10th European ALARA Network Workshop

Evolution of ALARA in Europe: from the 80's to the Next Decade

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0 Introduction

This paper sets the scene for the 10th Workshop of the European ALARA Network (EAN). It is an opportune time to review the success story of the development of the optimisation principle, the part the EAN and its precursor collaborations have played, and to provide an overview of the challenges for the future. Current issues and ways forward will be developed in both the Papers and Working Groups. As in previous Workshops one objective is to produce recommendations to the EC, international and national bodies, and to other stakeholders.

One of the features of the history of EAN and its precursors has been its interaction with, and influence on, international organisations, by fostering networking. The timeline of developments and interactions is described in the body of the paper.

1 Early Development

The modern ICRP formulation of the Optimisation of Radiation Protection principle has its origins in the publication of ICRP 22 [1] and ICRP 26 [2] in 1973 and 1977 respectively. As might be expected the intervening 3 decades has seen significant development of the understanding and practical implementation of the Optimisation of Radiation Protection principle. The paper by Holm et. al[1] sets out the current thinking by ICRP. Over the last 3 decades the rate of development of practical implementation has varied both geographically and across the different sectors using radiation. A significant driving force has been Commission (EC) sponsored projects culminating in the development of the EAN and its evolution into a self supporting entity. To understand where we are now and the challenges for the future it is instructive to review these developments. The history prior to the establishment of EAN can be split into three periods.

1973 – 1982

This first period was mainly focused on theoretical aspects and an evaluation of possible quantitative decision aiding techniques, with most emphasis being placed on cost effectiveness and cost benefit analysis (CBA). This was reflected in ICRP publication 37 [3] and in the first European Scientific Seminar on Radiation Protection Optimisation in 1979. Given the general context of the seventies, characterized by the faith in operational research tools[2] and economics to found public decisions in modern societies, it was perhaps inevitable that the first approach to answering the perceived question of how low was "as low as

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1 Optimisation in ICRP recommendations - new Developments broadening the process: Lars Erik Holm, Wolfgang Weiss, et al

2 Operational science is a mathematical approach developed by engineers and statisticians in the second half of the 20th century.

reasonably achievable" turned into the exploration of economic formula? The desire to explore the uses of decision-aiding techniques, and particularly CBA inevitably required placing a valuation on the cost of avoiding a man-Sv of collective dose. The various attempts at this were contentious but did help to develop thinking about assessments of risks and the relative levels of risk compared to other areas. In retrospect this focus on theory perhaps inhibited engagement from those involved in operational radiation protection and produced a legacy image of the subject that was difficult to overcome.

1982 to 1987

The second period from 1982 to 1987 was mainly devoted to the development of a structured empirical approach to optimisation, the ALARA Procedure, within which decision-aiding techniques, if required, could be used. This procedure was first presented at an IAEA international conference in 1986 [4] and with further development became one of the first ALARA "tools" to be widely used. It is shown in Figure 1. The key elements are that

- it provides for both qualitative and quantitative inputs to decisions;
- these are only inputs and still require the decision maker to make a decision
- the whole process depends on identifying and assessing the relevant factors.

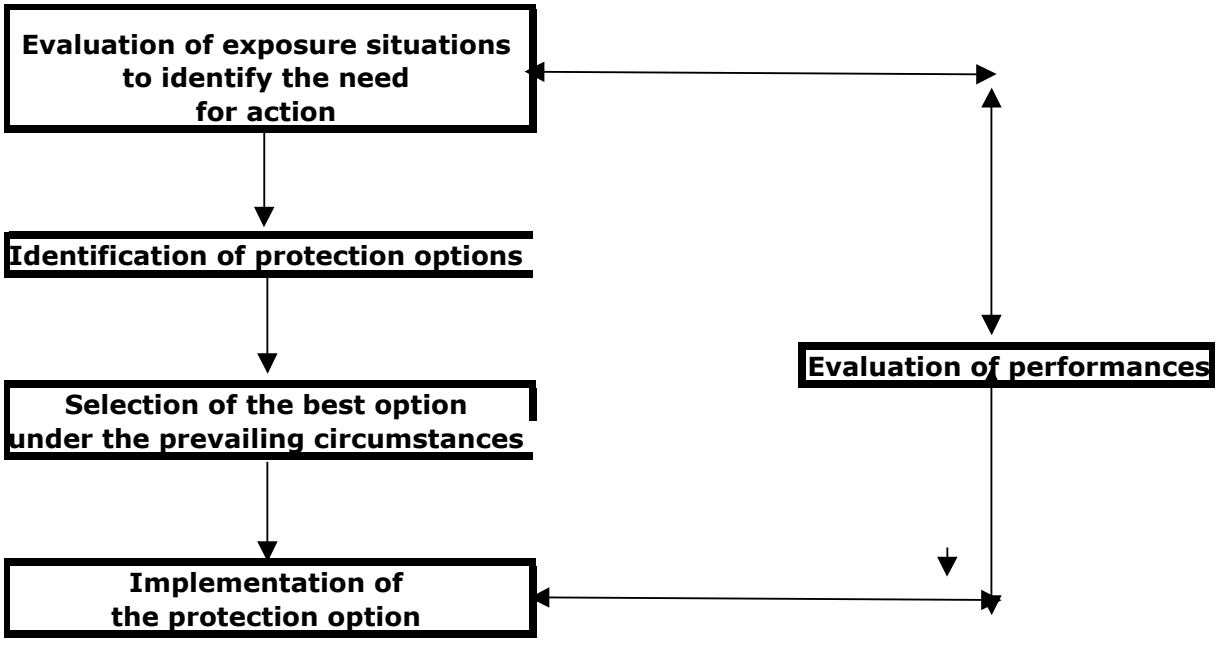

Figure 1: Schematic View of the Optimisation Process

The period also saw many case studies being carried out in a wide variety of installations both in relation to design and operational problems, but predominantly *a posteriori.* This work fed into ICRP's publication 55, Optimisation and decision making in radiological protection [5]. With some minor modifications the ALARA procedure was a key element of the document.

1987 - 1992

The third period saw the development of more pragmatic approaches and "tools". For example:

- 'ALARA Reviews' of radiation protection programmes. These use check lists or analytical trees as a basis and are similar in nature to 'safety tours' which look at a range of safety issues. Essentially they identify elements of the radiation protection programme that may not be optimal and warrant further investigation

- "Predictive ALARA Planning": This was a structured approach for ensuring that ALARA considerations were included in the planning of major projects, such as nuclear power plant outages. The key elements of this approach were

    - the planning of protective actions to achieve ALARA,
    - prediction of the doses involved with each of the tasks in the project, monitoring the evolution of doses and taking corrective actions if needed, and
    - the identification of feedback for future projects.

By the late 1980's, it was also becoming clear that, whilst the development of structured approaches provided 'tools' to pursue ALARA, this in itself did not achieve anything in practice unless there was a will to positively pursue the ALARA principle – in essence it required commitment from all those involved, nowadays usually referred to as the stakeholders. Clearly the commitment of management was a key point, but also that of the workforce and the regulators. In many cases it was a challenge for management to convey the commitment to the workforce. It required changing the culture of organisations through training and good management practices. Often this had a beneficial effect on safety in general and importantly on the operational efficiency. The commitment of regulators has also been important, as it is they who set the regulatory framework and can set the tone in how they enforce the regulations. Many regulators realised that the question "Have you done everything reasonably practicable to reduce exposure?" was a very powerful question – because it is difficult to prove that everything has been done!

In the second half of the 1980s and the early 1990s there was a number of driving forces that raised the awareness of the need for commitment to ALARA and its benefits. Perhaps the three most important drivers were:-

- Messages coming from ICRP that risk factors needed to be revised, which would tighten dose limits and put a downward pressure on dose distributions;
- The emergence, mainly in some nuclear facilities of real ALARA experiences (and a widening dissemination of the lessons learned from them) which clearly showed that it was reasonably practical to reduce doses, – providing there was commitment to ALARA, and,
- The setting up of new systems or studies aiming at providing statistics on individual and collective dose and occupational exposures distributions for benchmarking and better implementing ALARA - at nuclear power plants, such as the ISOE (International System on Occupational Exposure) system (NEA OECD/ IAEA in 1991)[3] - or in general, such as the EC projects which have led to the ESOREX system in 1997.

[3] The ISOE system was preceded by an EC database on occupational exposure in European NPPs since 1981.

The progress to date was brought together in the final report of the EC projects, which was published in 1991 as a book "ALARA: From theory towards practice" [6]. It included Case Studies and "boxed examples of many of the procedures and processes.
The format of the book was designed for it to be used as training material. As will be seen below it was both the product of, and input to, two series of training courses.

The above research programme of these early phases was supported by the EC, who also held four European Seminars on Optimisation [7,8,9,10] over this period, the last of which was in Luxembourg in April 1993. The evolution of the approach to ALARA can be traced through the proceedings of the four Seminars.

Optimisation Training Courses

As part of the above development process NRPB and CEPN proposed to the EC that they should develop a weeklong Optimisation training course, primarily targeted at the nuclear operators, but also appropriate for other large-scale users of radiation and for the regulators. These were separately funded by the EC and two such courses were run at the EC Research Centre in Ispra, Italy during the first half of the eighties. These were important events in the development of ALARA as they provided a two way process that both conveyed the developing thinking on the subject and in return got significant input from those "at the sharp end" who would have to practically implement ALARA. Indeed several of the participants of these courses went on to play a significant part in future research projects and the development of the EAN.

After a gap of a few years, these courses were restructured in 1990 to be more practically orientated and capable of being delivered across Europe. Courses were organised at Saclay (3 of them), France; Ringhals, Sweden; Karlsruhe, Germany; Madrid, Spain; Prague, Czech Republic and St Petersburg, Russian Federation. Over time these courses focused more strongly on work management approaches and the need for commitment. Again the feedback from these courses was a significant input to further research work and the concept of having a Network to share best practice and experiences.

EC Project 1992 – 1995

The EC funded a further research project on ALARA in Installations, starting in 1992, with SCK-CEN Mol, Belgium and GRS from Germany joining the team from NRPB and CEPN. The feedback from the optimisation training courses had identified a number of issues warranting further development. The key elements of the project were work on:

- ALARA and decommissioning: this built on the Belgian experience from their decommissioning of the BR3 PWR reactor at Mol. It reviewed various strategies for dismantling and the necessary data required to make sensible decisions
- ALARA and internal exposure: It had become apparent that whilst significant progress had been made on applying ALARA to external exposure, the same could not be said for the control of internal exposure. The key drivers were identified as greater uncertainty in mechanisms and scale of possible intakes of radioactive material, together with a perception, certainly amongst the workers, and some managers, that internal exposures were much worse than external and should be avoided at all costs.
- ALARA and Work Management: this developed the previously identified issue of commitment but also focused strongly on clearly identifying the factors affecting exposure, some of which were "human factors" (education, qualifications, experience

levels and communication between the management and the workforce. Another area investigated was work organisation (what is done where, when and under what ambient conditions).

- A new generation of ALARA tools:
  - A key element in preventing accidents and being able to mitigate the consequences is the ability to learn from previous mistakes. During the contract NRPB developed the Ionising Radiation Incident Database (IRID) [11] and subsequently CEPN developed a French equivalent Retour d'Experience sur les Incidents Radiologiques (RELIR) [12].
  - In decommissioning one of the main problems was lack of data on the radiation protection aspects of various decommissioning options. To address this SCK-CEN developed the DECOM database from their experience with BR3. GRS also provided relevant data.
  - OPTI-RP: there was a need for user-friendly software to enable non-specialists to use decision-aiding techniques. CEPN developed OPTI-RP basically focussing on cost benefit analysis (CBA).

The final report also looked at future challenges. It concluded that there was a need to disseminate the ALARA concept, culture and tools in a broader field than the nuclear sector (which had been the main focus) and that better focuses and mechanisms for the exchange and dissemination of practical experience were needed. It also proposed the establishment of a European ALARA network.

2- A Decade of the European ALARA Network

In 1996 the European Commission, took forward the recommendation from the research project and, within its 4th Framework programme of Research and Development (1996-1999), created the European ALARA Network (EAN). CEPN took on the role of the Network Co-ordinator with NRPB providing support. The key outputs were to be biannual Newsletters and an annual topical Workshop that was to provide recommendations to the EC and others. Over the next decade the EAN evolved in a number of areas which are elaborated as follows.

Over the earlier development phases and particularly through contacts made during the Optimisation training course, a network of individuals with expertise and enthusiasm had grown. These provided the core on which to build a more structured network. In developing the remit and structure of the network care was taken to build on individual interactions rather than organisational ones, to harness the motivation and drive that was essential in establishing a dynamic network that would progress. This is not to say that the organisations the individuals worked for, were not important. Indeed without them giving the time and effort of their staff, the EAN would not have existed. Similarly without the funding support from the EC, the EAN would not have developed beyond the initial state. It was the focus on the individual interactions that allowed speedy decision making on following up initiatives and reacting to evolving experiences.

2.1 Evolution of the EAN Objectives

The original objectives of EAN were:

- To promote the wider and more uniform use of optimisation techniques in the various fields of occupational application in Europe
- To provide a focus and a mechanism for the exchange and dissemination of information from practical experience and
- To propose topical issues of interest that should be subject of European meetings, workshops or research projects

These objectives have been progressively expanded. Similarly the scope of the Network, which was originally limited to improving occupational exposure in industry and research only, was expanded; first to include occupational exposure in medical and Naturally Occurring Radioactive Materials (NORM) areas, and then to other types of exposures as stated in the current signed terms and conditions (2005) [13]:

- To maintain, enhance and develop competence in radiation protection, with special emphasis on the implementation of the ALARA principle for occupational, public and patients exposures both in routine operations and emergency situations
- To contribute to the harmonisation of radiation protection policies and practices, particularly concerning ALARA, both at regulatory and operational levels within European countries.
- To contribute to the integration and effective co-operation of expertise in radiation protection that is available in the European countries;
- To cover all types of practices within the different sectors: nuclear, industrial (non-destructive testing), medical, research, and work with naturally occurring radioactive materials (NORM).
- To cover radiation protection themes relevant to all sectors, as well as themes specific to one or more sector(s).

2.2 Expansion of EAN participation

From the beginning, the operation of the network has relied on voluntary participation by individuals from institutions of different types: regulatory bodies, utilities, research teams, trade unions, etc.
Since 1996, the number of countries represented in the Steering Committee has increased from 8 to 19. The countries now participating are:

Table 1: Countries represented in the EAN Steering Group

Austria	Germany	Spain
Belgium	Greece	Sweden
Czech Republic	Iceland	Switzerland
Croatia,	Ireland	Netherlands
Denmark	Italy	United Kingdom
Finland	Norway	
France	Portugal	

During the first period (1996-2000), mainly experts in radiological protection from the regulatory bodies, research centres in radiological protection, and major utilities concerned

with the use of ionising radiations participated in EAN activities. During the second period (2001-2006) various other types of participants were invited and most of them are now regularly participating in the network activities. For example:

- representatives of professional bodies such as national and European societies for Non Destructive Testing, European Committee of Medical Radiographers and Radiological Technicians, Medical Physicians Associations, Medical Physicists Association,
- representatives of manufacturers of devices using ionising radiations
- representatives of manufacturers of radiation monitoring devices
- representatives of international organisations other than EC such as ILO, IAEA and more recently NEA OECD
- representatives of radiological protection training centres,
- some representatives of trade unions
- some representatives of NORM and NDT industries

2.3 Evolution of EAN products

From the beginning, EAN's most important events have been the **annual workshops** devoted to specific topics where it is thought that significant improvements are still possible and may be expected (see Table 2). Each of these events brought together between 70 and 120 participants with extensive personal experience, coming from many countries and with very different backgrounds and professions. The format of these workshops includes presentations and Working Groups that provide a forum for discussion of topics and identification of ways forward. The intention is to provide recommendations (about 10 per workshop) to each[4] category of stakeholders concerned with the topic. These recommendations are then widely distributed through the EAN website, the EAN Newsletters and publications in national radiological protection journals.

Table 2 The annual Workshops

Subject	Location and date
ALARA and decommissioning	Saclay, France, 1997
Good radiation practices in industry and research	Oxford, UK 1998
Managing internal exposure	Munich, Germany, 1999
Management of occupational radiological and non-radiological risks: lessons to be learned	Antwerp, Belgium, 2000
Industrial radiography, improvements in radiation protection	Rome, Italy, 2001
Occupational exposure optimisation in the medical and radio-pharmaceutical sectors	Madrid, Spain, 2002
Decommissioning and site remediation	Arnhem, The Netherlands, 2003
Occupational radiological protection control through inspection and self-assessment	Uppsala, Sweden 2004
Occupational Exposure to Natural Radiation	Augsburg, Germany, 2005
Experience and new developments in implementing ALARA in occupational, public and patient exposures	*Prague, Czeck Republic, 2006*
ALARA and waste management	*2008*

[4] International organisations, regulatory bodies, utilities, research centres, manufacturers, professional bodies, monitoring laboratories, trainers, … and the workers themselves

From the beginning EAN has also published the **ALARA Newsletter** twice a year (19 issues to date) to provide a link between all those concerned with ALARA. The newsletter is distributed through various channels, including national contacts, national radiation protection societies and the EC. All ALARA newsletters can be downloaded from the website. Feedback from different sources indicates that the Newsletters reach several thousand individuals or institutions, mainly in Europe, and that the lessons learned from incidents are among the most interesting information.

After one year of operation the EAN opened a **website** (http://www.eu-alara.net). This now provides access to electronic versions of the newsletters and the workshop papers, PowerPoint presentations, conclusions and recommendations. In 2001, about 30 individuals per day accessed the EAN website. In 2002 that number reached more than 130 individuals per day, and in 2005 - 2006 about 300 individuals per day. Around 550 different documents have been downloaded from the site (Newsletters, workshops presentations and SMOPIE [Strategies and Methods for Optimisation of Protection against Internal Exposures of Workers from Industrial Natural Sources] annexes mainly). Between five and ten presentations from each workshop have been downloaded more than 400 times and some (from the Workshops 3, 4, 6 on "internal exposure", "balancing radiological and non-radiological risks", "occupational exposure in the medical field and radiopharmaceutical industry") more than 2500 times (see Annex 2). The most recent issues of the Newsletter have also been downloaded between 2 and 3 thousands times.

By 2000 the EAN was a well-established network, therefore it was decided to make use of it as a vehicle to support **European surveys** on topics of interest to radiological protection. The first survey dealt with the actual implementation of the European BSS (2000)[14]. Its results were presented in Newsletter 9 in 2001; an update will be presented during this workshop. Other surveys dealt with the incidents data exchanges (2000-2002); the implementation of the EC Directive on Outside workers (2004-2005)[15]; their main results were also presented in the Newsletter. Finally, in 2003 and 2006, the Network was used for assessing its own effectiveness: the main results of which are presented in the next section.

Recommendations from the first few workshops identified a number of areas that the Network decided needed more in depth development. To address these it was also decided in 2001 to establish a number of working groups or sub-networks on topics that needed more than a workshop for reaching either in depth recommendations or developing some end products such as guidance, good practices book… The first of these, the **European ALARA sub-network on research reactors** (EASN) was set up in 2002. It was supported financially by the Commission during the fifth framework program of Research and Development and in 2005 became self-sustainable. In 2003 a joint working group between EAN and EFNDT(European Federation for Non-Destructive Testing) was set up to develop guidance for both the NDT companies and their clients. In 2006, the EC intends to support the creation of **European ALARA networks on NDT and NORM**.

In 2005 the **European Radioprotection Authorities Network (ERPAN)** was set up to deal with operational exchanges on regulation and control activities such as specific inspections and transcription of EC Directives into national regulations. Previously, in 2003, EAN served as a forum for discussing a radiological incidents and accident communication scale, proposed by the French regulatory body, that subsequently became the INES radiological protection scale [16], endorsed by the IAEA member states.

In 2006, a new **Working Group on ALARA Training** has just been set up at the request of the ENETRAP (European Network on Education and Training in Radiological Protection) research project to provide the Commission with the input of the EAN on what is needed at the European level as training and training material for improving the ALARA culture among concerned stakeholders within member and candidate states.

Two other suggestions from the EAN are now being progressed:

- the Commission has launched a call for tender to set up an **ALARA NORM Network**, and
- EAN is in discussion with other European partners (see section 4) to make a proposal for a **Medical ALARA Network**.

2.4 Evolution of the EAN organisation

As listed below the EC has provided funding to enable the Network to establish itself.

- The EAN was set up following a request of EC DG Research in its fourth framework program of research and development (1996-2000);
- support was continued during the 5th Framework Programme (FPRD 2001-2004).
- EC DG Environment supported financially the first three workshops; the financing of the following workshops was included in the research project of the fifth FPRD
- EC DG Environment also provided funding during a 12 months interim period between the 4th and 5th FPRD.

Since 2005 EAN has become a totally self-sustainable network both for its co-ordination costs and the organisation of the workshops.

The coordination itself has evolved from a quite informal organisation to something more formal, even if it remains very flexible. From the beginning the coordinator has been CEPN assisted by NRPB (today HPA). From 1996 to 1998 they were supported by a group composed of invited experts representing different fields of expertise and a number of European countries. In 1999 this expert group has become an expert Steering Group and in 2000 it became known as the EAN Steering Group with representatives from each country. However these representatives are not official representatives of the countries but are selected by the interested stakeholders in each country.

When EAN has become self-sustainable, the Steering Group unanimously adopted (in June 2005) a co-operation charter in order to keep the Network alive and ensure its self-sustainability. Currently 14 countries have decided to financially support its coordination while others support specific EAN actions such as workshops. A legal entity, not for profit organisation under the French law, has been set up as it was not possible to do this at the European level. The activities of EAN are described in its legal charter, as well as the roles of the coordinator, assistant coordinator, Steering Group, the national selection process (to be decided by the stakeholders in each country) of the Steering Group members. An Administrative Board is composed of the Steering Group members of the countries financing the coordination. It is also stated there that: “The network activities are open to each individual or institute, belonging to European countries, agreeing with the above-mentioned objectives. The participants participate to EAN activities on a voluntary basis.”

Finally, the EAN Steering Group has decided to establish more formal relationships with other European organisations. This now has been completed with ECRRT(European

Committee of Radiographers and Radiological Technologists) and EFOMP (European Federation of Organisations for Medical Physics) in the medical sector, as well as with EFNDT in the industry. These three organisations have accepted to participate to the program committee of this workshop, and the letters of intention from EFOMP and ECRRT, described common objectives for the future:
"EFOMP would like to manifest…its appreciation to the kind invitation made by EAN to act jointly in order to improve the Radiation Protection in the European Countries and will participate together with EAN to develop work or research projects in this area and particularly to facilitate the diffusion of a good radiological protection culture amongst all stakeholders concerned by medical exposures" and
"By the present we confirm that ECRRT/ISRRT will support and cooperate in the field of radioprotection with EAN in Europe".

3 Impacts and Lessons learned from EAN

3.1 A success story

Since 2000 the workshop recommendations have had a quite considerable impact (see in Annex 2 a more detailed description of such impacts). They have led to

- new international European projects (SMOPIE[5], EURAIDE[6]) with the participation of EAN members,
- some recommendations have been taken into account into the new ICRP draft recommendation[7], and
- they have initiated a continuous process of setting up new EAN sub-networks or new networks either composed of specific stakeholders (regulatory bodies) or devoted to specific sectors (Non-Destructive Testing, NORM, research reactors, etc).

These recommendations have also had many national impacts:

- modifications of national regulations and/or regulatory procedures[8],
- organisation of specific working groups between regulatory bodies and other stakeholders[9],
- development of specific monitoring devices[10],
- development of national radiological incident databases[11].

The effectiveness of these networks has been recognised at several IAEA international

[5] Strategies and Methods for Optimisation for of Protection against Internal Exposures of Workers from Industrial Natural Sources: a research project funded within the fifth FPRD following the first and third workshops recommendations.
[6] European Accident and Incident Data Exchange: a survey funded by EC DG TREN for the setting up of a new European system dealing with radiological incidents following the second workshop recommendations.
[7] Following a recommendation from the 9th EAN Workshop the paragraph 133 of the new ICRP draft, is directly related to the results of SMOPIE with respect to dose coefficients and low radon emanation.
[8] One of the most interesting impact has been the setting up by the Norwegian regulatory body of a long term national plan for improving radiological protection in implementing the recommendations from the previous EAN workshops.
[9] Many countries have set up such groups after the Rome workshop on "Industrial Radiography: Improvements in Radiation Protection" (5th) and the Madrid workshop "Occupational exposure optimisation in the Medical Field and Radiopharmaceutical Industry" (6th).
[10] For example EDF has promoted the development of an alarm device called "sentinelle" for advising worker when the source is not back in the container, following the Rome workshop on NDTs
[11] The French Society for Radiological Protection has set up the RELIR (feedback experience exchange system on radiological incidents) system after the second Workshop.

meetings (Geneva 2002[12]; Rabat 2003[13]). One of the targets of the International Action Plan on Occupational Exposure of the Agency is to support the spread of such ALARA networking all over the world in order to promote improvements in the radiological protection of workers. The EAN is represented in the Steering Group of that Action Plan and already participates as technical support and facilitator for a newly created network in central and Eastern Europe (RECAN) and a future network in south Asia and Pacific region.

The existence of EAN also provides a channel for the European Commission to perform surveys in Europe on its policy implementation or to reassess European radiation protection regulations. This has recently been the case for reviewing the Directive on Outside Workers.

What soon became noticeable during EAN lifetime was that the international network of the EAN provides a forum for discussions between stakeholders who otherwise would have little or no opportunity to interact. A typical example was the Rome workshop on "Industrial Radiography". This workshop brought together

- experts in radiological protection from international organisations, national regulatory bodies and research centres,
- representatives of non-destructive testing companies and of their clients,
- representatives of monitoring device manufacturers, training companies and trade unions.

In such an arena, where no binding decision has to be taken and where participants do not represent officially the "interest" of the institutions and countries they belong to (no "institutional" stake is directly at work), each stakeholder can listen to the "free speeches" of the others. As they all agree that the main objective is to reduce radiological risks for human beings, they try to reach consensual recommendations and generally succeed in doing so.

3.2 Reasons for success

EAN has been successful, and is still growing (number of countries participating, number of topics addressed, number of recommendations implemented, etc). One may wonder about the reasons for that success. To answer that question it is worth analysing the lessons learned from the networking experience. They may be summarised with a few words: personal links and communication, enthusiasm, flexibility and collective efficiency

3.2.1 Personal links and Communication

While most communication systems or procedures have been set up through institutional channels, the network favours personal links; it provides opportunities for communication between individuals, not institutions. It is able to introduce many "shortcuts", as it does not have to follow formal or administrative procedures. It brings together individuals with a common interest from the many types of stakeholders within EAN. It gives the opportunity to all these individuals to express their needs and to listen to each other.

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12 "International mechanisms for facilitating optimisation of occupational radiological protection, for example ALARA Networks- should be encouraged" [17]

13 The Rabat conference has stressed the importance of networking at regional levels, and the role from international organisations for supporting their setting up [18].

3.2.2 Enthusiasm

Experience shows that enthusiasm appears to be a real keyword for the success of the networks. This mainly comes from the fact that the network provides individuals with opportunities to put forward for discussion the real problems they encounter in their professional life, and together to try to find solutions to these problems. Therefore, enthusiasm is evident within all EAN actions, and tends to favour a bottom-up approach (workshops, work in small groups, web forum, panels. etc).

3.2.3 Flexibility

The network appears to be much more flexible at the international level than any other types of organisation. The EAN is quite independent, and can easily show its interest in new topics and involve representatives from new stakeholders according to the needs of the situation. No permission has to be requested; no formal rules have to be followed. Initiatives are easily taken, at least initially, in promoting new workshops, new groups, new sub-networks, new web-pages, etc. Of course, the main constraint remains the financing of some actions

3.2.4 Collective efficiency

By bringing together different types of stakeholders, or stakeholders from different countries, different backgrounds and different experiences, the network promotes the emergence of common solutions to problems that will take care of many, if not all, dimensions of these problems. These solutions tend to be easier to implement, as shown by experience from the networks participants, and therefore, have more chance of remaining sustainable.

3.3 Needed improvements

Many different categories of participants have been progressively integrated into the network, but it has been quite difficult to involve directly industrial workers/trade unions and representatives of small firms. For financial and practical reasons it is not easy to convince a manager to allow a worker to spend his work time in a workshop. Similarly it is not easy to convince the manager of a small firm to participate directly in such events. The answer may lie in using the power of the Internet and the use of panels.

The scope of the EAN has been progressively enlarged, starting from occupational radiological protection in industry and research only, and later on including occupational exposure in the medical, NDT and NORM sectors. At the beginning the other groups exposed to ionising radiation such as the general public and patients were not included within the EAN scope. However they have been introduced progressively through interfaces and synergies with occupational exposures. They are now fully in the scope of the new EAN, but they cannot be efficiently addressed without the active participation of new types of stakeholders, such as medical doctors who use ionising radiations, or representatives of the civil society, neither of which have so far had much interaction with EAN activities.

4 Looking for the future: challenges and possible answers

4.1 Some remaining long standing challenges

Medical sector

Medical exposure remains by far the largest component of man made exposure, both in terms of individual and collective exposure. Whilst some improvements have been made in reducing doses from well established techniques, the emergence of new technologies and the evolution of current techniques provides the potential to increase doses to patients and workers.
This places more emphasis on the appropriateness of medical Justification for exposures, involving medical professionals outside those normally involved and spreading the ALARA culture.

NORM

The scale of the problem, even if partly clarified during the 9th workshop, remains largely uncharted and needs to be further assessed. In most relevant industries, radiation exposure is thought to be a secondary issue and this emphasises the need for integrating radiological risk into a holistic approach. Finally, the exposure is mainly internal, and much has still to be done to provide adapted tools for dose assessment and management in an ALARA perspective.

Nuclear sector

While ALARA appears to be quite well integrated into the operational life of most nuclear facilities, there remains a challenge to effectively include ALARA into the design stage of the new generation of reactors and in the future Fusion cycle facilities. Another challenge is the implementation of ALARA for decommissioning in a context where uncertainty is a key aspect.

Non Destructive Testing sector

Even though there have been significant improvements in radiological protection in the gammagraphy industry during the last decade, it remains an area of high doses and risks. There are still differences between countries, in the effectiveness of the control measures and the ALARA culture. There is still significant potential to shorten the learning cycle for new organisations and countries with a rapidly expanding NDT sector.
Many countries are not members of any ALARA network, and the IAEA initiative to expand the availability of networks to facilitate the transfer of lessons and best practices provides the opportunity to avoid "reinventing the wheel".

Probabilistic risks assessment and management

While the ICRP has long established guidance on how to deal with probabilistic exposure situations within the optimisation of radiological protection process, there remain a lot of situations where the views of the different stakeholders (regulatory bodies, utilities, workers, public…) differ with regards to the probabilities of events. Uncertainties, as well, are a major topic of concern for the design of new installations and the decommissioning of the old ones. Practical and pragmatic approaches are still to be developed in these domains.

4.2 Some challenges created by a changing world

Improved security

Optimisation encompasses not just routine exposures but potential exposures arising from accidents etc. Typically this has involved judgements on resources allocated to design features of nuclear facilities or safety systems to prevent access to high dose rates versus the benefit of savings in potential doses. The potential threats from orphan sources or the deliberate theft for terrorist purposes has significantly increased the resources devoted to source security. In the vast majority of situations increased security can be obtained by better management systems and modest investments. However, there are some situations were there are balanced judgements to be made that may need to take into account risks other than radiological risks. In the extreme the particular use of radiation may no longer be justified. Similarly there is an expanding use of security measures using radiation based technologies. These bring with them justification and optimisation issues that the Network may need to address

Increased market competition

In a world of deregulation, competition appears to be a more and more stringent driving force. It impacts the resources allocated to radiological protection in most industrial sectors, including nuclear. This is a new challenge to be faced: how to ensure a good and improving protection of both workers and the public when financial and human resources are decreasing? Should it have an impact on the ALARA concept itself? How does the optimisation help facing that challenge?

Stakeholder involvement

The social and political contexts in terms of risk management no longer solely relies on the experts for assessing, evaluating and managing the risks. There is a strong social demand for finding ways of allowing individuals to participate to their own risks management, both for the workers and the public. Such an evolution is less evident in respect of patients. Therefore there is a need for finding appropriate means to allow stakeholders involvement in ALARA implementation.

Managing risk in contaminated lands

As a result of accidents, terrorists acts, or historical human activities society may have to face the management of contaminated lands and the risks for the human being living there. This is another challenge where optimisation of radiological protection should be implemented, taking care of quite new aspects such as the need to develop and transmit a “practical radiation protection culture” among the population facing a contaminated environment to allow each individual to behave day-to-day in a preventive way.

4.3 Possible answers to the challenges

4.3.1 A working group on ALARA tools

Even within a context where the procedural cost benefit approach has been complemented by other approaches favouring stakeholder involvement, there is a continuing need to have new adapted operational tools for managing in an ALARA manner the internal and external exposures for workers, public and the patients. These could address aspects such as dose and dose rate prediction, risk transfer, decision aiding etc. These should rely on the scientific knowledge and uncertainties, but as well should be adapted to the needs of the required information for a good management of the risk including stakeholder involvement.

4.3.2 A working group on ALARA training in Europe

Following the first ad hoc group set up in 2006, one may envisage in the following years that another group be set up to develop adapted training material for the industry, the medical sector and NORM. It will then be possible to build up new training sessions, maybe more focused on the new member states and the non-nuclear member states' needs.

4.3.3 To promote ALARA in the medical sector

As identified in section 4.1 there are a number of challenges in fostering an ALARA approach to some aspects of the medical sector. Arising from the experience of EAN members and on the excellent relationships with ECRRT and EFOMP, EAN will try to foster the establishment of a medical ALARA network. Particular areas of interest would be patient exposure and the use of new technologies, interventional procedures using X-Ray equipment outside the X-Ray departments, the management of radiological protection in major medical facilities and, for workers only, during the installation and maintenance of radiological equipment in the hospitals. This will need co-operation with many new stakeholders who have previously had only limited experience of developing an ALARA culture

4.3.4 To create a portal on ALARA and radiological protection in Europe

The success of the Website demonstrates that it is now fundamental to the aims of EAN. It is suggested that in the future it could evolve into a kind of "portal of radiological protection in Europe", where it should be possible to find documents, and references on national regulations, feedback on best practice, lessons learned from accidents, training material, statistics and a range of links to related subjects The use of the website to create forums for "on-line" discussions on radiation protection topics is already an on going process. It should also be worthwhile to use this to put radiological (occupational, patient and public) exposure risks into perspective with other risks.

4.3.5 To participate to initiatives concerning stakeholders involvement and set up a working group on workers involvement

Some forums[14] have been set up to exchange on, and learn lessons from, experiences dealing with stakeholder involvement. A recent IRPA initiative aims at developing for professionals a "code of conduct for stakeholder involvement in radiation protection"(Ref Salamanca workshop) ". EAN might be a partner for such initiatives making use of all its partnerships for facilitating different types of stakeholders to provide their input. Moreover, recommendations from several recent EAN Workshops have been **"to favour the involvement of the workers in their radiological risk management"**. Therefore EAN might create a working group for identifying and promoting new ways of involving the workers themselves into their occupational risk management. This might, for example, take different forms when dealing with nurses, aircrew, outside workers in the nuclear field, industrial radiographers or workers in the phosphate or mineral sands industries.

[14] For example by the NEA OECD or jointly by the British, French and Spanish societies of radiological protection;

4.3.6 To establish partnerships in Europe with other networks or organisations.

Some successful partnerships have already been established with international organisations such as EC, IAEA, ILO, WHO, NEA-OECD, the European Federation of Non Destructive Testing (EFNDT), the European Federation of Medical Physicists (EFOMP), the European Committee of Radiographers and Radiological Technicians (ECRRT), the ESOREX system. EAN should become a link between many other partners interested in one way or another in radiological protection: the European Radiological Society (ERS) and other medical Societies, the NORM industries professional organisations, the European Trade unions, some European training projects (ENETRAP, EUTERP…). Official co-operation letters of intention could be exchanged for promoting common actions, mutual recognition and information. Links should exist on the EAN website with description of the role and actions of each partner.

4.3.7 To enhance cooperation between regional ALARA networks.

It is clearly not the intention of EAN to support the setting up of a huge worldwide ALARA Network, as – contexts and problems to be solved are quite different from one region to another, - and as communication and human relationships between the members of a network should remain efficient and manageable. However, lessons learned from one region may be a good input for the others, therefore EAN is ready to participate to "ad hoc" cooperation with other regional networks.

Most European countries belong to EAN or RECAN [Regional European and Central Asian ALARA Networking], though Luxembourg still remains to be brought within the fold of EAN. An agreement has been signed between EAN and IAEA in order to strengthen the relationships between EAN and RECAN from the beginning and possibly even more so in the future. Other co-operations should be developed with potential future regional ALARA networks in the world. The IAEA and other international organisations (EC, NEA OECD) could facilitate such networking of networks to facilitate the emergence of new regional networks and then to help benefiting from each other experiences.

Conclusion

We can see how the precursor projects, administratively and financially supported by the European Commission had a significant impact on moving ALARA from a concept to an integral part of the day-to-day practice of radiation protection. This laid the foundation for the European ALARA Network, which over the last decade has provided a strong European focus for the development of best practice in pursuing ALARA. The Workshops in particular have proved to be a successful format for developing new initiatives and for issuing recommendations that have had, and are still having, a positive impact on radiological protection.

At this, the 10th EAN Workshop, we can celebrate a decade of positive impact of the EAN. However, we have to look forward to new challenges; and maintaining the enthusiasm and impetus necessary to meet these challenges. This paper has touched upon some of the possible ways forward, and we look forward to the Workshop identifying many strands of work for the future.

REFERENCES

[1] ICRP Publication 22, **Implication of Commission Recommendations that Doses be kept as Low as Readily Achievable**, Pergamon Press Oxford 1973.

[2] ICRP Publication 26, **Recommendations of ICRP**, Annals of ICRP 1(3) 1977, reprinted with additions in 1987

[3] ICRP Publication 37,

[4] IAEA international conference in 1986

[5] ICRP's publication 55, **Optimisation and decision making in radiological protection**

[6] **ALARA from theory towards practice**, EC report EUR 13796 EN DG Science,

[7] **Radiation Protection Optimisation: present experience and methods**, CEC proceedings of the European Scientific Seminar held in Luxembourg, 3 to 5 October 1979 Pergamon Press Oxford 1981

[8] **Radiation Protection Optimisation: As Low As Reasonably Achievable**, CEC proceedings of the second European Scientific Seminar held in Luxembourg, 8 and 9 November 1983 Report EUR 9173 EN, 1984

[9] **Radiation Protection Optimisation: Advances in practical implementation**, CEC proceedings of the third European Scientific Seminar held in Madrid, 12 to14 September 1988 Report EUR 12469 EN ; 1989.

[10] **Radiation protection optimisation: achievements and opportunities**, CEC proceedings of the fourth European Scientific Seminar held in Luxembourg, 20-22d April 1993 Report EUR 15234 EN, 1994. Research and Development 1991 four European Seminars on Optimisation [7,8,9,10]

[11] IRID V11

[12] RELIR CEPN R

[13] **Terms and conditions for the operation of the European ALARA Network (EAN)**, June 2005, Paris

[14] European BSS

[15] EC Directive outside workers survey CEPN R

[16] INES scale

[17] **First International Conference on Occupational Radiation Protection,** IAEA/ILO, Geneva, Switzerland, 26 to 30 August 2002

[18] **IAEA, ILO, WHO International Conference on National Infrastructures for Radiation Safety**, 31 August, 2 September 2003, Rabat, Morocco

[19] ICRP draft 2005

ANNEX 1. EVOLUTION OF EAN

Table 1. Members of the steering committee, by country, date of first participation and status

	Country	EAN SG member since	status
Initial members	BELGIUM	1996	Research Centre
	FRANCE	1996	Research centre in radiological protection
	GERMANY	1996	Regulatory body
	ITALY	1996	Regulatory body
	SPAIN	1996	Regulatory body
	SWEDEN	1996	Regulatory body
	SWITZERLAND	1996	Regulatory body
	UNITED KINGDOM	1996	Research centre in radiological protection
New members	THE NETHERLANDS	1998	Research centre in radiological protection
	NORWAY	1998	Regulatory body
	FINLAND	1999	Utility
	DENMARK	2000	Research Centre
	AUSTRIA	2001	Research Centre
	CZECH REPUBLIC	2001	Regulatory body
	CROATIA	2003	Technical dosimetry firm
	PORTUGAL	2003	Research centre in radiological protection
	IRELAND	2003	Regulatory body
	GREECE	2003	Regulatory body
	ICELAND	2006	Regulatory body

ANNEX 2. Number of Downloads for the top 40 downloaded files from the EAN website as of June 2006

1	EAN Newsletter13	3,152	1.97%
2	3rd Workshop O. Witschger	3,142	1.96%
3	4th Workshop An-Tornqvist	3,098	1.93%
4	EAN Newsletter14	3,030	1.89%
5	SMOPIE_Annex 3_Appendix1	2,826	1.76%
6	3rd Workshop P.Shaw	2,709	1.69%
7	EAN Newsletter 11	2,545	1.59%
8	6th Workshop HM Olerud poster	2,471	1.54%
9	6th Workshop Y Franken	2,407	1.50%
10	6th Workshop E Guibelade	2,218	1.38%
11	EAN Newsletter-12	2,194	1.37%
12	EAN Newsletter -15	2,115	1.32%
13	6th Workshop /J Fernandez	2,040	1.27%
14	6th Workshop F Zito	2,006	1.25%
15	3rd Workshop Erkens	1,930	1.20%
16	SMOPIE_Annex 2_	1,924	1.20%
17	6th Workshop /G Tosi	1,848	1.15%
18	6th Workshop G Tosi poster	1,846	1.15%
19	EAN Newsletter -10	v1,842	1.15%
20	3rd Workshop Mondini	1,779	1.11%
21	6th Workshop B Aubert	1,738	1.08%
22	3rd Workshop Simister	1,696	1.06%
23	SMOPIE_Annex 1	1,676	1.05%
24	6th Workshop M Whithy	1,587	<1%
25	3rd Workshop PosterVillanueva	1,517	<1%
26	2d Workshop Erkens	1,478	<1%
27	EAN Newsletter -5	1,478	<1%
28	3rd Workshop A.Van Weers	1,389	<1%
29	EAN Newsletter-1	1,366	<1%
30	EAN Newsletter-9	1,314	<1%
31	EAN Newsletter-8	1,286	<1%
32	4th Workshop An-Lierman	1,249	<1%
33	EAN Newsletter-7	1,226	<1%
34	6th Workshop Tosi poster n°2	1,225	<1%
35	4th Workshop -Holmes	1,225	<1%
36	7th Workshop_-S Mobb	1,206	<1%
37	4th Workshop -Dahle	1,188	<1%
38	6th Workshop J.Kopp	1,184	<1%
39	6th Workshop A.Widmark	1,169	<1%
40	3rd Workshop Lucci	1,166	<1%

ANNEX 3 IMPACTS of EAN

1. In Europe

During the second period of EAN's life, different stakeholders have implemented several recommendations from the EAN workshops. For example, these include:

1.1 International level

- The European Commission (DG RESEARCH) has supported and financed a new research project dealing with the management of internal exposure, the SMOPIE project(Strategies and Methods for Optimisation of Internal Exposure of workers from industrial natural sources) This project is co-ordinated by NRG from the Netherlands and the results are discussed at the EAN Steering Group. It deals with a totally new area for the Network: the NORM sector (naturally occurring radioactive materials).
- European Commission (DGENV) has decided to support EURAIDE (European Accident and Incident Data Exchange), a pilot study co-ordinated by the NRPB (UK). This pilot study will propose a management scheme for a radiation accident and incident data exchange system at the European level.
- European Commission radiation protection has supported financially the third, fourth and fifth workshops after recommendations from the first and second workshops.

1.2 National levels

- After the first Workshop (ALARA and Decommissioning), in Belgium, a working group for decommissioning of accelerators has been set up at the level of universities to take care of the recommendations. In Sweden several ideas from that Workshop were used when writing "Regulations on Planning for and during Decommissioning of Nuclear Facilities."
- After the second Workshop (Good Radiation Practices in Industry and Research), the French society of Radiological Protection has set up a network to provide lessons learned from occupational radiological incidents (RELIR), a new regulatory system to follow up incidents have been set up in Norway. Since then, the regulatory bodies in Austria, Switzerland and the Netherlands, as well as AVN in Belgium, are investigating solutions to create such systems. The Workshop also provided the impetus for the continuation of the IRID system in the UK, and the wider dissemination of the lessons learned from accidents via the NRPB website. A number of other issues raised at the second workshop, relating to good radiation practices, were taken into account in the subsequent revision of UK regulations. It is also noticeable that the French regulatory body has asked the new RELIR network to provide comments and advices on its new communication scale on radiological incidents and accidents.
- After the third Workshop (management of internal exposure), in Germany parts of the recommendations from the third Workshop have been introduced into regulatory guidelines (for example, the Draft guideline on the "Physical radiation protection control-incorporation monitoring"). The improvement of the management of internal exposure is also considered as an issue in the Netherlands since that Workshop. In the UK, the regulatory authorities have commissioned further studies into the dosimetric data applied to intakes of NORM, with the eventual aim of incorporating this into regulatory guidance.
- The fifth and sixth Workshops (respectively on Industrial Radiography and on Medical occupational exposure) have had an impact on many stakeholders behaviour in several countries. The regulatory body in Czech Republic now organises seminars with Non Destructive Testing companies, using the material from the fifth Workshop, this has led to an improvement of co-operation between these partners. That Workshop has also influenced the discussion of the authorities with the Dutch radiographers. The regulatory body in the Netherlands intends to integrate some recommendations from both workshops into guidance. In Italy, the medical health

physicists often refer to the sixth Workshop and in Sweden an analysis of the doses taken by personnel in the medical field is scheduled following that Workshop. In Germany, the Rome Workshop has intensified the co-operation between the German Society of Non-destructive Testing and the ALARA Network; this is considered as very important for harmonisation concerning safety of equipment and development of practical requirements; it is expected to lead sooner or later to the development of specific German guideline on "Safety in Technical Radiography".

- Furthermore, the new regulations in Norway now address more clearly the need for competence in radiological protection, following recommendations from several workshops.
- Following the 8th workshop, the licensing requirements from the Irish regulatory body have integrated the need for a self assessment procedure. Following a recommendation from that workshop a sub-network of regulatory bodies has been set up.

2 Outside Western Europe

Looking at the format and results of the EAN, the International Atomic Energy Agency of the United Nations, has started a process to set up similar networks in other regions in the world. The first of these other networks is the CEEAN (Central and Eastern European ALARA Network), which has been established in April 2002 with the participations of Armenia, Estonia, Belarus, Latvia and Lithuania. IAEA supports a member of the EAN Steering Committee to participate to CEEAN meetings and vice versa. The CEEAN has been replaced by the RECAN in 2006. Another regional network is planned in the South Asia and Pacific Region.

The ICRP is studying some request from EAN concerning the provision of adapted dose coefficients for the NORM area following a recommendation from the 9th workshop.