TRAINING IN RADIATION PROTECTION REQUIRED BY LEGISLATION: APPROACH DURING THE COVID-19 CRISIS AND PRACTICAL IMPLEMENTATION

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According to international and national legislation, various professional profiles require education and training in radiation protection. In Belgium, a new regulatory framework entered into force in early 2020, implementing the latest requirements of the 2013/59/EURATOM EU BSS Directive.

With the healthcare sector being under enormous pressure during this health crisis, various temporary measures were taken by the national regulator for the health professionals.

From a practical point of view, training courses in radiation protection were organised in adapted circumstances to prevent further spreading of the COVID-19 virus.

This article highlights the Belgian pragmatic approach of the regulator with regard to radiation protection education and training during the COVID-19 crisis, as well as the experience of a national training centre organising radiation protection education and training for diverse target audiences.

1 Introduction – overview of E&T requirements in radiation protection in Belgium

The Belgian Royal Decree of 20 July 2001 laying down the general regulations on the protection of the public, the workers and the environment against the hazards of ionizing radiation (ARBIS/RGPRI) [1], contained at that moment the transposition of the European directives in radiation protection. This included the former European directives 96/29/Euratom (basic safety standards) and 97/43/Euratom (patient directive). While at the European level the directive 2013/59/EURATOM "Basic Safety Standards" (BSS) [2] replaced 5 former directives, among which 96/29/Euratom and 97/43/Euratom, in Belgium the opposite approach was taken: only the general requirements and framework were maintained at level of the ARBIS/RGPRI, which underwent a thorough revision, while sector specific requirements were laid down in separate royal decrees.
This is also the case for the medical exposures, veterinary applications and distribution of radioactive products for in vivo or in vitro use in medicine, for which requirements are laid down resp. in the Medical Exposures Decree [3], the Veterinary Exposures Decree [4] and the In vivo-In vitro Decree [5].

The articles 14 (General responsibilities for the education, training and provision of information), 15 (Training of exposed workers and information provided to them), 16 (Information and training of workers potentially exposed to orphan sources), 17 (Prior information and training for emergency workers), 59 (Training and recognition), 79 (Recognition of services and experts), 82 (Radiation protection expert) and 84 (Radiation protection officer) of the BSS are transposed in the ARBIS/RGPRI for the workers, the emergency workers, the radiation protection officer, the radiation protection expert and the occupational physician. The articles 18 (Education, information and training in the field of medical exposure) and 83 (Medical physics expert) of the BSS are transposed into the Medical Exposures Decree for the practitioners and individuals involved in the practical aspects of medical radiological procedures, as well as for the medical physics expert.

Complementary to the regulations on the well-being of workers [6], which define general requirements on information and training about occupational risks, the ARBIS/RGPRI stipulates the obligation of the undertaking to *inform* workers and outside workers who may be exposed to ionizing radiation, including emergency workers, before their entry into service, about the occupational health risks due to ionizing radiation and protection against it. Female workers, including female outside workers, are informed of the risk of ionizing radiation to the embryo and foetus and to the necessity and duty of making an early declaration of pregnancy. They are informed of the risk to the infant when breastfeeding after intake of radionuclides or bodily contamination, and the importance of announcing their intention to breast-feed.
This information is regularly updated, depending on the needs, but at least once a year, and it is made available in writing [1].

In addition to this information, the undertaking has to organize sufficient and adapted *training* for each worker and outside worker specific for their workplace or function, about the use of equipment and substances that emit ionizing radiation.
The training is given when hiring, in the event of a transfer or change of position, when changing or introducing new work equipment, when introducing a new technology and is repeated according to the needs and documented.
In installations where orphan sources are most likely to be found or processed, training is provided by the competent authority, which also provides support to training courses organized by professional federations or companies. To this end, the FANC has developed several tools to inform companies and their workers [1].

Workers and outside workers who are identified in advance to be *involved in radiological emergency interventions* are informed of the risks that their interventions may entail and the precautions they should take. The information is adapted to the type of intervention and is regularly updated. The information takes into account the different possible emergencies that may arise and the type of intervention. If necessary, it also includes practical exercises.
The information is regularly updated, depending on the needs and at least every three years.
As soon as an emergency occurs, the information is repeated and supplemented with the relevant information according to the circumstances.
Interveners who volunteer again with full knowledge of the facts will also receive instructions when the reference level might be exceeded.
Workers and outside workers who have not been identified in advance to be involved in radiological emergency interventions are adequately informed before their intervention about the risks to their health and about the precautions to be taken in such cases. This information takes into account the existing emergency and the specific intervention conditions [1].

In order to obtain a recognition as *radiation protection expert (RPE)*, the applicant must hold a master degree in engineering sciences, industrial sciences, industrial engineering sciences, physics, chemistry or any other master degree in exact sciences or any other degree that provides its holder with suitable training. Furthermore, the applicant should have a diploma or certificates of training in radiation protection and nuclear safety, covering a truncus communis of at least 12 ECTS in radiation protection, and a number of ECTS for technology and nuclear safety that depends on the domain, from 24 ECTS for assignments in nuclear reactor installations downwards to 50 hours for the medical and industrial applications. A training of 35 hours is required for assignments in the transport of Class 7 dangerous goods characterized as fissile materials or materials presenting a risk of corrosion, and 20 hours for the transport of other class 7 dangerous goods. For assignments in nuclear installations, the application is subject to advice of an external advisory board [1].

Radiation protection officers (RPO) have to follow modular training courses corresponding to the nature of equipment or sources or the types of transports in which they are involved. The minimal duration and contents of the modules are specified in the regulations [7].

Occupational physicians involved in the medical surveillance of professionally exposed persons and outside workers are subject to a training programme of at least 150 hours of theory and at least 45 hours of practice on the subjects specified in the regulations, and an internship of at least 160 hours. For the medical surveillance of workers in nuclear installations, an additional training of 50 hours and an additional internship of at least 750 hours is required. The application for the recognition is subject to advice of an external advisory board [1].

In installations where medical radiological procedures are performed, the undertaking has to ensure that these are only performed by licensed practitioners and their authorized staff such as nurses and radiographers [3].

For *medical practitioners*, personal licenses for the use the medical radiological equipment or radioactive products are granted on the basis of their competence in the field of radiation protection in medical exposures, specific with respect to the nature and conditions of use of the medical radiological equipment or radioactive products they use : licenses can be obtained for the use of x-rays for medical imaging, equipment and sealed radioactive products in radiotherapy, non-sealed radioactive products in radiotherapy or radioactive products in nuclear medicine. A license is limited in time, with a typical validity period of 10 years, and is specific to certain radioactive products and types of medical radiological equipment and to certain application forms of the ionizing radiation.
The competence of practitioners is assessed according to diplomas, certificates and titles and according to proven scientific or professional elements. The regulations specify the number of hours and the topics for each basic education and training, ranging from 15 hours for dentists up to 200 hours for radiotherapy or nuclear medicine.
When the practitioner already holds or has held a license and seeks renewal, his competence will be assessed on the basis of compliance with the applicable continuing education requirements during the validity period of his past license. To this extent, the competent authority evaluates the initiatives for continuing education that are notified, and allocates for each target group the number of hours that will be taken into account for the renewal of their license or recognition [3].

Authorized staff such as nurses and radiographers who have an active role in medical exposure, are not subject to a personal license. A basic training of at least 50 hours regarding the radiation protection of the patient is required, with an additional 10 hours for radiotherapy or nuclear medicine [3].

In order to become a recognition as a *medical physics expert (MPE)* in a specific field of competence (radiology, radiotherapy or nuclear medicine), the applicant must have successfully completed a training in medical radiation physics consisting of either a master's degree of 120 credits or a master after master's degree of 60 credits, dedicated to the topics specified in the regulations.
If the applicant already has or has been recognized and seeks renewal, his competence will be assessed based on compliance with the applicable continuing education requirements during the validity period of this recognition and a report on the activities carried out during this period. A clinical internship of one year per field of competence is required (for a second field of competence 6 months if this second field of competence is radiology or nuclear medicine). The application is subject to advice of an external advisory board [3].

The *medical physics assistant (MPA)* must at least hold a bachelor's degree or a diploma recognized or declared equivalent in Belgium and have successfully completed a training at a level at least corresponding to that of non-university higher education and comprising a minimum of 20 credits spent on the subjects specified in the regulations [3].

Due to technical developments with possible implications for radiation protection, FANC may at any time impose specific complementary training for certain applications [3].

The undertaking is responsible for ensuring that the radiation protection officers, the authorized staff for medical exposures, the medical physics assistants have received the basic education and training and the continuing education in the field of radiation protection appropriate to their professional activities, without prejudice of the regulations on the health care professions, which stipulates the general requirement on their education and training and recognition as health care professional [3].

Pharmacists can obtain a recognition as *radiopharmacist* if they followed a university level study programme in radiopharmacy [5].

Veterinary practitioners have to follow an education and training of at least 40 hours for the use of x-rays and 112 hours for radiotherapeutic or nuclear medicine applications. For the *authorized staff* involved in veterinary practices, 24 hours of training are required, and an additional 8 hours for radiotherapeutic or nuclear medicine applications [4].

Continuous education is required for all categories of actors [1,3,4,5,7].

2 Impact of COVID-19

2.1 For the competent authority

2.1.1 Continuity plan of the competent authority

In March 2020, following the declaration of COVID-19 as a pandemic by WHO, at national level the Ministerial Decree of 13 March 2020 announced the federal phase of coordination and management of the COVID-19 crisis in Belgium. At that moment, the competent authority for nuclear safety and radiation protection, FANC, activated its internal crisis cell and its continuity plan for its activities. The nuclear and radiological sector being considered as an essential sector, also during lockdown the essential activities had to go on in order to continue ensuring safety and security. However in order to limit the spread of the Coronavirus, the activities in the various sectors had to be adjusted.

2.1.2 Measures for the health care services and professionals

Next to this general crisis cell, an additional internal crisis cell dedicated to the health care sector was created and activated, as this sector is highly impacted and under strain during the health crisis. Within this crisis cell “health care sector”, the situation of the pandemic in the medical installations was followed up continuously, by regular contacts with different stakeholders in this field. Decisions were taken based on the actual situation at each moment. The main aim of these measures was to facilitate where needed, in order to relieve some of the pressure on the healthcare staff, within the possibilities of the competent authority.

The coronavirus COVID-19 being an infectious disease that mostly affects the lungs and respiratory tract, it was noted that the capacity of medical radiological equipment, specifically X-ray devices needed for diagnosis and follow-up of the disease, might not be sufficient to meet the increased demand for medical imaging. Therefore, a temporal derogation from the general regulations in ARBIS/RGPRI was needed to allow commissioning of additional medical radiological equipment within the shortest possible time.
It was also noted that undertakings might be faced with a shortage of qualified personnel to assist practitioners with the necessary medical exposures in the context of the diagnosis and follow-up of patients for COVID-19, and that there might be a need to call on staff for assistance during medical exposures other than authorized staff.

For this purpose a safety measure was imposed by a nuclear inspector. This safety measure allows to derogate from the normal procedure, motivated by the exceptional circumstances that require exceptional measures. This made it possible to commission additional medical radiological equipment for conventional planar medical imaging without updating the operating license, provided there has been a favourable acceptance into service by an MPE in radiology and an RPE, and that the formal request to update the operating license is submitted to FANC within a reasonable period of time after the equipment has been taken into use, with a maximum of three months.
If the medical imaging of the thorax, using conventional planar imaging of patients for the diagnosis or treatment of the coronavirus COVID-19 can only be done in rooms with limited access due to the risk of contamination with the coronavirus COVID-19, doctors or nurses who do not meet the E&T requirements for radiographers may act as radiographers within the meaning of the Medical Exposures Decree [3], under the following conditions:

i. These persons have previously received a brief training on the essential elements in taking conventional X-rays from the MPE in radiology and the medical imaging service. The undertaking keeps a register of the persons involved who have received this training;
ii. Where applicable, there is close guidance and supervision of a radiographer during the medical exposure;
iii. The RPE must determine whether these persons should be considered as professionally exposed persons and the need for dosimetric follow-up. If dosimetry is necessary, a personal dosimeter must be worn. If this is not possible, an alternative dosimetric follow-up can be set up, for example by registering the number and type of exposures, so that afterwards a dose estimate can be made.

The safety measure was valid from the 1st of April 2020 until the 30th of June 2020 and was renewed on 23rd of October 2020 for 6 months. Of course, the basic principles of radiation protection continue to apply during the validity period of this safety measure.

FANC monitors compliance with the specific conditions that it may impose in the licenses and recognitions. The renewal of a license for the use of medical radiological equipment by practitioners, or the recognition of medical physics experts or radiopharmacists, is assessed based on compliance with the applicable continuing training requirements during the period covered by this license or recognition.
It had to be noted that practitioners, MPEs and radiopharmacists were at the moment of the crisis unable to meet the requirements with regard to the timely request for the extension of their authorization or recognition and compliance with the requirements for their continuing education as they had to prioritise certain tasks such as fighting the crisis and the acceptance of equipment necessary for this.

Therefore, it was considered appropriate to exempt all practitioners, medical physics experts and radiopharmacists from the obligation of continuing education for the year 2020. Finally, a single automatic extension of six months was granted for the licenses and recognitions that arrived at their end between 13th of March and 31st of August 2020.
These decrees were annexed to the individual licenses or recognitions issued by FANC.

2.1.3 Evaluation of basic and continuous education and training programmes

For basic training and education, provided by universities and colleges, FANC can verify the compliance of training programmes with the criteria set in the regulations [1,3,4,5,7]. However, the exact form of the education and training is not within the competence of FANC. The directives of the authorities competent for education, and the internal directives of the educational institution have to be respected. At the federal and regional level, measures have been taken on the one hand to avoid COVID contamination and on the other hand to allow universities and colleges to organize themselves in a more flexible way in this regard, for example with respect to the format of the education and training, the end of the academic year, the assessment method, etc. In a general way, online courses have been obliged at the federal level for universities and colleges.
Universities and colleges could therefore make the necessary adjustments to their current training programmes taking into account these guidelines and if the provisions of other applicable regulations, such as ARBIS/RGPRI and the Medical Exposures Decree are respected. In particular, these provisions impose a knowledge test but do not specify how this test should be organized in practice. This is the responsibility of the university or college, who has to ensure that the necessary knowledge and skills are acquired, regardless of the way of assessment.

FANC evaluates continuous education initiatives in order to determine to what extent, expressed in number of hours, it can be taken into account for the renewal of a license or recognition, for each target group. The same is done for radiographers, even if there is no individual license, in order to allow compliance check with the education and training requirements.

For all types of education and training, taking into account the federal COVID-19 measures, the competent authority accepts online courses which comply with the regulatory obligations. Participants must be registered and assessment must be performed when required by regulation. This is the case for training of employees, theoretical training for RPOs, academic training for professionals,...

2.1.4 Training initiatives provided by the competent authority

The competent authority provides some training initiatives itself. For these, alternative methods were used as well. The yearly symposium for occupational physicians was organised in the form of a webinar, with use of a voting tool to make it more interactive. The central examination for dentists with a foreign radiation protection certificate, which is organised by all Belgian universities in the premises of FANC, was organised physically, in different shifts, respecting social distancing and hygiene measures. The training for drivers of radioactive transport was organised online and an online tool for examination was used.

2.2 For the training providers

At the initial phase of the COVID-19 pandemic in Belgium (first months of 2020), training providers such as the SCK CEN Academy rearranged their face-to-face training courses in order to respect social distancing and hand hygiene. Practical exercises and technical visits were left out of the programmes or replaced by alternatives where possible (e.g. explanation by photographs).

At the Belgian Nuclear Research Centre (SCK CEN), the SCK CEN Academy worked in close contact with the internal service for prevention and protection at work, as well as the medical service, to determine feasible and effective protection measures to allow further training courses.

As the situation rapidly worsened over the next months, some training courses were postponed or cancelled. Practical training modules were organised in exceptional circumstances (e.g. mandatory trainings to warrant a safe working environment), with great care for prevention of contamination.

Since it became clear in the Spring of 2020 that large improvements were not to be expected in the upcoming months, training courses were postponed on a larger timescale (e.g. towards the upcoming year) and theoretical training courses were organised online by using webinar platforms. Preparations were made to convert some training modules into self-paced e-learning.

During the summer of 2020, preparations were made by many training providers to offer distance learning in a sustainable way, at least for the duration of the measures to restrict the further spreading of COVID-19.

3 Challenges and opportunities

3.1 For the competent authority

Taking into account the limitations set by the COVID-19 measures at the federal and regional level and the need to continue education and training in order to comply with regulations on one hand but on the other hand seeing the need for more qualified staff in certain domains, the competent authority had to adapt its activities and way of working. Derogations from the regulations cannot be taken on an informal basis, therefore safety measures and formal decisions in the form of extensions to existing licenses and recognitions had to be taken, as was detailed above.

While theoretical modules can relatively easily be converted in online learning and alternative forms of assessment can be organized, distance learning is more difficult to implement for practical training. During the COVID-crisis, risk of contamination makes it hard to organize it physically. For medical professions, additional difficulties exists, as medical departments are obviously too busy to organize training, and a higher risk of contamination exists in these environments. Video recordings were therefore allowed as an alternative during the crisis. However these are not ideal. More active simulator-like methods could be investigated.

As distance learning and more flexible ways of learning will also stay after the crisis, the challenge for the competent authority is to take into account this new reality in the requirements set in regulations.

3.2 For the training providers

In the early phase of the outbreak of COVID-19 in Belgium, where face-to-face training was still possible, large uncertainties were introduced on the necessary measures to implement, their effectiveness and duration. This uncertainty fuelled the hesitation of some companies to search or request training in radiation protection from external training providers.

The switch towards distance learning required the training organisers to invest in several resources: software licenses for qualitative online broadcasts and e-learning, hardware such as headsets, camera's and (tablet) computers. Other 'consumable' expenses from regular face-to-face training sessions were of course reduced (printed course material, coffee and lunches).

The administrative support of the training course needed to make a shift from room reservations, assurance of coffee and refreshments, lunches, reformatting and printing of course material towards electronic support in terms of trainee registration, connectivity and follow-up. Depending on the technology used, it posed a challenge to track the online participation of the trainees in order to

Next to common organisational issues, training providers were also urged to develop guidance for trainers and course participants. A lot of trainers were not familiar with online teaching and training, and needed an introduction into the technological tools to use (hardware and software), as well as how to convert training material towards an online format and how to engage the online audience for effective training. At the SCK CEN Academy, a dedicated webpage on the intranet was setup gathering all information about online training. For the training participants, guidance documents were developed to help the participants in the process of registration and access to the online environment (including the course material).

3.3 For the trainers

The application of social distancing and the use of simple PPEs such as face masks, face shields, gloves and disinfectant alcohol gels seemed easy to apply at first, but gave a whole new dimension to the training courses: the inability to read body language from the trainees and the inability to use body language during lecturing and training was disadvantageous to give effective training. The informal networking where background, training expectations and pre-knowledge could be discussed during (coffee) breaks was more difficult during face-to-face training and mostly absent during online training.

The training material had to be redesigned to meet the new COVID-19 setting. This resulted in the adaptation of the setup and (re-)used material for practical training, the creation of instructional videos where live demonstrations were no longer possible, and the reformatting of presentation files to suit the programmes of distant lecturing in a webinar format. Besides a large workload, this sometimes resulted in specific situations where the quality of training was negatively affected, e.g. a delay between the broadcasted presentations, advanced animations and video's not working,

In terms of practical skills, many trainers needed to familiarize themselves with webinar tools, extra hardware (table microphones, headsets and drawing tablets) and the optimisation of online lecturing environments (background, lightning, noise, stability of the network)

3.4 For the trainees

The application of social distancing and the use of PPEs in face-to-face training resulted also in similar experiences for the trainees: the networking during coffee breaks became difficult, as well as the cooperation between trainees for practical exercises, peer discussions and group assignments.
The participation of distant learning activities required some level of discipline to stay focused on the screen. In terms of resources, it was challenging for some trainees to get access to a personal screen and audio devices to follow the training courses, in combination with a stable network and a quit environment. Access to the digital training course material was ensured by the training provider where needed. A large advantage for both trainers and trainees was the gain in time since physical relocation was not needed.
From the feedback of 148 training course participants of 13 online training courses in radiation protection organised by the SCK CEN Academy from March 2020 to March 2020 it became clear that the majority were satisfied to very satisfied on the webinar software used (MS Teams, Adobe Connect and Bigmarker).

Depending on the type of training (e.g. multi-day training vs short webinar in the framework of continuous professional development), the overall preference of the participants was expressed to a face-to-face format in comparison with online training. Recurring remarks were the need for increased amounts of breaks during online training, as well as the need for more interaction.

4 Future outlook

To ensure a high level of protection for the population, the workers, the patient and the environment, and to optimise and improve the related policy and its practical application, a continuous effort is needed to assure the knowledge, skills and competences of scientists and professionals in radiation protection. Even in challenging times of a worldwide pandemic, the radiological and nuclear sector found a way to ensure an offer for radiation protection training, although mainly limited to mainly theoretical training. The regulatory authority facilitated a practical approach with respect of the requirements of the legislation, and the training providers switched gears to offer adapted programmes to professionals and students where necessary.

For the training providers it became clear that on the long term investments are needed to maintain distant learning. By now (spring 2021), most training providers in radiation protection in Belgium are ready to offer online engagement, but are also longing forward to reinitiate face-to-face training courses with all associated (dis)advantages.

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