Abstract. The Treaty establishing the European Atomic Energy Community places an obligation on the Community to establish basic safety standards for the protection of the general public and workers against the dangers arising from ionising radiation. Since its establishment in 1957, Euratom has regularly legislated and issued guidance in many areas driven by scientific developments, by experience with former legislation or by the identification of regulatory gaps. Most recently, the Community issued two major pieces of radiation protection legislation. In May 1996, the new Basic Safety Standards Directive was issued followed by the Directive on medical exposures in June 1997. The EU Basic Safety Standards improve the protection of workers in particular by the reduction of annual dose limits and the extension of the scope to natural radiation sources. This paper gives consideration to whether the protection of workers against the dangers arising from ionising radiation should be seen as an isolated subject or integrated into the wider aspects of workplace safety and worker health policy. Examples are presented of situations where radiological and non-radiological safety considerations led to unbalanced situations and to accidents.
1. INTRODUCTION

During the last four decades the European Atomic Energy Community has placed high emphasis on legislative and research activities aimed at creating best conditions for the protection of workers and the general public against dangers arising from ionising radiation. The starting point of this particular European health policy was the 1957 Euratom Treaty [1]. This treaty established the European Atomic Energy Community and vested it with far-reaching competencies. Since 1959, the Community has issued at regular intervals basic safety standards for the radiological protection of workers and the general public. Repeated updates have improved and strengthened the provisions and have led to protection standards for all categories of workers, as well as for members of the general public.

2. THE LEGISLATIVE PROCEDURE

In order to meet the obligation under Article 2b of the Euratom Treaty, the legislative procedure laid down in Article 31 of the Treaty must be followed. The Treaty requires the Commission to obtain the opinion of a group of radiation protection experts on any legislative initiative. Following this step, the Treaty foresees the consultation of the Social and Economic Committee of the European Parliament once the Commission has submitted its proposal to the Council. The European Council adopts new legislation by a qualified majority. Since the first Basic Safety Standards, Council Directives addressed to the Member States have been considered to be the most appropriate legal instrument, to facilitate transposition into national legislation. According to Article 161 of the Treaty, a Directive is binding on the Member States with regard to the results to be achieved but leaves the national authorities the choice of the form and methods.

Article 33 of the Treaty foresees that Member States shall communicate to the Commission all draft legislation implementing EU radiation protection legislation. In order to ensure a harmonised approach within the EU, the Commission may issue recommendations on Member States’ draft provisions.

3. THE BASIC SAFETY STANDARDS

The major reason for initiating the revision of the 1980 Basic Safety Standards [2] was to bring European radiation protection legislation into line with the 1990 ICRP Recommendations No 60 [3]. Important new features of the ICRP No 60 Recommendations made it necessary to develop a new structure for the Directive. Therefore, the latest BSS Directive (96/29/EURATOM) [4] does not simply amend the former legislation but it repeals the 1980 and 1984 Basic Safety Standards Directives [5].

3.1 Extended Scope of the Standards

The ICRP had introduced a fundamental distinction between practices and intervention. Practices are defined as human activities that can increase the exposure of individuals to radiation from a source, and interventions are to be seen as human activities aimed at preventing or decreasing the exposure of individuals. An important feature of the 1996 Basic Safety Standards Directive is that, unlike ICRP, a distinction is made between three situations: practices, work activities and interventions. Work activities are activities involving the presence of natural radiation sources.

3.1.1 Practices

By definition of the Directive, practices relate to artificial radiation sources or to natural radiation sources where radioactive substances are processed for their radioactive, fissile or fertile properties.

3.1.2 Interventions
Intervention situations are now dealt with much more explicitly than before. Intervention situations account for radiological emergencies and for lasting radioactive contamination resulting from past practices or work activities.

3.1.3 Work activities

The extended scope of the Directive now includes human activities involving natural radiation sources. The structure of the Directive is such that, a priori, all work activities are within the scope of the Directive. It is up to Member States to identify, by specific surveys, which work activities are of concern and may require appropriate forms of regulatory control. Such flexibility is necessary in view of industrial or geological particularities of the different Member States. Most of them must set up a new legal framework for this purpose and have little experience with the regulation of natural radiation sources. The Directive specifies that consideration has to be given to terrestrial natural radiation sources, including exposure to radon gas, to work activities involving ores or residues containing enhanced levels of natural radioactivity and to cosmic radiation during the operation of aircraft. It is for the Member States to decide whether a particular human activity is fully or partially covered by the scope of the Directive.

3.2 General Principles

3.2.1 Justification

The Directive requires that all practices shall be justified in advance and existing practices may be examined again. Justification is a complex issue and may include factors that are wider than those directly related to radiological protection.

3.2.2 Optimisation

If the practice is justified, the optimisation principle is of primary importance for radiological protection whether at design or at the operational stage. The operational application of the ALARA principle has lead to the introduction of the concept of dose constraints. The key to successful implementation of the optimisation principle is a strong commitment at the management and operational level. This commitment has to be translated into the allocation of responsibilities among key personnel and into training and education programmes. The application of the ALARA principle requires judgement based on common sense and experience.

3.2.3 Dose Limits

An important new feature of the BSS Directive is the reduction of annual dose limits. The Directive introduces the ICRP concept of effective dose and requires uniform methodologies for the estimation of doses to be applied. The new concept of a 5-year average dose limit of 100 mSv and a limit of 50 mSv in one single year within this period is reflected in the BSS Directive. However, the Directive leaves the freedom to Member States to introduce an annual dose limit. About half of the Member States have made use of this option and introduced a 20 mSv annual dose limit.
3.3 Operational Protection of Workers

The BSS Directive requires for any practice involving ionising radiation that operational control should follow a structured approach. In Title VI, the Directive gives the individual steps of the procedure. It stipulates that the routine and reasonably foreseeable potential sources of exposure are to be identified. The realistic magnitude of expected doses shall be estimated and subsequently the radiological protection measures necessary to satisfy the optimisation principle shall be determined. In order to meet the ALARA principle, the creation of an operational radiation protection programme, commensurate with the radiological risk, is necessary to ensure effective management of the protection measures. This also requires periodical appraisals of the programme with the aim of identifying overlaps and room for improvements. The intervals should be dependent on the practice and the magnitude of doses and associated risks. Maintaining the control of the radiation source and of the occupationally exposed workers is an essential function of the management. There are two major mechanisms that help to achieve this goal: the classification of workplaces and the categorisation of workers.

3.3.1 Classification of Workplaces

One well established mechanism is the use of designated areas. The ICRP Recommendations describe the concept of designated areas, which is broadly reflected by the Directive. The Directive requires the classification of workplaces into controlled and supervised areas based on estimates of possible radiation doses, the expected frequency and possible consequences of incidents including the spread of contamination. It is important to note that the Directive now places reduced emphasis on the level of dose and on any derived dose rate for the definition of the boundaries of supervised or controlled areas, and rather puts responsibility on the operator for the classification and delineation of working areas.

According to Article 18 of the Directive, it is not necessary to make special arrangements where the annual dose is not liable to exceed 1 mSv per year.

3.3.1.1 Controlled areas: Controlled areas are locally limited zones subject to specific procedures and working rules to which access is controlled and only permitted to workers who have received appropriate instructions. Specific arrangements and procedures shall be made for the purpose of preventing the spread of radioactive contamination. The Directive requires that competent authorities shall establish guidance on the criteria for classification of areas and that operators shall keep the working conditions under review.

3.3.1.2 Supervised areas: Workers may receive doses above 1 mSv outside controlled areas and therefore working conditions shall be kept under surveillance. For this purpose, the Directive lays down specific provisions for areas within which a worker is liable to receive an annual dose in excess of 1 mSv. This area shall be designated as supervised and the working arrangements and conditions shall be kept under review.

3.3.2 Categorisation of Workers

The BSS Directive requires that for purposes of monitoring and surveillance a distinction shall be made between two categories of workers on the basis of possible exposures. ICRP 60 Recommendations and the BSS Directive identify three major grounds for the decision to provide individual monitoring. The primary factor is the expected level of doses or intakes, secondly the likely variation in the doses or incorporation of radioactivity and finally the complexity of the measurement techniques. In this context, the assessment of internal doses is more difficult than that of external exposures.

The distinction between categories of workers as laid down in the Euratom BSS is not shared by the ICRP or by the International Basic Safety Standards (IAEA, Vienna). It is not recommended by the International Labour Organisation either (Convention No 115, the Recommendation No 114) [6]. However, the concept of the EU Basic Safety Standards does not introduce any discrimination in
terms of the level of protection afforded to workers and is highly effective in connection with the classification of workplaces.

3.3.2.1 Category A Workers: The concept of category A and B workers is thus maintained by all Member States of the EU as the basis for the purposes of monitoring and surveillance. Individual monitoring should be systematic for category A workers who, by definition, are liable to receive annual doses exceeding 6 mSv or 3/10 of equivalent dose limits for extremities.

3.3.2.2 Category B Workers: Category B workers should be subject to systematic assessment of individual doses based either on individual monitoring or the results of workplace monitoring. It is also appropriate to make generic assessments for groups of workers.

3.4 Record Keeping

The BSS Directive requires record keeping of individual exposures for both categories of workers during their working life and retained afterwards until the worker would have attained the age of 75 years but not less than for 30 calendar years from the termination of work as a classified worker. Also required is the record keeping of results of workplace monitoring used for the estimation or assessment of individual doses.

3.5 Medical Surveillance

Regular medical surveillance of the workforce forms part of the general occupational health policy and related national rules and regulations. Supplementary to these general rules, the medical surveillance of workers occupationally exposed to ionising radiation requires specific examinations in relation to working conditions. On that basis, the medical practitioner has to decide for each category A worker on his fitness for the tasks assigned to him. The Directive provides that workers shall have access to their medical records including dosimetric results. The BSS Directive provides specific requirements for occupational radiation protection of women. While the risks associated with exposures to ionising radiation are similar for women and men, there is a particular risk for the unborn child. The BSS Directive therefore recognises special radiation protection requirements for pregnant and nursing women.

4. OUTSIDE WORKERS DIRECTIVE

Council Directive 90/641/Euratom [7], on the operational protection of outside workers exposed to ionising radiation during their activities in controlled areas provides for a binding set of rules aimed at supplementing the Basic Safety Standards Directive (80/836/EURATOM). The purpose of this Directive is to ensure at European Union level that the radiological protection situation for temporary contract workers is equivalent to that offered to those workers permanently employed by the operators of the controlled areas. The Outside Workers Directive requires prior reporting and authorisation for outside undertakings and introduces requirements additional to the fundamental principles for the operational radiological protection of workers. It is important to underline that the Directive is not only applicable to the nuclear industry, but covers all work sectors where controlled areas are operated in the sense of the Basic Safety Standards Directive. Since the adoption of the Outside Workers Directive, the working arrangements for workers in all sectors have considerably changed. As a consequence of the completion of the internal market, an ever-increasing number of workers perform their activity consecutively in Member States other than the one where their employer is legally registered. Self-employment is another form of employment situation that allows more flexibility and is therefore attractive to specialists and experts in specific work sectors. For these and other reasons (reference to Directive 96/29 rather than 80/836) a revision of the Outside Workers Directive is currently being considered.

5. IMPLEMENTATION
The Euratom Treaty provides specific instruments for ensuring the correct transposition of measures into national legislation (Article 33 requires Member States to transmit legislation in draft, so that the Commission can make appropriate recommendations). A key element in the successful implementation of the EU radiation protection policy is the additional guidance provided by the Commission to stakeholders at all levels. In order to provide guidance for the implementation of the Basic Safety Standards Directive, the Commission published a Communication [8] and specific recommendations for the implementation of Title VII of the Directive on natural radiation at workplaces [9]. Under the Euratom Treaty, the European Commission also sponsors a considerable research programme. Furthermore, the European Commission has launched several projects directly linked to the operational implementation of the BSS Directive.

5.1 Transposition

Within the European Union, the Member States were obliged to complete the transposition of the 1996 Basic Safety Standards before May 2000. The full implementation and integration of the new radiation protection concepts into national regulations is now finalised to a great extent. Additional to the ongoing activities in the current Member States, ten Central and Eastern European countries will join the EU in 2004 and have to demonstrate to the European Union that they have correctly adopted all EU radiation protection legislation at the foreseen date of entry.

5.2 Operational Projects

5.2.1 ALARA Projects

The implementation of the optimisation principle has been the central point of the activities of the Radiation Protection Unit for more than two decades. The ALARA network [10], conferences on radiation protection optimisation, ALARA workshops and a series of ALARA training courses were initiated. The results of dose assessments to workers in particular sectors identified a considerable number of opportunities for improvement of practices. The EC has recently initiated the creation of a European ALARA Network in the non-destructive testing sector. Apart from the radiation protection sector, the European federation of non-destructive testing EFNDT and representatives from non-destructive testing utilities are represented on the steering committee.

5.2.2 Job-related Doses in NPP

During the late 1970s, the European Commission received information about a considerable increase in radiation doses to workers in Nuclear Power Plants during operation and in particular during shutdown for refuelling and maintenance. In order to help the operators to implement the ALARA principle, the Radiation Protection Unit initiated a project aimed at promoting the exchange of information and experience between the operators and to provide them with feedback and information on good practice [11]. The radiation protection departments returned annually a commonly agreed questionnaire containing detailed information on collective and individual doses to workers assigned to defined jobs or departments during operation and shutdown periods. The Commission evaluated and analysed the data and discussed the results during an annual meeting with all contributors. According to the participating nuclear power plant operators, this project was of great value for the operational implementation of the ALARA concept and the reduction of doses to workers. In 1989, the Commission offered its co-operation with the NEA of the OCDE. This co-operation lead directly to the creation of the ISOE (Information System on Occupational Exposure: network co-sponsored by OECD and IAEA) project. Now, after 20 years of operation, the Radiation Protection Unit will finalise this project and publish the collected data, the analysis and statistics.

5.2.3 Occupational Exposure ESOREX

In order to identify the particular sectors where radiation protection of workers can be improved, the European Commission initiated the European Survey on Occupational radiation exposure, the ESOREX project. The aim of this multi-annual activity is to assist radiation protection competent bodies in Europe in the design and operation of national dose registers. Furthermore the individual
dose data monitored, registered and recorded provides an excellent tool to identify trends and developments in occupational exposures of all classified workers in Europe [12]. The project also assists the member States authorities in the implementation of the requirement, laid down in Article 38(5) of the BSS Directive, that Member States shall facilitate the exchange of dosimetric and medical data of workers between involved departments and services.

5.2.4 Accidents and Incidents EURAIDE

In the same context, the increasing number of registered mishaps or incidents involving radioactive sources initiated another important project. The Commission awarded a contract for a study on the feasibility of a European data and information exchange system on incidents and accidents involving radiation sources or substances in the industrial sector. The EURAIDE study showed there is a need for feedback and the exchange of lessons learned in this sector. There is room for harmonisation of recording and reporting procedures in European countries [13].

5.2.5 Protection of Aircrew, EPCARD

Radiation exposure of aircrew is one of the most complex occupational radiation protection areas. This multidisciplinary activity required considerable research before it was possible to identify the most appropriate methodology for the operational implementation of protection measures. Existing international conventions, multinational regulations and agreements as well as national air safety and transport rules had to be respected and incorporated into a final approach for the radiological protection of aircrew. The Commission supported the development of a computer code for the assessment of generic route dose data based on the most recent scientific findings. The EPCARD programme [14] is an excellent tool for the air industry and competent radiation protection authorities for the implementation of Article 42 of the BSS Directive on protection of aircrew.

5.2.6 Training and Education

Another important aspect of radiation protection is the role of the qualified expert. The BSS Directive makes many references to the role, the responsibilities and the tasks of these particular important actors. Therefore, the training and education is of great importance for the operational implementation of radiation protection. In this context, the Commission has recently commissioned a study assessing the Status of the Radiation Protection Qualified Expert in the EU Member, Accession and Candidate States. The study resulted in a fairly comprehensive overview of the present situation. It identified requirements to move forward to mutual recognition of qualifications and diplomas and revealed a wide interest in the establishment of a European Discussion Platform. Therefore, the Commission will initiate the creation of a European radiation protection training and education platform. This platform should form the basis for defining a methodology aimed at harmonising national radiation protection training and education and for a system of mutual recognition of diplomas and qualifications.

Pursuant to Article 3(c) of the EC Treaty, the abolition of obstacles to freedom of movement between Member States of persons and services implies the possibility of pursuing a profession in a Member State other than the one where these persons have acquired their professional qualifications. For those professions for which the European Union has not laid down minimum levels of qualification, Member States reserve the option of fixing their own levels with a view to guaranteeing the quality of services provided in their country. Currently the mobility of qualified radiation protection experts is very limited, due to restrictive national rules and regulations.

The expert group established under Article 31 of the Euratom treaty supervises this activity and provides for recommendations and advice for the creation of the planned European radiation protection training and education platform.

6. COMMON HEALTH AND SAFETY POLICY

 Radiation protection is an integral part of sound and comprehensive health and safety management. There are important general work place safety and public health concepts equally applicable to any
field of endeavour. Involved stakeholders already cope with health and safety policies that address all hazards, with radiation protection being part of the whole.
6.1 Conventional Health and Safety at Work

In 1989 the European Union issued the European Framework Directive on health and safety at the workplace [15]. The scope of this directive covers all forms of occupational hazards, and is also applicable to general work conditions of workers involved with ionising radiation. This Framework Directive was relevant to the revision of the radiation protection Basic Safety Standards Directive. A number of requirements of the Framework Directive overlay or directly overlap the scope of the BSS Directive, such as general risk assessments, engaging qualified experts and occupational medical surveillance.

Systematically, Member States regulate at national level activities involving ionising radiation by regulations dealing mainly with non-nuclear practices. Frequently, the scope of national transport regulations, social law, workplace safety requirements, norms and safety standards for industrial activities and products cover activities involving ionising radiation. The protection of workers against the dangers arising from ionising radiation is not an isolated subject in workplace safety and worker health policy. It is part of a package of regulatory measures and actions taken in the industrial, social and health policy sector.

Therefore, radiation protection in industry, education, research and medicine has to follow these changes. Radiation protection in the future will be multidisciplinary, involving different interest groups and specialised services. In order to improve the overall health situation of workers exposed to ionising radiation, it is necessary to establish procedures both for management decisions and for technical advice, including training and information for workers.

6.2 Overlapping Safety Requirements: some examples

Mutual influence between radiological and non-radiological risks can be illustrated by some practical examples [16], [17], [18], [19]. The request to minimise exposure and to reduce radioactive waste may highlight ignorance of other regulations for safety at workplace. A worker who has to use special tools may decide to protect his tools against radioactive contamination. This change in the design of tools may be a cause of severe accidents.

Another example highlights the need, in some circumstances, for defining priorities and for managing simultaneously two risks, for instance the radiological one and an asbestos problem. During the decommissioning of a nuclear power plant it was found that the asbestos concentration in a controlled area was above the legal limiting value. Applying the regulations for asbestos removal and the implementation of radiological protection requirements may not be fully compatible. An in-depth analysis and ALARA procedure for reducing both the radiological risk and the risk from inhalation of asbestos requires a multidisciplinary approach involving players from different health and safety disciplines. There are several fields in industry where operational radiation protection measures may increase risks due to other physical or chemical agents.

On the other hand, workers’ health may be considerably improved if radiation protection measures are included in overall workplace safety regulations. In this context, protection measures aimed at preventing inhalation of exhaust gas during arc welding using Thorium electrodes will protect against inhalation of radioactivity as well as the inhalation of chemical agents. Similar approaches may count for handling Zircon sand. Radiation protection measures for preventing permanent body contact with sand sacks and protection against inhalation of radioactive dust also protects against orthopaedic lumbar disease as well as against hazards to the pulmonary tract of the workers.

Another example is the protection of aircrew. The requested change of working schedules of highly exposed aircrew may have a positive influence on overall safety because it may reduce health impacts due to stressful working hours.

One of the most discussed areas is Radon at workplaces. Protection measures against inhalation of Radon at workplaces may create a considerable economic burden on companies and are therefore sometimes not seen as justified. However, the ventilation of underground mines reduces not only the exposure to Radon gas but improves considerably the working atmosphere and consequently the health protection of the miners. Other working sectors such as spas or mineral water springs or drinking water supply facilities need careful examination of the Radon concentration and the subsequent protection measures to be put in place.
7. CONCLUSIONS

It is not an overstatement to say that the European radiation protection policy has contributed significantly to the achievement of the current high standard of radiological protection of workers and the general public within the European Union. The harmonised implementation of the EU Basic Safety Standards and the other radiation protection related Directives into national regulations is the result of continuous efforts of the European Union. In this context, the radiation protection policy of the European Union always followed promptly the recommendations of the ICRP.

Further pursuing international harmonisation and to make effective use of the available resources, the Commission co-operates closely with international organisations such as the IAEA, the NEA, as well as the ILO, ISO, IRPA and national radiation protection associations and organisations.

It must be emphasised that most workers are exposed to a wide variety of other risks. Consequently, the radiological protection issue will no longer be seen as isolated and disconnected from other developments in society, which is undergoing deep-rooted changes. One of these important developments in the industrial sector is the integration process of areas that have been historically separated from each other. Therefore, the subject of radiation protection in industry, education, research and medicine has to follow these changes. Radiation protection in the future will be a more multidisciplinary initiative involving different interest groups and specialised services. Natural radiation sources at workplaces are an excellent example for these developments.

Another problem for future radiation protection is changing working conditions. Mobility of workers, temporary work as well as self-employment may prompt a need for additional requirements for operational radiation protection. In this context, education, vocational training and information of workers and the role of the qualified radiation protection experts have to be carefully reconsidered.

The Commission, together with the other European institutions, will continue to co-ordinate scientific, social, economical and legal activities in support of future concepts aimed at maintaining and improving the already remarkable level of radiological protection for workers.

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