detriment to health was considered too high were banned several decades ago in application of this principle. For existing activities, justification is reassessed when license renewal applications are made if current know-how and technology so warrants.

Optimisation is a notion that must be considered in the technical and economic context, and it requires a high level of involvement on the part of the professionals. ASN considers in particular that the suppliers of non-medical devices must be at the core of the optimisation approach (see point 1|3). They are responsible for putting the devices on the market and must therefore design them such that the exposure of the future users is minimised. ASN also checks application of the principle of optimisation when examining the license application files, when conducting its inspections, and when analysing the various significant events notified to it.

3|2|2 Applicable licensing and notification legal systems

Applications relating to the holding and use of ionising radiation sources are reviewed by the regional divisions of ASN. Examination of license applications for the manufacture and distribution of sources is for its part carried out at a central, national level.

Licensing system

In accordance with the simplification process and the graduated approach to the radiological risks and implications, ASN continued with the revision of the licensing application forms. Following on from the ASN resolution specifying the content of

1. The Ministry of Defence replaces the Prefect for ICPEs located on military sites. ASN also carries out the Prefect's duties for ICPEs located within the perimeter of a BNI.

the files to be included with the licensing applications (resolution 2010-DC-0192), new forms implementing the provisions of this resolution were drawn up and issued in 2012:

– the application form for a license to hold, use or manufacture sealed radioactive sources (AUTO/IND/SS);
– the application form for a license to hold, use or manufacture non-sealed radioactive sources (AUTO/IND/SNS).

These forms supplement the process of revision of all the forms, which was started in 2011, using to a graded approach to the risks, according to the envisaged nuclear activity. They list the documents that must be enclosed with the application.

All the documents listed in the appendix to ASN resolution 2010-DC-0192 of 22nd July 2010 must of course be held by the applicant and kept available for the inspectors in the event of verification. It is moreover possible that ASN will request further information during its examination of the license application.

To better integrate the true situation of responsibilities in the non-medical sectors, where the radioactive sources and devices are often managed more by an entity than by an individual, these new forms provide the possibility of making license applications as a representative of an artificial person, in application of Article R. 1333-24 of the Public Health Code.

Notification system

To achieve a balance in the sectors of activity subject to notification or licensing, and therefore better adapt the regulatory requirements to the radiation protection implications, ASN introduced a notification system for the industrial, research and veterinary sectors in 2009. This led to the publication of several approved resolutions (see chapter 3) defining on the one hand the scope of application of this new system and on the other, its implementation procedures.

The following are concerned:

– veterinary radiodiagnostic devices (fixed only) meeting one of the following conditions:
  • the emission beam is directional and vertical, except for all tomography devices;
  • the device is used for intra-oral radiography (ASN resolution 2009-DC-0146 of 16th July 2009, amended by resolution 2009-DC-0162 of 20th October 2009, *Official Journal* of 26th February 2010);
– electrical devices emitting ionising radiation, for which the equivalent dose rate at 10 cm from all accessible surfaces in normal conditions of use and as a result of their design, is less than 10 µSv/h.
  The notification form drawn up by ASN to facilitate application of resolution 2009-DC-0148 defining the detailed content of the information to be appended to the notifications has been designed so as to simplify its utilisation and processing. No document has to be added to the notification form if the devices declared meet the requirements specified in ASN's resolutions and are eligible for this system.

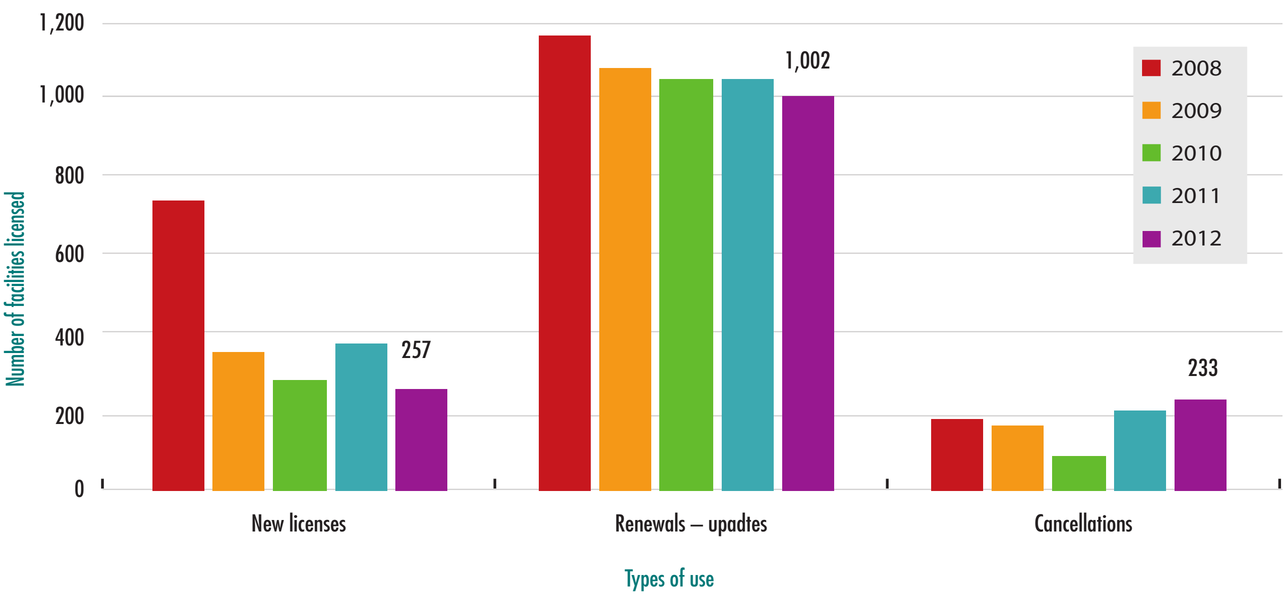
In 2012, the notification system was extended to include companies installing, maintaining or removing ionisation chamber smoke detectors (see point 3|3). Following the publication on 15th March 2012 of ASN resolution 2011-DC-0252, a notification form was drafted and placed on-line on *www.asn.fr*.

3|2|3 Statistics for 2012

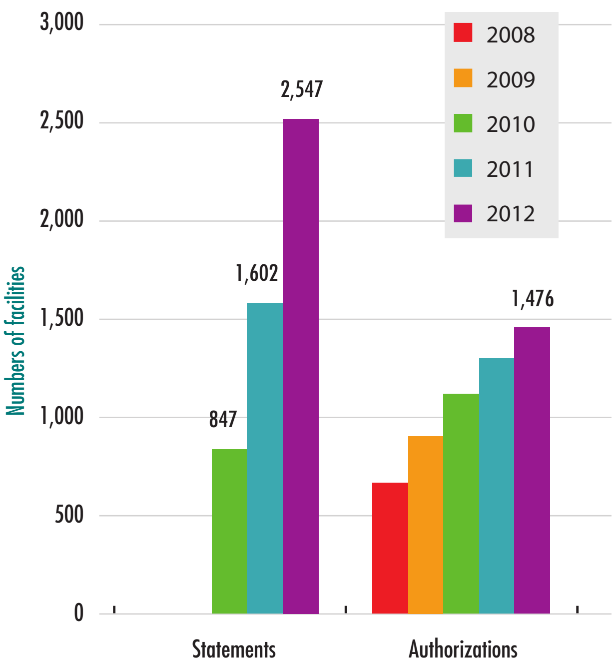
Suppliers

In the light of the fundamental role played in the radiation protection of future users by the suppliers of sources or devices containing them (see points 1|3 and 3|2|1), ASN exercises particularly strict control in this field. During the course of 2012, 53 license or license renewal applications were examined by ASN, and more than 48 inspections were carried out.

Graph 5: Radioactive source "user" licenses delivered each year



Graph 6: Total number of "user" licenses and notifications for electrical devices generating ionising radiation



In the particular case of cyclotrons, for which ASN has had oversight responsibility since early 2010, each new facility or major modification of an existing facility is the subject of a complete examination by ASN. The main radiation protection issues on these facilities must be considered as of the design stage. Application of the relevant standards, in particular standard NF M 62-105 "Industrial accelerators: installations", ISO 10648-2 "Containment enclosures" and ISO 17873 "Nuclear facilities - Criteria for the design and operation of ventilation systems for nuclear installations other than nuclear reactors", guarantees safe use of the equipment and a significant reduction in risks.

Users

Case of radioactive sources
In 2012, ASN reviewed and notified 257 new licenses, 1,002 license renewals or updates and 233 license cancellations. Graph 5 presents the licenses issued or cancelled in 2012 and trends in this area for the last five years.

Once the license is obtained, the licensee can procure sources. To do this, it collects supply request forms from the Institute of Radiation Protection and Nuclear Safety (IRSN), enabling the institute to verify - as part of its duty to keep the inventory of ionising radiation sources up to date - that the orders are in conformity with the licenses of both the user and the supplier. If the order is correct, the movement is then recorded by IRSN, which notifies the interested parties that delivery can take place. In the event of any difficulty, the movement is not validated and ASN is contacted by IRSN.

Case of electrical generators of ionising radiation
ASN has been responsible for regulating these devices since 2002, and is gradually building up its capacity in this area where numerous administrative situations need to be regularised. It granted 179 licenses and 177 license renewals for the use of electrical X-ray generators in 2012. Given the new regulatory provisions allowing the implementation of a notification system in place of the licensing system since 2010, ASN also delivered 945 notification receipts in 2012.
A total of 1,476 licenses and 2,547 notification receipts have been delivered for electrical devices emitting ionising radiation since decree 2002-460 was issued. Graph 6 illustrates this trend over the past five years.

3|3 Unjustified or prohibited activities

3|3|1 Application of the ban on the intentional addition of radionuclides in consumer goods and construction products

The Public Health Code indicates *"that the intentional addition of radionuclides to consumer goods and construction products is prohibited"* (Articles R. 1333-2 and 3).

The trading of radioactive stones or decorative objects, accessories containing sources of tritium such as watches, key-rings, hunting equipment (sighting devices), navigation equipment (bearing compasses) or equipment for river fishing (strike detectors) is specifically prohibited.

Article R. 1333-4 of this same code provides that "waivers (to these prohibitions] can, if they are justified by the advantages they bring in relation to the health risks they can represent, be granted by order of the Minister in charge of Health and, depending on the case, by the Minister in charge of Consumption or the Minister in charge of Construction, after consulting ASN and HCSP (French High Public Health Council)". No waiver is possible for foodstuffs, toys, jewellery and cosmetic products.

This regulatory arrangement was implemented for the first time in 2011 for a waiver request concerning the use of a neutron analysis device in several cement works. ASN was called on by the Government to examine the waiver request (ASN opinion 2011-AV-0105 of 11/01/2011) and give an opinion on a draft order granting this waiver (ASN opinion 2011-AV-0124 of 07/07/2011).

The waiver to the ban on adding radionuclides for the purpose of neutron analysis in the manufacture of cement was granted by an order of 18th November 2011 from the ministers in charge of health and construction (*Official Journal* of 3rd December 2011).

Light bulbs containing small quantities of radioactive substances

Certain light bulbs, chiefly very high intensity discharge lamps used in public places or professional environments, and in certain vehicles, contain small quantities of radioactive substances (krypton-85, thorium-232 or tritium). These substances serve to increase the light intensity or facilitate illumination of the lamps. Addition of these radioactive substances has been common practice for several decades.

On the basis of technical assessments demonstrating their very low impact in terms of radiation protection, several European countries have exempted these objects from the licensing or notification system provided for by the European regulations relative to radiation protection. Other countries, such as France, are currently assessing the technical reports available on this subject.

ASN has taken up this issue since 2009, reminding the manufacturers concerned by the production and distribution of light bulbs that the intentional introduction of radionuclides into consumer goods is prohibited in France by the Public Health Code. To put their situation in order, the manufacturers have lodged files with the DGPR (General Directorate for Risk Prevention), applying for a waiver to this prohibition. These files were transmitted to ASN on 19th October 2011 and are currently being examined, with the assistance of IRSN. In April 2012, on the basis of the initial results of this examination, ASN indicated that it had identified no health risk that would warrant it requesting, as a preventive measure, the cessation of the sale of these lamps and the removal of the lamps already installed.

3|3|2 Application of the principle of justification for existing activities

In application of the principle described in point 3|2|1, the justification of existing activities must be re-assessed periodically in the light of current knowledge and technological changes. If the activities are no longer justified by the benefits they bring, or with respect to other non-ionising technologies that bring comparable benefits, they must be withdrawn from the market. A transient period for definitive withdrawal from the market may be necessary, depending on the technical and economic context, particularly when a technological substitution is necessary.

Smoke detectors containing radioactive sources

Devices containing radioactive sources have been used for several decades to detect smoke in buildings, as part of fire-fighting policy. These devices comprise two ionisation chambers, of which only one allows the combustion gases to enter. By comparing the strength of the current crossing the two chambers, a change in the atmosphere can be detected when the smoke enters the unsealed chamber. This triggers the fire alarm. Several type of radionuclides were initially used to ionise the content of the two chambers (americium-241, plutonium-238, nickel-63, krypton-85), but only americium is currently used in the devices available on the market. The activity of the most recent sources used does not exceed 37 kBq, and the structure of the detector, in normal use, prevents any propagation of radioactive substances into the environment.

New non-ionising technologies have gradually come to compete with these devices. Optical devices now provide comparable detection quality, and can therefore satisfy the regulatory and normative fire detection requirements. ASN therefore considers that smoke detection devices using radioactive sources are no longer justified and that the seven million ionic smoke detectors installed on 300,000 sites must be progressively replaced.

Regulatory changes were developed on the basis of the ASN proposal. They were submitted for consultation to various groups and entities representative of the stakeholders involved. They were also examined by the Advisory committee of experts in radiation protection (GPRAD), the HCSP (French High Public Health Council), the Simplification Commissioner, and the CCEN (Consultative Committee for the Evaluation of Standards). A presentation note was posted on the web site of the HCTISN (French High Committee for Transparency and Information on Nuclear Security).

The order introducing the waiver to Article R.1333-2 of the Public Health Code for ionisation chamber smoke detectors was signed on 18th November 2011, further to ASN opinion 2011-AV-0134, and published in the *Official Journal* on 3rd December 2011. The regulatory system is supplemented by two ASN resolutions published on 15th March 2012:

1. Resolution 2011-DC-0252 of 21st December 2011 subjecting certain nuclear activities to notification in application of 2° of Article R. 1333-19 of the Public Health Code;
2. Resolution 2011-DC-0253 of 21st December 2011 defining the particular conditions of use and the procedures for the registration, monitoring, recovery and disposal of ionisation chamber smoke detectors.

Surge suppressors

Surge suppressors (sometimes called lightning arresters) are small objects with a very low level of radioactivity used to protect telephone lines against voltage surges in the event of lightning strike. The use of surge suppressors has been gradually abandoned since the end of the 1970s, but the number remaining

Dismantling of smoke detectors

to be removed, collected and disposed of is still very high (approximately 1 million units). Once installed, these devices do not present an exposure risk for people, but there can be a risk of contamination if they are handled without taking precautions. These risks must be taken into account in the removal, storage and disposal operations in order to protect the public and the workers. ASN issued a reminder of this to *France Télécom*, which is currently drawing up a plan of action to organise the removal and disposal of surge suppressors in compliance with the regulations.

Lightning arresters

ASN wants to see the progressive and organised recovery of these radioactive lightning arresters, and for several years now has been informing the professionals to ensure that their removal complies with radiation protection requirements for workers and the public. ASN has stepped up its action in this respect since 2009, by reminding the professionals of their obligations, particularly that of having an ASN license for the activity of removing and storing the lightning arresters pursuant to Articles L.1333-1, L.1333-4, and R.1333-17 of the Public Health Code. At the same time, ASN has been carrying out field checks on the companies involved in the recovery of these objects since 2011.

In 2012, ASN launched a campaign of measurements carried out by IRSN, together with companies, to assess the protective measures necessary when removing radioactive lightning arresters. This measurement campaign will lead to the production of guidelines intended for the professionals. These guidelines, currently being drafted by ASN, ANDRA and IRSN, should be published in 2013.

ASN recalls that it is firmly in favour of having lightning arresters removed using procedures compliant with the applicable regulations, in order to guarantee the protection of individuals. Together with ANDRA, it is examining the arrangements for accelerated[2] withdrawal, once ANDRA's recovery capacity has been increased, by 2013.

Locating the radioactive lightning arresters around the country is an essential step in eventually being able to remove all of the installed items. This is one of the goals of the INAPARAD association and its website *www.paratonnerres-radioactifs.fr.*

ASN underlines the benefits of this survey and of informing the owners of these lightning arresters. It does however recall that removing these lightning arresters is not currently mandatory, that it must be done by authorised companies and that pending the full availability of ANDRA recovery capacity, priorities must be established according to the physical condition of the lightning arresters and/or the refurbishment plans for the buildings concerned.

Additional information on radioactive lightning arresters is available on the following web sites: *www.andra.fr* and *www.paratonnerres-radioactifs.com.*

Surge arrester on a telephone line

3|4 Reinforcement of the regulation of electrical devices generating ionising radiation

ASN wishes to supplement the provisions introduced into the Public Health Code in 2007, and thus complete the development of the regulatory framework allowing the distribution of electrical devices for generating ionising radiation to be subject to licensing in the same way as the suppliers of radioactive sources. Experience shows that in this respect, the joint technical examination of files by ASN and the device suppliers/manufacturers brings substantial gains in radiation protection optimisation (see points 1|3 and 3|2|1).

For electrical devices used for non-medical purposes, there is no equivalent of the mandatory CE marking for medical devices, such as to confirm conformity with several European standards covering various fields, including radiation protection. Furthermore, experience feedback shows that a large number of devices do not have a certificate of conformity to the standards applicable in France. These standards have been mandatory for many years now, but some of their requirements have become partly obsolete or inapplicable due to the lack of recent revisions.

Back in 2006, ASN contacted the Ministry of Labour, the LCIE (Central Laboratory of the Electrical Industries), the CEA and IRSN, and urged the Union Technique de l'Electricité (UTE) to start updating these standards.

With regard to the design of facilities, the UTE ran a process to revise the NF-C 15-160 standards and the associated specific

2. The current rate of removal is about 500 lightning arresters per year.

Radioactive lightning arresters

In 1914, Léo Szilard, a Hungarian scientist, developed the first lightning arrester with a radioactive head. In 1932 the French company Hélita put the first radioactive lightning arrester onto the market. Companies subsequently developed other products, including the brands Duval Messien, Franklin France and Indelec. Having radioactive sources on the head of the lightning arrester was supposed to increase the protection range compared with a "conventional" lightning arrester, by making the air around the sealed sources conductive. The arresters were equipped, according to their type, with sealed sources of radium-226, and subsequently americium-241.

Radioactive lightning arresters were manufactured and installed in France between 1932 and 1986. The ban on the sale of radioactive lightning arresters was declared in 1987. This order did not make the removal of installed radioactive lightning arresters compulsory. Consequently, there is no obligation to remove the radioactive lightning arresters installed in France at present, apart from in certain ICPEs (order of 15th January 2008 setting the removal deadline at 1st January 2012) and certain installations under Ministry of Defence responsibility (order of 1st October 2007 setting the removal deadline at 1st January 2014).

ANDRA estimates that there are still 40,000 radioactive lightning arresters installed in France. ASN considers that these radioactive objects - even if they generally present no risk unless handled - contain sources with significant levels of activity and therefore present exposure risks for the people coming into contact with them, during their removal for example.

Furthermore, experience has shown that the containment of radioactive sources can deteriorate over time, thereby increasing the radiological risks when the lightning arrester is removed. The removal operations must therefore be carried out by specialist companies and be directed towards the disposal routes established by ANDRA.

Cutting off the head of a radium lightning arrester

standards (installation standards). Based on this work, ASN initiated an update of the design and outfitting rules for installations within which X-rays are produced and used. This project concerns industrial and scientific (research) facilities, such as industrial radiography in a bunker using X-rays, veterinary radiology and medical facilities such as conventional radiology, dental radiology and scanners. A report defining the orientations and requirements was presented to the Advisory Committees for radiation protection (GPRAD) and for medical applications of ionising radiation (GPMED) in March 2012. A technical resolution should be published by ASN very shortly.

With regard to the design of the devices, and in the absence of any pertinent national or international baseline technical requirements, ASN is looking into the development of the applicable technical requirements for licensing the devices. After presenting the first orientations to the GPRAD in June 2010, ASN continued its work with the support of IRSN and the assistance of other reference players such as the CEA and the LCIE, with a view to developing a baseline technical standard for this type of device. The results of the technical work were presented to the GPRAD in December 2011.

Similarly to ASN resolution 2008-DC-0109 relative to the distribution of radioactive sources, ASN is currently preparing the regulatory changes necessary, based on the work done to define the detailed content of the information that must be enclosed with the initial applications for a license to distribute X-ray generators.

3|5 Detection of radioactivity in France

ASN considers that the increase in the number of cases of detection of radioactivity in metals and consumer goods across the world is worrying. Noteworthy recent findings include:
– in 2012, the repeated discovery in Belgian and German ports (April, July, September), of containers in which there were objects contaminated with cobalt-60 (stools, electric bicycles, torches, etc.) from India or China;
– a case in which radiation portal monitors in Belgian ports were triggered by containers being shipped to France, reported by the AFCN (Federal Agency for Nuclear Regulation), ASN's Belgian counterpart (tap kits contaminated with cobalt-60).
– an accident that occurred in April 2010 on a metal recycling site in India, and was rated level 4 on the INES international radiological events scale;

– the discovery in July 2010 in the port of Genoa Voltri in Italy, of a container displaying a dose rate on contact of 600mSv/h, originating from Saudi Arabia.

At present, the French regulations concerning the movements of goods at the French borders do not provide for specific checks to search for radioactive substances.

In the light of this experience feedback, ASN has strengthened its contacts with the administrations concerned by this field, and with its European counterparts, notably by participating in a European conference aimed at sharing good practices in radioactivity detection in strategic places (ports, airports, etc.). ASN effectively considers that France must rapidly adopt a national strategy for radioactivity detection on its territory, and make the corresponding investments in equipment and training.

Given the possible economic side-effects of these incidents, ASN recommends that all firms involved in commercial trading of metal-based products with countries outside the European Union, conduct checks on the radioactivity level of the imported products.

3|6 Implementation of monitoring of radioactive source protection against malicious acts

Even if the safety and radiation protection measures as a result of the regulations do guarantee a certain level of protection against the risk of malicious acts, they cannot be considered sufficient. Strengthening the monitoring of protection against malicious acts[3] concerning the most hazardous sealed radioactive sources was thus strongly encouraged by IAEA, which published a Code of Conduct on the Safety and Security of Radioactive Sources (approved by the Board of Governors on 8th September 2003) along with guidelines for the import and export of radioactive sources (published in 2005).The G8 supported this approach, including at the Evian summit (June 2003) and France sent IAEA confirmation that it was working on implementation of the guidelines stipulated in the Code of Conduct (undertaken by the Governor for France on 7th January 2004). The general aim of the Code is to obtain a high level of safety and security for those radioactive sources which can constitute a significant risk for individuals, society and the environment.

Monitoring sources for radiation protection and safety purposes and monitoring them to combat malicious acts have many aspects in common and mutually consistent objectives. This is why ASN's counterparts abroad are usually responsible for monitoring both domains. ASN has the necessary hands-on knowledge of the sources concerned - which are regularly inspected by its regional divisions - to accomplish both missions.

The Government decided to entrust ASN with the task of monitoring the follow-up and protection measures falling to the body responsible for the nuclear activity. It could in particular consist of limiting source access to duly authorised persons only, of placing one or more physical protective barriers between the source and unauthorised persons, of making intruder detection systems mandatory, or of ensuring source tracking. The legislative process initiated in 2008 by the Government with the assistance of ASN, led to a bill being tabled before the Senate in 2012.

3. Notion often summarized by the word "security", as opposed to "safety", which designates all the technical and organisational measures aiming to reduce the probability of an accident and, if an incident were to occur, to mitigate the consequences

4 THE MAIN INCIDENTS IN 2012

The inspections conducted on radiation sources and a complete round-up of radiation protection events in the non-BNI field are presented in chapter 4 of this report.

Of the incidents that occurred in 2012, two events concerning industrial gamma radiography led to detailed experience feedback.

To these 2012 incidents can be added that of 22nd September 2011 at the STIC company in Rambervillers (Vosges *département*) during a weld check by the Montereau test laboratory (Yvelines *département*), and those which took place in 2010 at the Feursmétal company in Feurs (Loire *département*) and that of Hachette and Driout in Saint-Dizier (Haute-Marne *département*).

Industrial radiology activities have serious radiation protection implications for the workers and are an inspection priority for ASN, with more than 100 inspections carried out per year in this field, including unannounced night-time inspections on the work sites.

ASN considers these incidents to be serious and is worried by the rise in the number of incidents, reflecting a lack of radiation

TO BE NOTED IN 2012

Incident of 28th March 2012 - Le Blayais NPP

During maintenance work carried out on various parts of reactor 1 in the Le Blayais NPP, which was shut down for a ten-yearly outage inspection, checks were made on the quality of welds on a valve which had just been replaced in the reactor building.

These gamma radiography checks were performed by the CEP Industrie company (Bureau Veritas). *It used a GAM 120 type gamma radiography device, equipped with a radioactive source of iridium-192 with an activity of 2.4 TBq.*

At the end of the checking operation, during the night of 19th to 20th March 2012, the operators were unable to return the source to its safe position in the device, as the source had become separated from its drive cable.

As soon as the incident was detected, radiologists from CEP Industrie and EDF staff from the NPP tightened up the safety perimeter in order to prevent access to the room containing the source and rule out all risk of abnormal exposure of the workers present. All the EDF staff and contractors required to work in the building were informed of the situation. Certain work sites were interrupted as a precaution.

On 21st March 2012, ASN carried out an inspection on the site to check that this safety perimeter had been properly set up and that the area was under appropriate surveillance.

CEP Industrie and EDF called in the technical expertise of the CEGELEC company, which is a distributor of this type of gamma ray projector in France, in order to define a strategy for recovering the radioactive source (the gamma ray projector was placed on a raised platform, only accessible via a safety ladder and in a heavily congested area, making for difficult access, with a dosimetric environment of about 400 mGy/h at the top of the safety ladder).

Considering that the operation to recover the blocked source was not covered by the standard license held by the gamma radiography operators and the distributor CEGELEC, ASN asked the companies concerned by the intervention to submit a license application specifically intended to cover the source recovery operations, as required by the Public Health Code. As the user company, EDF was also asked to coordinate the preparation of this operation.

There were some gaps in the first file submitted gaps and in particular it would have entailed operator exposure to dose rates of about 400 mGy/h for the several seconds needed to connect a source recovery device. ASN did not approve this operation, which could have led to worker exposure in the event of any problems during the intervention and it issued several requests for additional data.

After further analysis, EDF identified solutions for installing biological protection around the source remotely, thus reducing source radiation without the risk of worker exposure.

Based on an updated file taking account of the new and more favourable radiological environment, ASN issued the licenses needed for the work, which took place on 18th April 2012, in accordance with the planned arrangements.

This event led to no abnormal exposure of the workers and was rated level 1 on the 8-level INES scale (0 to 7).

TO BE NOTED IN 2012

Incident of 12th July 2012 - Esso Refinery at Fos-sur-Mer

ASN was informed by the Applus RTD - CTS company of an incident that had occurred in the evening of Wednesday 13th June 2012 during a weld check within the Esso Refinery at Fos-sur-Mer (Bouches-du-Rhône département).

The device used, a GAM 80 type gamma ray projector, contained a 2 TBq radioactive source of iridium-192 which could not be returned to its safety position inside the device and had remained jammed in the ejector tube.

The operators then established a safety perimeter to prevent all risk of abnormal exposure of other workers. As of the following day, ASN carried out an inspection on the site to check that this safety perimeter had been properly set up and that the area was under appropriate surveillance. The installation of lead-based protection around the source enabled the safety perimeter to be reduced without impeding the operation and safety of the refinery.

ASN carried out an inspection on 20th June 2012 and asked that with the support of specialist companies, the necessary steps be taken to recover the source in complete safety. The follow-up letter to this inspection is available on the website www.asnfr.

During the inspection, it became apparent that the operator had first of all made various attempts to free the source before following the prescribed measures in the event of an incident. These manual interventions led to exposure at high dose rates, in particular of the hands. The regulation and mandatory dosimeter worn by the operator revealed a "whole body" dose of 5.2 mSv, below the limit set by the regulations (20 mSv). However, the additional investigation carried out by IRSN at the request of ASN showed exposure of the hands of about 500 mSv, or the regulation limit for the annual exposure of the extremities in just a single exposure. This dose level is not however liable to lead to the appearance of deterministic effects for the operator.

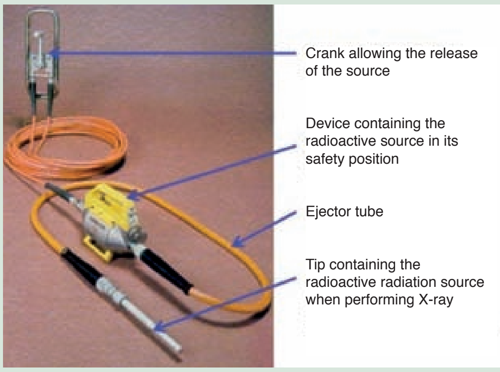
The Applus RTD - CTS company looked for robotic means of intervention and proposed an intervention protocol to ASN in order to remove the device and the radioactive source from the refinery's production units. The intervention required technical examination and authorisation by ASN prior to performance and was then carried out successfully on 3rd July 2012. The doses received by the operators during the operation (maximum of 0.006 mSv) proved to be lower than the dosimetric estimates and far lower than the regulation limits.

This event caused no radiation exposure for the public. ASN rated this event level 2 on the 8-level INES scale (0 to 7), owing to the observed practices which ran contrary to radiation protection rules and owing to the dose received by the hands of the operator.

UNDERSTAND

Source blockage in gamma radiography

Gamma radiography is a non-destructive testing technique consisting in positioning a radioactive source close to the element to be inspected, in order to obtain a radiographic image which can subsequently be used to check the quality of the part.



The loss of control of the sources is one of the main causes of incidents in this field. It can lead to significant exposure of the workers nearby, or even of the public if used in an urban area. This loss of control is primarily encountered in two situations:

- *the radioactive source remains blocked in its ejector tube. The cause of the blockage is often the presence of foreign bodies in the tube, or deterioration of the tube itself;*
- *the source-holder containing the radionuclide is no longer connected to the remote control. The cable joining the source and the remote control is not correctly connected and the source can no longer be operated.*

France has an inventory of gamma radiography devices compliant with technical specifications that are stricter than the international standards. However, equipment failures can never be ruled out, especially in the event of poor upkeep of the equipment. Operator errors are also observed as being the cause of incidents.

ASN also notes that the procedures and steps to be taken by the radiologists when faced with these situations are insufficiently understood and adhered to.

protection culture and consideration of the potential risks by the operators. Even though the regulations are on the whole adhered to and are more demanding than the international standards, ASN feels that improvements are required in preparing the work sites and in managing incidents, with greater involvement on the part of the ordering customer, especially in the petrochemical sector.

On 27th September 2012, ASN sent a circular letter to all operators reminding them of the regulations and asking that improvements be made in the preparation of work sites and the management of incidents. ASN has initiated steps to tighten up the regulations in this respect. It underlines that there are alternative methods which should be studied by the ordering customers and their contractors (consult the information on *www.asn.fr*).

5 ASSESSMENT OF RADIATION PROTECTION IN THE INDUSTRIAL, RESEARCH AND VETERINARY FIELDS, AND OUTLOOK

In the field of regulating applications of ionising radiation in the industrial, research and veterinary sector, ASN is working to ensure that the operators take full account of the risks involved in the use of ionising radiation. This problem is accentuated by the diversity and the number of the parties involved.

Industrial radiology

The recent gamma radiography incidents (see point 4) were a reminder of the significant issues related to radiation protection in industrial radiography activities. Over and above the health risks for the operators, the economic consequences of accidents can be considerable.

The work conditions on the site (poor accessibility, night work, etc.), equipment maintenance (projector, guide tubes, etc.) are major factors affecting personnel safety. The incidents often result from sources getting jammed outside the safe shielded position. ASN notes that the exposure rates and condition of the equipment are not unrelated to the probability of an incident. It moreover underlines that if any equipment operating anomalies are observed, such as abnormal source projection or retraction forces, operations should be immediately stopped and the equipment inspected. Furthermore, if a source becomes jammed, no attempt should be made to free it, and the on-site emergency plans required by the regulations - though rarely drawn up - must be implemented.

In addition to the incidents noted, ASN considers from its inspections that the way risks are taken into account varies between companies. Although on the whole the regulations relating to worker training and the periodic external inspection of sources and devices are satisfied, further progress must be made in work preparation, particularly for on-site operations (predicted dose evaluations, marking out of zones, etc.) and in the coordination between the ordering companies and contractors to enhance work preparation and allow the application of effective preventive measures.

After considering the questions of justification and optimisation, the non-destructive testing professionals have drafted guides, including a guide for companies seeking an alternative to iridium-192 for the gamma radiography inspection of pipe fabrication welds (ALTER'X, coordinated by the French Welding Institute), and a guide coordinated by the French confederation of non-destructive testing (COFREND), promoting the use of alternative methods and including functional tools such as a flow chart for identifying the gamma radiography substitution conditions, or tables describing the inspection and its objectives.

ASN considers that the involvement of the ordering customers is insufficient in this field and that they have a vital role to play in ensuring progress in radiation protection in industrial radiography.

The regulation and monitoring of industrial radiography is a priority for ASN, with more than 100 inspections carried out in 2012, some in collaboration with the labour inspectorate. This priority is maintained in 2013.

Enhancing the awareness of all the players is also a priority. Regional initiatives to establish charters of good practices in industrial radiography have been underway for several years at the instigation of ASN and the labour inspectorate, particularly in the Provence-Alpes-Côte d'Azur, Haute-Normandie, Rhône-Alpes, Nord - Pas-de-Calais and Bretagne/Pays de la Loire regions. These initiatives allow regular exchanges between the various stakeholders and will therefore be continued. The ASN divisions and other regional administrations concerned also organise regional awareness-raising and discussion symposia which are attracting growing interest from the stakeholders of this branch.

As mentioned in point 4, ASN is taking steps to tighten up the regulations in the field of industrial radiography. Contacts have been made with the COFREND and the General Directorate for Labour (DGT) to draft the outlines of a text to be presented to the Advisory Committee for radiation protection. This tightening of the regulations will also involve the ordering customers with regard to justification and the human and material resources available in the event of incidents. .

Research

ASN's monitoring of establishments and laboratories using radioactive sources for research purposes, which began in 2002, shows a distinct improvement in radiation protection in this sector. ASN notes a gain in overall awareness of the importance of radiation protection issues.

The actions taken over the last few years have produced appreciable results, particularly in the involvement of Persons Competent in Radiation protection (PCRs), the training of exposed workers and radiation protection technical inspections.

The situation could still however be further improved with regard to certain points of the regulations, particularly internal radiation protection monitoring (programme, frequency, traceability), the management of radioactive effluents and waste and the disposal of old sealed sources.

In 2012, ASN reinforced its contacts with the nine occupational health and safety inspectors of the Ministry in charge of Research in order to discuss inspection practices and look into reciprocal methods of exchanging information to improve the effectiveness and complementarity of the inspections. A convention is currently being drafted.

Veterinary

With regard to veterinary structures, the administrative situation has been continuously improving for a number of years now (as at end 2012, nearly 2,200 structures had been notified or authorised) but this is still unsatisfactory given the number of establishments utilising ionising radiation in the country (about 5,000).

The extensive nationwide commitment of the profession to harmonising practices, raising awareness, training student veterinary surgeons and drafting framework documents and guides is seen in a very positive light by ASN, which every year takes part in meetings with the profession's national bodies (more particularly the veterinary radiation protection commission) jointly with the DGT.

Considerable progress has been made with regard to the presence of a PCR, dosimetric monitoring, wearing of personal protection equipment and standardisation of radiation protection documents. Good initiatives taken by recently trained veterinary surgeons have also been seen, reflecting the profession's commitment to training.

The inspections carried out by ASN however showed that the work of the national professional institutions in the field of radiation protection is not uniformly taken into account in the field.

ASN's 2012 inspection programme focused mainly on the equestrian sector, where nearly 30% of the specialised structures in this branch of veterinary medicine were inspected. The findings revealed several areas for improvement, in particular concerning the radiation protection of persons from outside the veterinary structures (grooms, animal owners) who frequently attend the radiodiagnosis examinations. The justification for certain diagnostic operations outdoors when specially designed premises for this type of application are available, should be examined and further researched in 2013 with the national bodies.

Removal of lightning arresters

The removal of old lightning arresters containing radioactive sources is an activity requiring strict radiation protection measures (see point 3.2.2). A guide, currently being prepared by ASN, ANDRA and IRSN will be published in 2013 for the attention of the professionals. At the same time, ASN and ANDRA are studying possible accelerated removal, which is dependent on ANDRA's removed items recovery capacity, which should be increased by 2013.

ASN recalls that it is firmly in favour of having radioactive lightning arresters removed using procedures compliant with the applicable regulations, in order to guarantee the protection of individuals.

Suppliers of ionising radiation sources

As stated in point 3|4, ASN considers that the regulatory oversight of suppliers of electrical ionising radiation generators is still insufficient, given that the technical characteristics of the devices put on the market are of prime importance for optimising the exposure protection of their users. The work conducted by ASN in this area should enable a decision setting the technical requirements for the devices distributed in France to be established in 2013.

ASN is also stepping up its inspections in radiopharmaceutical research and production using cyclotrons. 29 low and medium energy cyclotrons (excluding basic nuclear installations) are currently operating in France, of which 22 cyclotrons are used for day-to-day production of drugs needed for the medical imaging sector. Four cyclotrons are devoted solely to the production of drugs for clinical trials and three cyclotrons are used for research purposes, with no use on humans.

ASN performs more than a dozen inspections on these facilities every year. The radiation protection organisation of these facilities is satisfactory and they are fully familiar with the regulations. However, obtaining the certificate of aptitude for handling industrial radiology devices (CAMARI), which is mandatory for the users of a cyclotron, remains a priority area for improvement.

The cyclotron contains no permanent radioactive source. In normal operation, the very short lifetime of the radio-isotopes manufactured (< 2h) makes for very rapid decay. The production units employ systems to trap radioactive gases emitted during the synthesis process. Environmental discharges are monitored by the manufacturer and limits are set in the licenses issued by ASN. Liquid and solid waste containing radioisotopes emitting positrons are stored for several days before being dealt with as non-radioactive waste.

Source security

The legislative process initiated in 2008 by the Government, with the assistance of ASN, led to a Bill being submitted to the Senate in 2012, with a view to setting up monitoring of the protection of radioactive sources against malicious acts. In 2013, ASN and its institutional partners will continue to prepare the implementing texts required for effective monitoring. At the same time, it will in 2013 continue with and strengthen the actions started in 2012 aiming at drawing up an inventory of the existing installations, on the occasion of the radiation protection inspections it carries out.