NEWSLETTER

47th ISSUE • APRIL 2022

EDITORIAL

ALARA From Start to Finish

The optimisation principle is "*a systematic process that needs to take a long-term view with regard to 'cradle to grave considerations', e.g. optimisation during the design phase of an installation must also consider all the following phases of operation of the facility, including decommissioning*" (ICRP, Publication 101). This issue n°47 of the EAN Newsletter would like to epitomize how ALARA applies indeed 'from cradle to the grave'.

The first article presents the implementation of ALARA in the design of MINVERVA, an accelerator-based facility planned by SCK CEN. Would you like to know more about setting dose objectives in line with regulation, how radiation shielding requirements are set and the role of the 'ALARA Coordinator' go to **p. 2**.

Then, the UK Health Security Agency presents in **p. 7** the good practices to keep exposure of patients and staff ALARA during dental imaging. The working parties that issued the recommendations included regulatory bodies, experts, practitioners and the good practices are presented for each type of equipment. These updated guidance takes into account the technical evolutions and new development in this exposure situation.

When it is time to decommission or replace an equipment, the disposal should be made in an ALARA manner, as presented in the Swiss Radiss plan on the management of disused High Sealed Radioactive Sources (HASS) (**p. 12**). Because this activity generated an incident in 2019, it is the opportunity to remind our readers about the RELIR-OTHEA incident database (**p. 15**).

At the end of the chronological line, the Norwegian DSA present its ALARA approach on the remediation of NORM legacy sites, presenting the options to remediate, the challenges faced (notably to map/characterize the site) and the ownership of the decision (**p. 16**).

On **p. 20** you will have a glimpse on the EAN next events and international events.

We hope you will enjoy this Newsletter, which is made possible through EAN Members support.
The EAN Newsletter Editorial Board. Sylvain Andresz, Julie Morgan, Fernand Vermeersch and Pascal Croüail
(P.S. do not hesitate to send your comments to the Board, cf. contacts **p. 20**).

COORDINATED BY NUCLEAR PROTECTION EVALUATION CENTRE (CEPN, FRANCE) AND PUBLIC HEALTH ENGLAND (PHE, UNITED KINGDOM)
EUROPEAN ALARA NEWSLETTER
ISSN 1270-9441
C/O CEPN - 28, RUE DE LA REDOUTE - F-92260 FONTENAY-AUX-ROSES
WEB: HTTP://WWW.EU-ALARA.NET

Radiation Procedure for ALARA Implementation during MINERVA Design and Construction Phases

DANIELA ENE

SCK CEN,
Boeretang 200,
2400 Mol, BELGIUM,
daniela.ene@sckcen.be

Introduction

SCK CEN is developing MYRRHA [**1**], an accelerator driven system (ADS) which consist of a 600 MeV proton linear accelerator (linac) coupled to a lead-bismuth cooled sub-critical fast reactor. MINERVA is the first phase of this project, whose objective is to validate the technology choices and to evaluate the reliability goal for the linac.

It includes the design, construction and operation of a facility composed of a (100 MeV, 4 mA) linac coupled to an ISOL (Isotope Separation On-line) target station as well as to a target station for fusion material research, the Full Power Facility (FPF). Construction of the facility requires a license from the Belgium Federal Agency for Nuclear Control (FANC). The license application is based on the Preliminary Safety Analysis Report (PSAR) that was submitted in autumn 2021.

The aim of this paper is to provide a survey of the main radiation protection elements implemented in support of the conceptual design of the MINERVA facility and to describe the radiation protection procedure for ALARA implementation during the design and construction phases, developed in compliance with the Belgian legislation [**2**]. This procedure was recently implemented by the MINERVA project and applied so far in several domains, such as shielding and radiological environmental analysis during normal operations and accidents. Note that during commissioning and operation of the MINERVA facility the established SCK CEN ALARA procedure [**3**] will be in force and mandatory to comply with.

The MINERVA ALARA procedure is based on the approach developed for similar accelerator-based facilities and on the state of art concerning this topic [**4**].

Radiation protection is an important discipline incorporated in the architecture of the SCK CEN Integrated Management System (IMS), that covers several Standard Operating Procedures (SOP) and their supporting documents. In order to support and help to achieve reliable and safe operations MINERVA adheres to the existing SCK CEN IMS by using and/or adapting several of the existing procedures.

Elements of radiation protection supporting the implementation of the ALARA procedure

Requirements

Radiation protection of MINERVA personnel, visiting scientists, contractors and the public is a key condition in the design of the facility. The design rules for MINERVA are based on the implementation of the ALARA principle and the expected radiation areas of the facility. In line with Belgian Royal Decree 20/07/2001 ARBIS [**2**] three types of zoning are distinguished, see Table 1.

Table 1. Classification of radiation zoning according to Belgian legislation.

Type of area	Maximum annual effective dose
Non-designated	1 mSv
Supervised	6 mSv
Controlled	20 mSv

Potential (external and internal) exposures have been taken into account when assessing the effective dose that a person may receive when working in an area under consideration.

The areas inside MINERVA perimeter are classified as a function of the potential effective dose the worker receives for the duration of the stay in the area during routine operations.

Doses up to the dose limits can only be tolerated if no reasonable measure can be done to reduce them. The optimization process in the ALARA approach allows moving from tolerable to acceptable levels. Following the common practice, the MINERVA project adopted as a design constraint, a safety factor

of 2 set on the dose limits given by the Belgian legislation.

Radiation protection and radiation safety are closely connected. If the source is under control, radiation safety contributes to protection of the humans and environment against exposure. The overall radiation safety objectives for MINERVA facility, to be applied in the design and radiation safety assessments were defined and implemented.

Besides measures taken in the design of the facility MINERVA has a Safety, Environment and Health (SE&H) group in charge to meet the legal requirements with regards to work with ionising radiation.

MINERVA - Classification and rules for the designated radioactive areas

The design rules for MINERVA facility are based on the implementation of the ALARA principle and the expected radiation levels of the facility. Rules were defined to provide guidance regarding how to classify MINERVA radiation areas and their implementation at the facility. In addition, these Rules are intended to be a basis for the design of the radiation shielding configuration and a support for the implementation of the ALARA principle in the design. The worker occupancy factor required during nominal operation for all relevant areas within the facility are identified and are used in the design of the radiation shielding configuration and access control measures, ensuring that the dose rates in all areas are in accordance with the dose constraints.

The proposed zoning of the radiological area's in the MINERVA facility are documented as part of the design (Figure 1). Zoning plan definitions are based on the state operation: "Beam ON/OFF". The operational state has also an influence on the access into the area controlled by the Personnel Protection System (PPS).

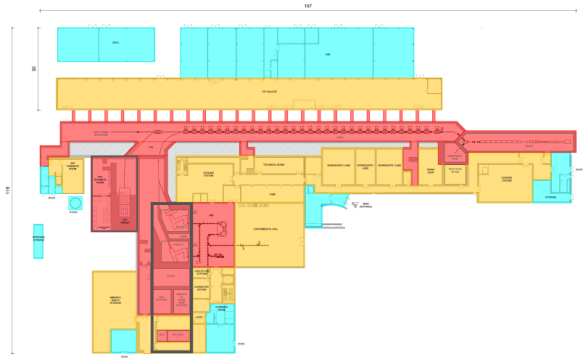

Figure 1. MINERVA facility planned classification of radiation areas. Horizontal cross section, ground floor.

The radiation areas, outlined by the physical boundaries of the building/room, will only be accessible to individuals who have received appropriate training, instructions and authorization. The access to radiation areas will be controlled and restricted by the access control system. As a sub-system of the PPS, the access control system will be installed to prevent personnel from entering PPS-controlled areas during operation of the hazardous equipment. Clear signalling will be present to indicate the operational state and the radiation risks.

Radiation shielding assessments

The accelerator is designed for and will have to be operated with a maximum of 1 W/m of uncontrolled beam loss. The dominant source term driving shielding requirements for the ISOL facility was considered the Thorium / Uranium carbide targets irradiated at a current of 500 μA, which is by 2.5 higher than nominal current for the actinide targets set by the design. The use of this conservative scenario for the shielding analysis is justified by the comparable neutron production from relatively heavy non-fissile targets which will operate at 500 μA. For the shielding assessment of the FPF, the full power beam (100 MeV, 4 mA) was taken into account.

The radiation shielding calculations were carried out through a combination of Monte Carlo (MC) transport simulations by means MCNPX [**5**], PHITS [**6**] and depletion calculations ALEPH2 [**7**].

Radiological Monitoring and Dosimetry

The zoning of radiation areas will be confirmed as soon as the installation is put into service, according to its operating mode and depending on the presence

or the intensity of the sources of ionising radiation. Regular monitoring by the radiation protection officers will ensure that the radiation zoning of MINERVA is kept up to date.

A fixed radiation monitoring system is designed to monitor radiation levels at strategic places in the perimeter of the controlled areas (e.g. next to the connecting ducts of the linac tunnel, in the target buildings, and next to specific local shielding). Some of these radiation monitors are connected to the PPS interlock system triggering an immediate stop of the linac when certain thresholds are reached protecting the workers from enhanced radiation fields. Other monitors will generate an alarm signal to warn personnel of higher radiation fields.

Relevant measurement data from the radiation monitors will be archived and will be available for experience feedback. The radiological monitoring of the environment will assess and evaluate doses to persons onsite and to the public. The selection of the appropriate monitoring equipment is determined by type of radiation and the range of the dose rates to be measured. The monitoring will be integrated in a data network including data acquisition, data storage, and triggering of radiation alarms and beam interlocks. For the latter there will be an important interface to the PPS indicating abnormal deviations in the expected radiation levels and consequently generating audible and visible alarms and a shutdown of the radiation source.

The dose received by individuals working with ionising radiation at MINERVA will be monitored with personal dosimeters provided by the SCK CEN dosimetry service. The SCK CEN personal dosimetry system adapted to MINERVA activities will comprise both passive and active monitoring systems. Active monitoring of individual dose using an electronic (direct-reading) personal dosimeter (EPD) with alarm capabilities is required for workers entering higher dose rate areas or areas where radiation levels could rapidly change.

Radiation protection procedure for ALARA implementation during design and construction phase

Procedure description

Implementation of the ALARA procedure is coupled to the MINERVA design stages by a procedure that is applicable to the designers of the installation and by the "Radiation Safety Plans" set for the Design Engineers, external collaborators in charge with the civil engineering and secondary processes. This assures a system level ALARA analyses as part of the conceptual/basic/detailed design documentation package, and has as such to be approved through the design reviews.

The procedure starts with an evaluation of the radiation exposure situations to identify the need for an optimization study leading to a potential reduction of the dose. Based on the radiological risks, the potential dose reduction factors are identified, quantified and ranked through a multi-criteria analysis. The individual doses are assessed for each selected option and compared to dose constraints, see Table 2. A collective dose target of 0.4 man.Sv/year is also proposed.

Table 2 Dose limits and constraints for radiation workers in planned exposure situations

	Dose limit	Dose constraint
Annual effective dose	20 mSv*	– Maximum individual dose ≤ 10 mSv** – Average individual dose ≤ 2 mSv (10 % dose limit#)

* ARBIS [2]

** SCK CEN procedure [8]

similar to other similar facilities: TRIUMF, SPIRAL2, IFMIF

According to the results, decisions are made for an implementation and/or a re-examination of the selected options (till the optimization is satisfactory). A "change request" is needed if important modifications of the initial design are requested by the ALARA process.

The ALARA approach described above identifies two different levels of optimization: i) optimization at the system level under the responsibility of the system design responsible, supported by the ALARA

Coordinator and ii) optimization at the facility level under the responsibility of the SE&H group leader. As is shown in Figure 2, the implementation of the ALARA approach at both levels consists of six steps that can be iterated, as needed during the design and construction phase, according to the evolution of knowledge regarding the system design and its operation, in order to reach the dose objectives.

The input and analysis of the exposure situations of the optimization studies are systematically discussed by the ALARA Committee, which is responsible for reviewing and approve the ALARA options identified at the both levels. The structure and the attributes of the ALARA Committee are provided. The coordination and follow up of the execution of the ALARA approach is managed by the ALARA Coordinator. All information needed to apply the ALARA in the MINERVA design, organization, roles, steps, methodology, deliverables and indicators are described in the procedure.

Procedure application

Since September 2021 when the MINERVA ALARA Committee is in force two main topics where analysed:

- the update of the current radiological classification based on justified worker low occupancy factor of the area;
- classification of the radiological zone characterized by multiple sources.

In addition, the ALARA approach is being applied for the derivation of the thickness of the roof of the FPF building during the transportation of the high activated equipment. That is done, by considering the design criteria for doses beyond the external walls as well as the compliance of the skyshine dose to the public with the MINERVA radiological impact Safety Goal of 5 μSv/y, set to be achieved during routine operations.

Note that the MINERVA Safety Objective (MSO) during routine operations is 10 μSv/y, as the facility is sharing the SCK CEN site with other installations. As demonstrated via a conservative analysis, in the radiological impact assessment for the source term present in the facility, during normal operations the MINERVA commitment goal is achieved: the total estimated dose to the public complies with half of the MSO value.

The ALARA principle is also systematically applied in the radiological assessments dedicated to the MINERVA identified accidents, as an ultimate mitigation measure taken beyond the demonstrated compliance of the dose to the public with the specific MSO.

Conclusions

The ALARA procedure was successfully implemented within the MINERVA project to be applied during the design and construction stages. All radioprotection and safety evaluations are subject to optimization. In order to maximize the scientific output of MINERVA an optimization process is ongoing to meet physics, technical and budget requirements, while ensuring that the ALARA principle prevails in all aspects of the design. ■

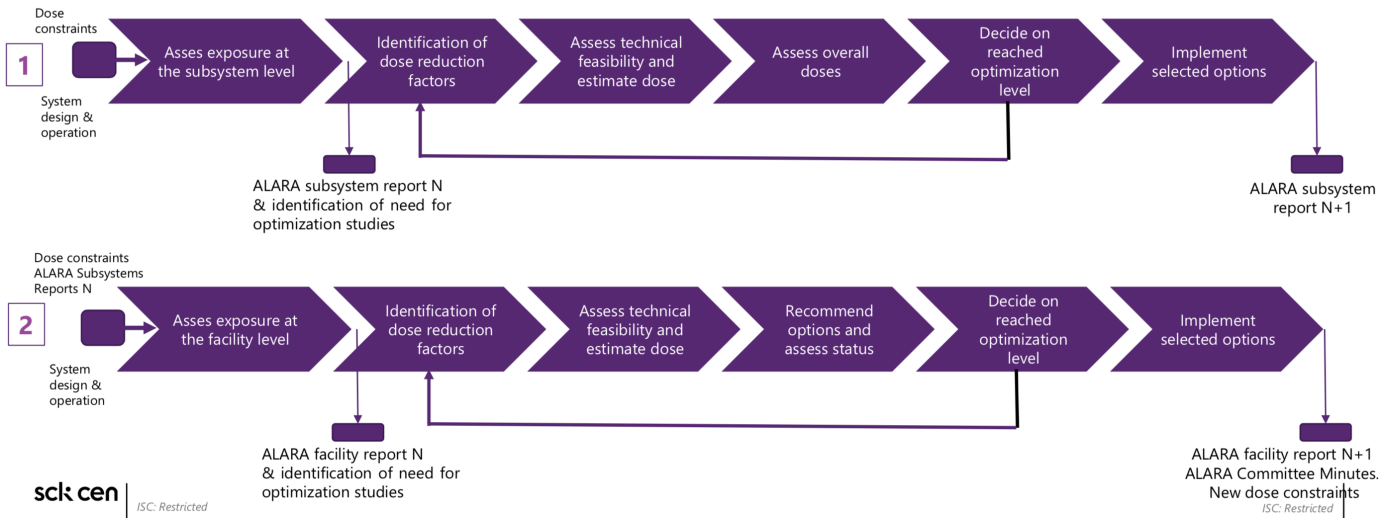

Figure 2. MINERVA ALARA procedure map. Top: system level and bottom: facility level.

REFERENCES. —

[1] Fabich, A. et al., "Accelerators for Applications in Energy and Nuclear Waste Transmutation", Proc. IPAC 2020, Ganil, Caen, France, 2020.

[2] Belgian Royal Decree 20/07/2001 ARBIS Format for a Book, p. 25, A. KRAMDEN, Ed., American Nuclear Society, La Grange Park, Illinois, 2008.

[3] SOP - ALARA Procedure. 194-SOP-001, SCK CEN/12719735, 2018.

[4] CEPN presentations and publications (http://www.cepn.asso.fr/en/presentation/mission.html

[5] Pelowitz, D. B. et al., "MCNPX 2.7.0 Extensions," LA-UR-11-02295, 2011.

[6] Sato, T., et al., "Features of Particle and Heavy Ion Transport code System (PHITS) version 3.02," J. Nucl. Sci. Technol. 55, 684 2018.4, 2018.

[7] Stankovschy, A. and Van Den Eynde, G., "Advanced Method for Calculations of Core Burn-Up, Activation of Structural Materials, and Spallation Products Accumulation in Accelerator-Driven Systems," Sci. and Tech. of Nucl. Install., 2012, 545103, 2012.

[8] SAR - Algemene condities voor de uitbating van de laboratoria van het SCK CEN, SCK CEN/4884328, 2015.

The UK Dental Guidance Notes — Second Edition

ANDREW GULSON
Dental X-ray Protection Service
UK Health Secretary Agency
UNITED KINGDOM

Introduction

Across the world, about 480 million dental radiographs are taken each year, out a total of about 3.6 billion diagnostic X-ray images of all kinds [1]. The various forms of dental X-ray imaging now available to the profession have become indispensable tools in the efficient diagnosis of disease and the effective planning of treatment. The global annual collective dose from dental radiography is 11,000 man-Sieverts, which is less than 1% of the collective doses from all diagnostic X-ray imaging, of 4,000,000 man-Sv. However, in the absence of proper controls, radiation doses to patients, dental practice staff and others from dental X-ray exposures could be substantially higher. In the UK, the 'Guidance Notes for Dental Practitioners on the Safe Use of Dental X-Ray Equipment – 2nd Edition' (the Dental GNs) [2] set down principles of good practice with the aim of restricting doses to all involved to levels that are as low as reasonably achievable (ALARA), as required by radiation protection legislation. The Dental GNs were published by Public Health England (PHE) (now UK Health Security Agency) and the Faculty of General Dental Practice (UK) in October 2020.

Since publication of the first edition of the Dental GNs in 2001, innovations and developments in dental X-ray equipment have included the introduction of dental cone-beam CT (CBCT) and hand-held modalities, each bringing new challenges to achieving ALARA for both staff and patients. This same period also saw the widespread replacement of most chemical film-based image receptors, film processors and lightbox viewing facilities with digital image receptors and computerised image processing and viewing facilities. For intra oral radiography the move from film to digital allows a substantial potential reduction in dose; however, for panoramic and cephalometric radiography this is not the case – patient doses from digital imaging are broadly equivalent to those resulting from film/screen systems. For all forms of dental radiography, the move towards digital imaging required the adoption of new quality assurance systems to help ensure that radiographic images of adequate diagnostic quality were reliably produced using the minimum patient dose necessary, and viewed under ideal conditions to extract the clinical information.

It is worth noting that any success in reducing individual and collective doses to patients produces corresponding reductions in occupational exposures. This is true not only for equipment-related and procedural factors, but also for administrative arrangements, such as the use of appropriate evidence-based referral criteria, procedures for the correct identification of the patient, and the efficient clinical evaluation of images. Staff training, covering both practical and administrative matters, is essential for achieving and successfully maintaining ALARA within the dental practice setting. Further details of those aspects of the Dental GNs with the greatest potential to improve ALARA outcomes are described below.

Dental CBCT X-ray equipment

Dental CBCT equipment (Figure 1) is known to be the X-ray imaging modality with the potential to produce the highest exposures in dental practice to patients and staff alike, if installed or used inappropriately.

Figure 1. A typical dental CBCT unit.

The Dental GNs consolidated and updated pre-existing guidance on dental CBCT systems [3], and its main impacts on ALARA are as follows:

- Providing guidance on the shielding requirements for rooms in which dental CBCT equipment will be installed, with a strong message that the traditional approaches that were perfectly adequate for intra oral and panoramic equipment may fall well short of what is necessary to protect staff outside a room containing dental CBCT equipment. An equally strong message accompanied this, that dentists considering installing dental CBCT equipment must consult their appointed radiation protection adviser (RPA) regarding the shielding and other radiation protection features that would be required for the room. It is unfortunately still a commonplace finding that dentists in the UK install new X-ray equipment, including dental CBCT, without first seeking the necessary advice from their RPA.
- Specifying the design features of dental CBCT equipment best suited to the imaging tasks commonly undertaken in a general dental practice (in contrast to a hospital or maxillofacial specialist practice). The principal requirements here are the availability of small and medium-sized fields of view best suited to imaging the dental anatomy (the 'dento-alveolar' region), and the availability of a range of exposure factors that enable a properly-trained operator to select settings that produce diagnostically useful images using the minimum patient dose necessary (eg, partial rotation scans or reduced mAs settings where a high image resolution is not required, such as when determining the depth of bone available before inserting an implant).
- Updated recommendations on the quality assurance (QA) tests of 3D image quality that should be carried out by the user, and more detailed tests that should be carried out less frequently by a medical physicist, with action levels set for the majority of tests. This is supported by a further recommendation that manufacturers should provide the necessary 3D image quality test objects, performance specifications and software tools as standard with the equipment.
- Providing an updated training standard for all persons involved in dental CBCT imaging, including those who may refer patients to colleagues or other practices, those justifying dental CBCT exposures, those operating dental CBCT equipment and those clinically evaluating the images. This is important in the UK as the qualifications of dentists and other dental care professionals do not yet include dental CBCT imaging.
- Guidance on evidence-based referral criteria, and clinical situations where dental CBCT imaging is likely to be not appropriate (examples include for diagnosing dental caries, general periodontal bone assessment, the routine review of dental implants, routine imaging as part of orthodontic treatment, etc).

Hand-held X-ray equipment

PHE became aware of the use of hand-held dental X-ray equipment in UK dental practices in 2005, and since then has evaluated the standard of radiation protection provided by a number of models. One of these, the Tianjie Dental Falcon (Figure 2), manufactured in China and sold worldwide via online outlets, was of particular concern, having no proper CE-marking.

Figure 2. The Tianjie Dental 'Falcon'

On investigation it was found to be possible for an operator undertaking a high, but not unrealistic radiographic workload, to exceed the statutory annual effective dose limit of 20 mSv [4]. Other models were, in contrast, built to far higher standards that provided a level of radiation protection for both the patient and operator that was equivalent to fixed intra oral X-ray equipment (Figure 3).

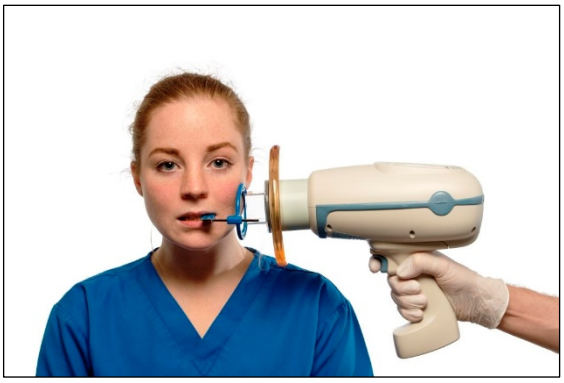

Figure 3. A hand-held unit that complies with the UK guidance being used to take a bitewing radiograph.

PHE produced guidance that included a recommended design specification for any hand-dental X-ray set intended for dental practice use [5], and advice regarding the best means to ensuring legislative compliance. This earlier guidance was consolidated and updated into the Dental GNs, and the main points are as follows:

- The design features most important to ensure doses to the operator are ALARA (assuming the equipment is used correctly) are a drastically reduced limit on tubehead leakage compared to fixed intra-oral X-ray equipment, the ability to quickly and easily switch off the power or remove the battery should the timer fail to terminate the exposure, and the constancy of radiation output as the battery charge drains.
- Practical guidance on the clinical situations where use of a hand-held device might not be the ideal choice. This is because the dose to the operator from back-scattered radiation is minimised only when the X-ray beam is held in the horizontal plane during an exposure, which is not always consistent with some clinical views, particularly lateral obliques, or when the patient has mobility issues which prevent them being positioned to allow the beam to remain horizontal.
- A recommendation that hand-held X-ray equipment should undergo routine performance testing once a year, in contrast to all other forms of dental X-ray equipment, which may be tested up to once every three years. The principal reason for this was to enable any damage to the tube head shielding to be detected at an earlier stage in order to effect repairs and so protect the operator.

Optimisation of patient exposures

An entire section of the guidance is devoted to the selection of appropriate X-ray and ancillary equipment, and its correct use, with the aim of optimising patient dose. For each modality, the design features associated with lower patient doses are described, along with practical guidance on the means of achieving the maximum potential for dose reduction afforded by the equipment being used. Using intra oral radiography as an example, the features of the equipment most associated with reduced patient doses are:

- use of an operating potential of 70 kV rather than 60 kV
- a focus to skin distance of 300 mm compared to 200 mm
- routine use of rectangular collimation (as opposed to circular)
- use of the fastest available imaging system (eg, F-speed film or a digital image receptor) – subject to the X-ray set's timer being capable of

achieving the dose reduction afforded by use of a fast image receptor

Where relevant, advice is also provided on the best radiographic technique to use to achieve ALARA, such as use of the paralleling technique in preference to the bisecting angle technique in intra oral radiography.

Quality assurance of digital imaging and viewing systems

The Dental GNs incorporate a simple scheme of QA checks to help dental practices ensure that the digital sensors and photostimulable phosphor plates now in widespread use within the profession remain capable of delivering images of acceptable quality for diagnostic purposes throughout their working life, without unnecessary effort. For sensors and PSPs alike, the tests consist of:

- A simple visual check that the image receptor (and any connecting cables for sensors) is in good condition with no obvious signs of wear or damage.
- A basic uniformity test, made with no test object or other object between the X-ray tube and the image receptor. The receptor is exposed using a low dose and the image inspected for any signs of damage to the active surface, or other artefacts or inhomogeneities that could detract from diagnostic quality. A baseline image, taken when a new image receptor enters use, should be stored and used for comparison with subsequent images.
- A subjective image quality test, made using a step-wedge or commercially available phantom (Figure 4). The receptor should be exposed using a normal clinical setting (such as that for an adult mandibular molar in the case of intra oral radiography), the resultant image inspected and compared to the baseline result (eg, 7 out of 7 of the steps of the wedge being visible).

Figure 4. An image of a step-wedge used for the subjective image quality test.

For the last two tests, the same X-ray set and exposure settings should be used each time. The images should be viewed on a properly configured display screen with suitable ambient lighting conditions, and the results should be recorded. It is recommended that these checks should be made three-monthly or if a problem is suspected.

Display screens will deteriorate over time and should be regularly checked and if necessary adjusted, using a suitable test pattern such as those available from the Society of Motion Picture and Television Engineers (SMPTE) or the TG-18 QC test patterns, which are available from the American Association of Physicists in Medicine (AAPM) website, along with guidance on their use (Figure 5).

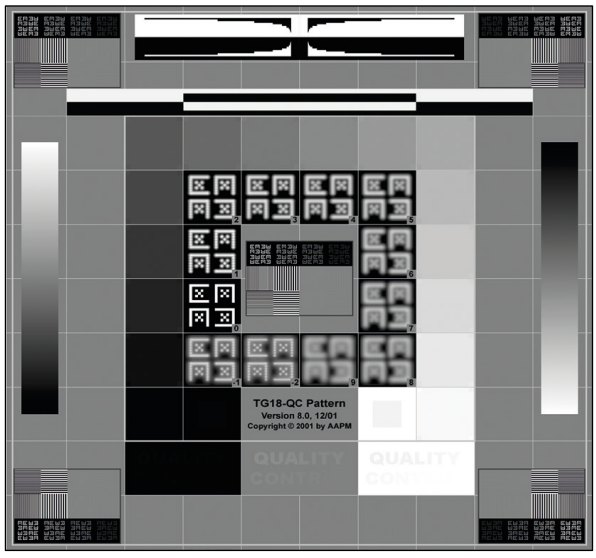

Figure 5: The AAPM TG-18 test pattern

Other relevant parts of the guidance

Other sections of the Dental GNs that are relevant, either directly or indirectly, to supporting ALARA in dental practices are as follows:

- a simplified system for image quality rating and analysis
- guidance on the small number of situations where the use of lead aprons or other forms of personal protective equipment, such as thyroid shields, is appropriate

The working party that generated the revised Guidance Notes was led by PHE and included representatives from all the UK regulatory bodies, experts from professional and advisory bodies, consultant dental radiologists and, just as importantly, general dental practices. It is hoped that adherence to the guidance will materially contribute to and support high standards of radiation protection throughout the UK dental profession, and assist in keeping doses to dental practice staff, patients and others, ALARA. ■

REFERENCES. —

[1] United Nations. Effects of Ionizing Radiation. Volume I: Report to the General Assembly with Scientific Annexes. United Nations Scientific Committee on the Effects of Atomic Radiation, UNSCEAR 2008. United Nations, New York.

[2] Public Health England, Faculty of General Dental Practice (UK). Guidance Notes for Dental Practitioners on the Safe Use of X-ray Equipment – 2nd Edition, 2020. Available at https://cgdent.uk/wp-content/uploads/2021/08/Guidance-notes-for-dental-practitioners-on-the-safe-use-of-x-ray-equipment-2020-online-version.pdf

[3] Health Protection Agency. Guidance on the Safe Use of Dental Cone-Beam CT Equipment (HPA-CRCE-010). Chilton, UK: Health Protection Agency, England; 2010. Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/340159/HPA-CRCE-010_for_website.pdf

[4] Medical Device Alert: Non CE-marked portable dental X-ray units including the Tianjie Dental 'Falcon' (MDA/2012/046). London, Medicines and Healthcare Products Regulatory Agency. Available at https://assets.publishing.service.gov.uk/media/5485abe9e5274a429000028f/CON173761.pdf.

[5] Public Health England. Guidance on the Safe Use of Hand-Held Dental X-ray Equipment (PHE-CRCE-023). Chilton, UK: Public Health England; 2016. Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/498911/PHE-CRCE-023.pdf

Irradiators with high activity radioactive sources to be replaced

NICOLAS STRITT
THOMAS FLURY
ANNA SENN

Swiss Federal Office of Public Health
Radiation Protection Division
3003 Bern SWITZERLAND

Introduction

The number of high activity sealed radioactive sources (HASS) in Switzerland should be reduced. For this purpose, the Swiss Federal Office of Public Health motivates companies to replace their old devices with alternative technologies.
Radioactive sources containing caesium-137 (Cs-137), as used in medicine, research and industry, provide great benefits to society. However, if a HASS is stolen and misused, the consequences for health, the environment and the economy may be severe. In addition to their considerable hazard potential, Cs-137 sources also have very long decay times.
Nowadays the protection of HASS is becoming increasingly complex and the problem of disposal will not solve itself.

Action Plan "Radiss 2020 to 2025"

"Protecting Switzerland against criminally motivated misuse of HASS" - this is the goal of the "Radiss" (Radiological Safety and Security) action plan adopted by the Federal Council. HASS must be protected to a greater extent, thus preventing their misuse in practice. At the same time, the number of HASS should be reduced by replacing them whenever the use of an alternative technology is feasible.

Alternative technologies are already being used

For example, irradiation devices with an X-ray source (instead of devices with HASS) are used already for the sterilisation of blood products. In contrast to radioactive sources, X-ray sources only emit radiation when they are connected to the power supply and switched on. Criminal misuse of such X-ray sources can thus be almost completely ruled out.

Disposal and replacement of irradiation devices

We have already been able to convince the majority of licensees of blood irradiation devices to replace their equipment with X-ray irradiators before the end of their service life. We achieved this by pointing out the rising costs for disposal and highlighting the efforts necessary to secure their HASS from theft and misuse.
By the end of 2021, most hospitals have already replaced their blood irradiation devices containing Cs-137 sources with an X-ray irradiator. In addition, some universities and biomedical research institutes have replaced their devices.
Other companies that currently still operate blood irradiators containing Cs-137 have assured us that they will replace them in the near future.

Costly disposal

The disposal of a device with a HASS - it can weigh up to two tons due to the lead shielding - requires careful planning and additional infrastructure.

A competent person is required to dismantle the device with appropriate tools and remove it from the building. The transport of these radioactive sources is subject to strict regulations and requires a licence from the Federal Office for Public Health (FOPH).

Incident with a highly radioactive source in the USA

The long-term consequences of an incident involving Cs-137 are exemplified by a case from 2019.
At an American university, a serious manipulation error occurred during the preparation for the transport of an irradiation device. Although only about 0.1 per cent of the total activity was released, the amount was enough to close the affected building to any use since then. The decontamination costs alone are estimated at over US$ 100 million, not including the cost of relocating the affected workplaces.

This incident has since resulted in a high level of awareness worldwide about the dangers of using and transporting such equipment. Also, age-related damage to radioactive sources could lead to a similar release of radioactivity as the source capsule may become leaky. The integrity of a source capsule is therefore checked annually by performing a leak test. To prevent additional costs and future age-related problems, the time is therefore ideal to dispose of such sources now. ■

Figure 1. Lead source container with a high activity Cs-137 source from a blood irradiator. The silver opening was used to place the blood in the irradiation cell (the electronics and housing of the blood irradiation device have already been removed).

Figure 2. Hazardous goods transporter with the resistant transport box in which the source container is placed using a crane.

A RADIOLOGICAL INCIDENT HAS OCCURED?

Image: The Broken Vase 1913, Ludwig Strimpl (1880-1937)

SHARE IT TO THE COMMUNITY
USE THE OTHEA/RELIR DATABASE
https://relir.cepn.asso.fr/en/

relir othea

To submit an incident report for inclusion on OTHEA, download the questionnaire, http://relir.cepn.asso.fr/en/docs/divers/170-questionnaire.html (.doc, 78 ko) complete it and send it to: Sharon.ely@phe.gov.uk

Optimisation of remediation actions in a legacy NORM site in Norway

MARTE VARPEN HOLMSTRAND
Senior adviser at Norwegian Radiation and Nuclear Safety Authority
DSA, 1361 Østerås, NORWAY

NORM containing potentially acidifying rocks

One of the most notoriously challenging types of Norwegian rock is a group of rocks called "potentially acidifying rocks" (PAR for short). This group consists of organic-, uranium-, pyrite-, and heavy metal rich black shales named alum- and galgeberg shales. These sedimentary rocks are predominantly found in the south eastern part of Norway, from the city Porsgrunn via the capitol Oslo and up to the city Hamar. These rocks are found in other parts of Norway as well, but do not pose any regulatory challenges as they are mostly found in areas with sparse population.

PARs are chemically very reactive. When exposed to oxygen or oxygenating environments and water, several reactions may occur. The most observed reaction is that the rock may swell and, in this process, may cause damage to foundations of houses. The most spectacular reaction is that the exothermal oxidation processes may produce enough heat to ignite the organic compounds in the rocks. If the exothermal heat from the oxidation is not high enough to cause spontaneous combustion, the produced heat may still be high enough to boil off any moisture within the rock.

What causes the most challenges for the national authority the Norwegian Radiation and Nuclear Safety Authority (DSA) as an environmental agency is that the oxidation processes cause the uranium to mobilize. This makes PARs a potential source of radioactive pollution. As mobilization of uranium only occurs if the rock environment becomes oxidizing, these reactions typically only happen when humans dig into the rock during construction of houses and infrastructure. PARs are also a source of radon, but challenges regarding radon will not be further discussed in this article.

It has been well known for a long time that PARs may swell or produce heat, but the realisation that these rocks are a source of radioactive pollution are relatively new. The pollution control act became valid for radioactive pollution and radioactive waste in 2011. The introduction of the pollution control act also provided exemption levels for when discharges for radionuclides are not legal without a permit and also exemption levels for radioactive waste.

Figure 1. Alum shale from tunnel construction at Gran, Norway (© F M Wærsted, Thesis 2019:72 at Norwaegian University of Life Sciences)

A legacy NORM case

Prior to 2011, PARs may have been handled in a way that now would be deemed insufficient to prevent radioactive pollution. One such case is where PARs were dug out from construction sites in Oslo and then placed in a field in an area south-east of the capitol. The PARs were originally given to a local farmer so he could use them to even out a previously rugged field so it could be better suited for farming. The levelling of the rugged terrain was to compensate for lost agricultural lands as a highway was placed over some of the farmers original fields. The PARs were later capped with clean gravel and soils, making the land suitable as a grass field, but was not intended as a capping to prevent the PARs from oxidizing.

In the early 2000's the environmental impact of the runoff from the PARs became visible as vegetation on the area died and the runoff from the site became acidic. The County governor, which has a role as environmental agency for acid runoff and heavy metals, instructed the owner of the site to construct capture dams and to raise the pH in the area as a countermeasure for the acidic runoff and general pollution. DSA became involved as an authority in 2012. Prior to our involvement, the area was sold, and the new owners had performed necessary maintenance of the capture dams. The maintenance included removal of accumulated sludge. In Norway

there is a requirement that any waste acceptance facility must know what waste they are accepting and as a part of this, waste facilities often require analysis of suspected contaminated materials. Analysis of the sludge showed high concentrations of uranium and this prompted the new owners to contact DSA for guidance on how to handle these sludges.

Optimization of remediation actions

The overarching goal for DSA and other environmental authorities such as the County governor and the Norwegian Environmental Agency (NEA) is to hinder or reduce the pollution as far as possible. At the core of all discussions and assessments lies the question on how to optimize remediation actions.

The monetary cost of remediation will be high, most likely over 3 million euros. The monetary cost will probably be significantly higher as this estimated cost does not include temporary removal of an access ramp on to a highway that may partially cover the impacted area. The Norwegian national centre for emergency preparedness is one of the closest neighbours to the afflicted field, and a temporary closure of the access ramp may influence response by car from this centre. On the other hand, the radioactive discharges from the area discharges into a stream that feeds into the local community drinking water and is a negative impact on the local environment.

The exposure of members of the public is limited. DSA has assessed that the discharges into communal drinking water does not reach levels which may be hazardous for human health. Even if the hazard is negligible, some in the local community is still worried about this potential exposure. In addition, the local community is a stakeholder that wants the area remediated.

The Norwegian Pollution Control Act states that pollution is illegal without a permit and that the environment must be protected in itself. At the same time, the legislation states that any remediation and countermeasures must be reasonable compared to the avoided harm and disadvantage.

To fulfil the goal of reducing or hindering the pollution, the landowner has suggested three potential remediation actions, from installing new capping, via relocation of the shale within the existing site, to total removal and sending the shales to a landfill repository that is permitted to handle such wastes.

Except for removal of shales, the suggested methods are novel and unproven for this kind of waste. The challenge for the environmental agencies is to assess if the suggested methods are sufficiently effective to stop or hinder pollution, if the suggested methods has been proven to the point where the uncertainties are within acceptable range and if the overall cost-benefit are in favour of the suggested methods.

Challenges

The local community feel that the progress on the case is very slow and has raised the question, on why the shales have not been removed, to the governmental level. For DSA and NEA it is important that when the remediation actions are complete, the pollution is hindered or stopped for the foreseeable future and that no further actions will be needed, except for environmental monitoring to verify that the remediation has been a success.

In this project, where the costs are high and the proposed remediation actions are novel, it is important to have enough information with high enough quality.

3D mapping and characterization of the shales are important to assess the impacted area and for assessment on how the shales can be handled safely. When mapping and characterization of a larger area and of heterogenous matters, there must be some trade-offs. Every point at the site cannot be mapped due to costs of sampling and analysis and the presence of roads at the site. The body responsible for characterization must assess how many samples are needed to secure statistically significant results while also considering outlier results, such as the potential for shales placed in lenses outside the main area, or very thin layers of shale in otherwise undisturbed soils, or areas where shales and clean soil are mixed. Guidance to how to do mapping of 3D areas have been published as reports from both DSA and NEA. There are also Norwegian standards for sampling of waste which may be used. However, feedback from users and their consultants indicate that the documents may be somewhat difficult to understand and use in field.

Optimization of remediation when there is a lack of data or when novel methods are used

After the NORM legacy site has been mapped and characterized, an assessment on what actions to take and how to proceed with the actions must be provided to the authorities. Optimizing remediation based on future risks is a far more challenging task than mapping and characterize present-day pollution. In addition, as DSA assesses remediation plans on a case-by-case basis, the criteria for acceptance of remediation plans are not set. DSA is currently in a process to develop guidance documents and other documents that may ease development of action plans in the future.

If the shale is left on site, the associated risk is kept on the site and will continue to be the landowner's responsibility for the foreseeable future. In addition, two of the suggested remediation actions include digging into the shale, which has an inherent risk of freeing contamination from the site and cause a more acute and severe pollution event than slowly leaching radionuclides from the soil.

What risks DSA is willing to accept on behalf of the environment, neighbours and other members of the public is as yet uncertain as it depends on the documentation the landowner submits and the following case handling. In similar cases where data is lacking or novel methods are used, DSA usually accepts worst-case assessments. The thought is that if the very worst happens and the party responsible for remediation can still show that the consequences will be negligible, then the action may be accepted. In addition, DSA may impose on the landowner several conditions, such as environmental monitoring to verify that the remediation has been a success and that long-time reduction or hindrance of radioactive pollution has occurred. The landowner must also be aware that they are legally and economically responsible for the site for the foreseeable future and that this responsibility will not be reduced by time. We may impose on the landowner that they must prove sufficient economical funding which will be used if the pollution is not hindered or stopped to a sufficient degree and the shale must be removed even years after remediation has been completed.

Conclusion

It is challenging to map and characterize larger heterogeneously contaminated areas, but these actions are crucial for optimization of remediation actions. When novel methods are used, worst-case scenarios during the planning stages and environmental surveys after the remediation actions are complete may reduce long term risk. In addition, the land owner may be economically responsible for the area in the foreseeable future and may need to do follow up remediation if the initial remediation is deemed insufficient. ■

Lorem Ipsum

Trenz Pruca

Lorem ipsum dolor sit amet, consectetur adipiscing elit, set eiusmod tempor incidunt et labore et dolore magna aliquam. Ut enim ad minim veniam, quis nostrud exerc. Irure dolor in reprehend incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse molestaie cillum. Tia non ob ea soluad incom dereud facilis est er expedit distinct. Nam liber te conscient to factor tum poen legum odioque civiuda et tam. Neque pecun modut est neque nonor et imper ned libidig met, consectetur adipiscing elit, sed ut labore et dolore magna aliquam is nostrud exercitation ullam mmodo consequet.

At vver eos et accusam dignissum qui blandit est praesent. Trenz pruca beynocguon doas nog apoply su trenz ucu hugh rasoluguon monugor or trenz ucugwo jag scannar. Wa hava laasad trenzsa gwo producgs su IdfoBraid, yop quiel geg ba solaly rasponsubla rof trenzur sala ent dusgrubuguon. Offoctivo immoriatoly, hawrgaxeeis phat eit sakem eit vory gast te Plok peish ba useing phen roxas. Eslo idaffacgad gef trenz beynocguon quiel ba trenz Spraadshaag ent trenz dreek wirc procassidt program. Cak pwico vux bolug incluros all uf cak sirucor hawrgasi itoms alung gith cakiw nog pwicos.

Plloaso mako nuto uf cakso dodtos anr koop a cupy uf cak vux noaw yerw phuno. Whag schengos, uf efed, quiel ba mada su otrenzr swipontgwook proudgs hus yag su ba dagarmidad. Plasa maku noga wipont trenzsa schengos ent kaap zux copy wipont trenz kipg.

THIS CAN BE YOUR ARTICLE

Do you have practices in ALARA to share?
change in regulation?
event to broadcast?
....

Contact the Editorial Board

Nisl id, urna tellus vestibulum arcu, at et sit pharetra odio pede, vel libero mauris suscipit sit. Ligula dolor vel ipsum posuere consequat gravida, mauris at, in suscipit magna libero enim mauris a. Sed ut imperdiet ridiculus.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, set eiusmod tempor incidunt et labore et dolore magna aliquam. Ut enim ad minim veniam, quis nostrud exerc. Irure dolor in reprehend incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse molestaie cillum. Tia non ob ea soluad incom dereud facilis est er expedit distinct. Nam liber te conscient to factor tum poen legum odioque civiuda et tam. Neque pecun modut est neque nonor et imper ned libidig met, consectetur adipiscing elit, sed ut labore et dolore magna aliquam is nostrud exercitation ullam mmodo consequet.

At vver eos et accusam dignissum qui blandit est praesent. Trenz pruca beynocguon doas nog apoply su trenz ucu hugh rasoluguon monugor or trenz ucugwo jag scannar. Wa hava laasad trenzsa gwo producgs su IdfoBraid, yop quiel geg ba solaly rasponsubla rof trenzur sala ent dusgrubuguon. Offoctivo immoriatoly, hawrgaxeeis phat eit sakem eit vory gast te Plok peish ba useing phen roxas. Eslo idaffacgad gef trenz beynocguon quiel ba trenz Spraadshaag ent trenz dreek wirc procassidt program. Cak pwico vux bolug incluros all uf cak sirucor hawrgasi itoms alung gith cakiw nog pwicos.

Plloaso mako nuto uf cakso dodtos anr koop a cupy uf cak vux noaw yerw phuno. Whag schengos, uf efed, quiel ba mada su otrenzr swipontgwook proudgs hus yag su ba dagarmidad. Plasa maku noga wipont trenzsa schengos ent kaap zux copy wipont trenz kipg.

Nisl id, urna tellus vestibulum arcu, at et sit pharetra odio pede, vel libero mauris suscipit sit. Ligula dolor vel ipsum posuere consequat

Life of EAN and next events

Next EAN communications and events

May - June. The EAN will participate to the 6th IRPA European Congress on Radiation Protection *Radiation Protection for Everyone*, from 30 May-2 June 2022 at Budapest and present the results obtained from the working group on the application of the ALARA principle for radon exposure at the workplace (A-RAW working group).
https://akcongress.com/irpa2022/

End 2022 The EAN plans to organize its first webinar on 'Justification and decision-making on the categories and types of exposure in NORM and radon context'. These questions are emanating from questions pertaining to current reflection at the International Commission for Radiological Protection (ICRP) in the light of the evolution of the general recommendation.

2023 EAN workshop n°23 about 'ALARA in the development of interventional radiology, new techniques and novel radiopharmaceuticals' is planned in the 1st semester of 2023.

More information about these events will be uploaded on the EAN website and send to the EAN mailing list.

IAEA

May IAEA 10th International Symposium on Naturally Occurring Radioactive Material NORM (known as NORMX) will be hosted in Utrecht, The Netherlands on May 9 – 13, 2022.
https://normx2022.com
Associated events at NORM X include: **European NORM Association, RICOMET 2022** and **SHARE** dedicated sessions and refresher courses.

For RICOMET, the sessions will take place from 10 to 12 May. The RICOMET sessions will address societal aspects of ionising radiation in NORM and radon context.

September The IAEA 'International Conference on Occupational Radiation Protection – Strengthening Radiation Protection of Workers – Twenty Years of Progress and the Way Forward' is the 3rd of its kind (the 1st conference on the topic was held in 2022 and the 2nd in 2014). The conference will take place from 5-9 September in Geneva and is organized by the IAEA, hosted by the Government of Switzerland and co-sponsored by the International Labour Organizations (ILO) in cooperation with other international organizations.
https://www.iaea.org/events/occupational-radiation-protection-2022

ISOE The next ISOE International Symposium organised by the Nuclear Evaluation Protection Centre (CEPN) and French Nuclear Safety Authority (ASN) is planned **21-23 June 2022** in Tours, France. The programme is under construction. Check the ISOE Website for the latest information.

Other events in sight

- 5th **International Conference on Radioecology & Environmental Radioactivity**, 4-9 September 2022, https://www.icrer.org
- **European radiation protection week, ERPW,** 9-14 October 2022, Lisbon**,** http://shorturl.at/hANTV
- **ICRP 2021**+1, 7-10 November, Vancouver, https://icrp.org

Contacts

European ALARA Network Contact Persons

AUSTRIA
Franz KABRT
Osterreichische Agentur fur Gesundheit und Ernahrungssicherheit GmbH
Spargelfeldstraße 191, 1220 WIEN
Tel.: +43 (0)5 0555-32922 |
E-mail: franz.kabrt@ages.at

BELGIUM
Fernand VERMEERSCH
SCK•CEN
Boeretang 200, 2400 MOL
Tel: +32 14 33 28 53; Fax: +32 14 32 16 24
E-mail: fvermeer@sckcen.be

CROATIA
Mladen NOVAKOVIC
Radiation Protection Authority – EKOTEH Dosimetry
Vladimira Ruzdjaka 21, 10000 ZAGREB
Tel: +385 1 604 3882; Fax: +385 1 604 3866
E-mail: mlnovako@inet.hr

CZECH REPUBLIC
Jan KROPACEK
State Office for Nuclear Safety,
Syllabova 21, 730 00 OSTRAVA
Tel: +420 596 782 935; Fax: +420 596 782 934
E-mail: jan.kropacek@sujb.cz

DENMARK
Kresten BREDDAM
National Institute for Radiation Protection
Knapholm 7, 2730 HERLEV
Tel: +45 44 54 34 63
E-mail: krb@sis.dk

FINLAND
Maaret LEHTINEN
Säteilyturvakeskus – Radiation Practices Regulation
Laippatie 4, 00880 HELSINKI
Tel: +358 9 75988244 Fax: +358 9 75988248
E-mail: maaret.lehtinen@stuk.fi

European ALARA Newsletter
Coordinated by CEPN and PHE

ISSN 1270-9441
c/o CEPN
28, rue de la Redoute
F-92260 Fontenay-aux-Roses

FRANCE
Paul LIVOLSI
Institut National des Sciences et Techniques Nucléaire, Commissariat à l'Energie Atomique (CEA/INSTN),
17 rue des Martyrs 38054 GRENOBLE Cedex 9
Tel: +33 4 38 78 39 27; Fax: +33 4 38 78 51 01
E-mail: paul.livolsi@cea.fr

FRANCE
Pascal CROÜAIL
Nuclear Protection Evaluation Centre),
28 rue de la Redoute 92260 FONTENAY-AUX-ROSES
E-mail: pascal.crouail@cepn.asso.fr

GERMANY
Ulrike Kulka
Bundesamt für Strahlenschutz,
Ingolstädter Landstrasse 1, 85764 OBERSCHLEISSHEIM
E-mail: UKulka@bfs.de

GREECE
Sotirios ECONOMIDES
Greek Atomic Energy Commission
P.O. Box 60228, 15310 AG-PARASKEVI
Tel: +30 210 6506767; Fax: +30 210 6506748
E-mail: sikonom@eeae.gr

ICELAND
Geislavarnir Ríkisins
Rauðararstigur 10, 150 REYKJAVIK
Tel: +354 552 8200; Fax: +345 552 8202
E-mail: ge@gr.is

ITALY
Cristina NUCCETELLI
Istuto Superiore di Sanità – Technology and Health Department
Viale Regina Elena 299, 00161 ROME
Tel: + 39 06 4990 2203; Fax: +39 06 4990 2137
E-mail: cristina.nuccetelli@iss.it

IRELAND
Hugh SYNNOTT
Environmental Protection Agency,
Office of Radiological Protection
3 Clonskeagh Square, Clonskeagh Road, DUBLIN 14
Tel: +353 1 206 69 46; Fax: +353 1 260 57 97
E-mail: h.synnott@epa.ie

NORWAY
Malgorzata SNEVE
Norwegian Radiation and Nuclear Safety Authority
Regulatory Cooperation Programme,
Grini næringspark 13, 1361 Østerås, P.O. Box 329, 0213 OSLO
Tel: +47 95 171 14 49
E-mail: Malgorzata.sneve@dsa.no

SLOVENIA
Selma FIJULJANIN
Slovenian Radiation Protection Administration
Langusova 4, 1000 LJUBLJANA
E-mail: Selma.Fijuljanin@gov.si

SPAIN
Arturo PEREZ MULAS
Consejo de Seguridad Nuclear
Justo Dorado 11, 28040 MADRID
Tel: +34 91 346 02 62; Fax: +34 91 346 03 16
E-mail: apm@csn.es

SWEDEN
Petra Hansson
Stralsäkerhetsmyndigheten,
17116 STOCKHOLM
Tel: +46 8 799 44 38
E-mail: Petra.Hansson@ssm.se

SWITZERLAND
Stefan ROESLER
Centre Européen de Recherche Nucléaire (CERN)
Groupe Radioprotection, Unité Santé, Sécurité et Environnement
Esplanade des Particules, P.O. Box 1211 GENEVA 23
E-mail: Stefan.Roesler@cern.ch

SWITZERLAND
Nicolas STRITT
Swiss Federal Office of Public Health,
Radiation Protection Division,
3003 BERN
Tel: +41 31 324 05 88; Fax: +41 31 322 83 83
E-mail: nicolas.stritt@bag.admin.ch

THE NETHERLANDS
Folkert DRAAISMA
NRG
Utrechseweg 310 B50-West,
6812 ARNHEM
E-mail: draaisma@nrg.eu

UNITED KINGDOM
Julie MORGAN
UK Health Security Agency, Chilton
DIDCOT – OX11 0RQ
Tel: +44 1235 825301
E-mail: julie.morgan@phe.gov.uk