The Evolution of Networking in radiation protection:

From health physics professionals expertise to all concerned stakeholder's involvement.

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Abstract. The 90's have been characterized by new development of standards, socio-political and technological evolutions which both have had an impact on the radiological risk management. That evolution has induced (and led to) the emergence of a second generation of networks in radiological protection, after the first one composed of the national radiological protection associations set up after the Second World War. Two of the first networks from that second generation are the International System on Occupational Exposure (ISOE) and the European ALARA Network (EAN). Their success has led the international Agencies (IAEA, ILO, WHO) to support the setting up of ALARA networks in other regions of the world. Since less than five years other types of networks putting together different types of stakeholders have been set up on different geographical bases from worldwide networks to very local ones; they sometimes cover a specific topic (training for example) or a specific domain (cardiology for example), they are more often multi topics and multi sectorial; they are always relying on communication and exchanges through direct contacts, most often complemented by emails, web sites and forum…

KEYWORDS: Networks, ALARA, Stakeholders, History

1 . Introduction: before the 90's

Since the end of the fifties[2], and during the following decades[3], many national associations of health physics practitioners coming from all sectors of activities (research, industry, medical, regulatory bodies,) have been set up; they all came together at the international level in the International Radiation Protection Association (IRPA) in 1964. In parallel, during the same period, the medical health physicists, who were already members of the previously mentioned health physics associations, felt the need to set up their specific national and international professional associations. This has led in 1963 to the establishment of the International Organisation for Medical Physics (IOMP). Both health physics and medical physics associations were and have traditionally mainly focussed on following up the scientific knowledge evolution on the one hand and on discussing dose and dose rate measurement technologies on the other. These associations, particularly the medical physicists, also often act as promoters for their own profession in the different sectors.

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2 The Health Physics Society in the United States has been set up in 1956

[3] The Japanese, UK and French Societies have been set up respectively in 1961, 1963 and 1965

All other users of ionising radiation have their own groups, associations and networks, in some cases for a very long time (radiologists, workers trade unions in the industry …since the beginning of the 20th century), or more recently following the development of new technologies (nuclear medicine doctors, non destructive testing companies associations … after the second world war or even later). In many cases, these groups put only little emphasize on radiation protection[4], and set up only few links concerning that topic with the other stakeholders.

Moreover one can say that most associations, both health physicists' ones and others were not particularly dealing with low dose risk management and decision-making in maintaining exposures ALARA.

Finally, up to the 90's, radiological risk management has mainly remained a procedural top-down approach relying especially on the health physicists' expertise and characterised by the three words: time, distance, shielding.

2. Evolution of the context during the 90's

The 90's have been characterized by new developments of standards as well as socio-political and technological evolutions which all have had an impact on the radiological risk management. From the standards point of view, ICRP, IAEA, EC and national authorities have in particular largely developed the concept of ALARA[5] and how to implement it. From a socio-political point of view, that period has seen the increase of the so-called stakeholders demand in participating to many collective and individual decisions processes when dealing in particular with risks' management. From the technological point of view that period has seen the emergence and wide diffusion of totally new communication means such as web and emails.

As for the evolution of the radiation protection system rationale, ICRP took note of these tendencies in its recommendations, in particular in ICRP 82 (1999)[6] the socio-political and cultural considerations were recognised as usually influencing the final decision on the level of protection and as a consequence, the participation of all relevant stakeholders in the decision making process rather than only the radiation protection specialists was encouraged. More recently, in ICRP 101[7] the Commission now considers that *"the involvement of stakeholders is seen as an important input to the optimisation process"* because it *"reinforces the safety culture and introduces the necessary flexibility in the management of the radiological risk that is needed to achieve more effective and sustainable decisions"*.

Following the evolution of the global context, radiation protection in practice is now relying on a fourth term "stakeholder[8] commitment" and the technical evolution has favoured the emergence of new types of networks as an adequate and modern answer to the above-mentioned socio-political demand.

3. The emergence of a new international networking during the 90's

At the beginning of the 90s, taking into account the above-mentioned evolutions and in particular the important role of communication and feedback exchanges in facilitating the optimisation of

[4] However, one has to remind that the radiologists were, in 1928, at the origin of the International Commission on Radiation Protection, at a time when only deterministic effects were well known for professional exposures.
[5] ALARA is an acronym for « As Low As Reasonably Achievable », which means that all exposures shall be kept as low as reasonably achievable. It is the wording of the optimisation of radiological protection that is the main principle in ICRP recommendations.
[6] Protection of the public in situations of prolonged exposure; ICRP Publication 82; Ann. ICRP 29, 1999
[7] The optimisation of radiation protection: broadening the process ICRP Publication 101 Part2 Ann. ICRP 36
[8] Stakeholder as defined by ICRP-101 Part 2, page 86: « those parties who have interest in and concern about a situation »

occupational exposures, the OECD Nuclear Energy Agency (NEA), the International Atomic Energy Agency (IAEA) and the European Commission (EC), have set up *ad hoc* stakeholder networks with the help of some research teams in France (CEPN), the UK (NRPB) and the US (BNL ALARA Centre). The first two networks, focussing on the diffusion of a good radiation protection culture among all stakeholders concerned by occupational exposure, are described below. A third network set up at the same period by the World health Organisation (WHO) is also described.

3.1 The International System on Occupational Exposure (ISOE)[9]: a worldwide "sector-specific" network, mainly devoted to radiation protection specialists

ISOE was created in 1992 by the NEA to provide a forum for radiation protection experts from both utilities and national regulatory bodies to share occupational exposure data and good practice, and to discuss, promote, and co-ordinate international co-operative undertakings in the area of worker protection at nuclear power plants (NPPs). The NEA and the IAEA now promote and sponsor the ISOE Programme. The objective of ISOE has been more precisely defined in its Terms and Conditions as:

"…To make available to the participants:

- Broad and regularly updated information on methods to improve the protection of workers and on occupational exposure in nuclear power plants; and
- A mechanism for dissemination of information on these issues, as a contribution to the optimisation of radiation protection."

The first element of achieving this objective was to create a worldwide, occupational exposure database was created, drawing on the experience of the EC dose-job related System. ISOE now collects data from more than 90% of all operating commercial reactors in the world, and is expanding to include reactors in decommissioning. The database includes information on annual collective dose at the level of plant, job or occupational category, and has proven to be very useful in identifying trends and at promoting improvements. However, from the beginning it was apparent that a database was not enough to fulfil end users' needs. As such, ISOE included a communication network, organising direct contacts between the radiation protection managers and regulatory bodies, not only to collect data, but also to share experience. This emphasis on communications and shared practices was then expanded in the form of international ALARA symposia, which brought together Radiation Protection experts from NPPs and from regulatory authorities, but also from contractors and vendors. Originally these symposia were alternately organised in Europe and in the US, but their success has lead to their organisation in the other regions of the world. The International ALARA Symposium has proven to be very successful, providing a forum for the exchange of practical information and experience, now including a specific session for discussions among NPP radiation protection managers, and another session for regulatory bodies. In addition to these annual meetings, more day-to-day requests for information have been handled through email among ISOE members since the programmes inception.

Looking at the evolution of ISOE over its more than fifteen years of life, one can see that the system mix of top-down (databases, software, etc) and bottom-up (workshops, *ad hoc* meetings, email forums, etc) approaches is a success, and though ISOE is relatively decentralised, it remains a quite formalised network. In order to better serve its stakeholders, a recent evolution has been towards more fluid and dynamic communications in a bottom-up fashion, in particular in making more use of web-based on-line access to ISOE information, and providing all participants with more user friendly forums, with an ALARA library and easy to handle lists of contacts from all over the world.

What has been noticeable from the beginning within the ISOE system is that **a world community of**

[9] More information on ISOE is available on the website: www.isoe-network.net

NPP and regulatory bodies radiation protection professionals exists; they are facing the same type of problems in their day-to-day working life, and they have limited opportunity to get together, particularly with colleagues from abroad[10]. The establishment of an international network has, despite the language barrier, provided them with the possibility of addressing their actual problems directly with others, directly receiving quick answers and opinions from others (within less than two weeks in the email forum system, in real time in the small group discussions or during *ad hoc* days), to learn from each other and avoid the duplication of problems already encountered.

3.2 The European ALARA Network (EAN)[11]: a regional multi-sectorial network open to all types of stakeholders

In the mid 90's ALARA was no longer considered as a subject for fundamental research, and there was a need for a European support for spreading ALARA among all sectors and countries, finding solutions adapted to very different situations for its practical implementation. Therefore, in 1996 the European Commission, within its 4th Framework programme of Research and Development (1996-1999), created a European ALARA Network (EAN) and continued to support EAN during the 5th Framework Programme (2001-2004). Since 2005 EAN has become a self-sustainable network.

From the beginning the network has been relying on a voluntary participation from individuals and/or 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 20. The scope and objectives of the network have been progressively enlarged. The initial focus was on improving occupational exposure in industry and research (mainly through initiating proposals and facilitating cooperation on ALARA implementation). This was expanded to include medical and Naturally Occurring Radioactive Materials (NORM) areas and now covers the optimisation of radiation protection of all types of exposures: workers, public and patients.

The most important events of EAN are the annual workshops devoted to specific topics where it is thought that large improvements are still possible and may be expected (see Table 1). These events brought together a few dozen participants with extensive personal experience, coming from many countries and with very different backgrounds and professions, **including health physics professionals and other types of stakeholders**. These workshops provide a significant scope for work in groups with direct exchanges. They are designed to provide recommendations (about 10 per workshop) to each[12] category of stakeholders concerned with the topic. These recommendations are then widely distributed through the EAN website, the EAN Newsletters and publications in national radiation protection journals.

[10] See in particular the testimonies of participants in « ISOE; Ten years of experience » document NEA/OECD, 2002

[11] More information on EAN is available on the website: www.eu-alara.net

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

Table 1: The annual EAN 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 radiation 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, Czech Republic, 2006
ALARA in radioactive waste management	Athens, Greece, 2008
ALARA in the Safety and Security of Radioactive Sources	Vienna (Austria), 2009

Since 2000 these workshops' recommendations have had a quite considerable impact. They have led to new European projects (SMOPIE[13], EURAIDE[14]) with the participation of EAN members, and they have initiated a continuous process of setting up new EAN sub-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,
- Organisation of specific working groups between regulatory bodies and other stakeholders,
- Development of specific monitoring devices,
- Development of national lessons learned from incident databases.

What became noticeable quite soon with EAN is that such an international network provides an exceptional opportunity for discussions with stakeholders who have no other place to do it. The example of the Rome workshop on "Industrial Radiography" is typical: this workshop brought together experts in radiation protection from international organisations, national regulatory bodies and research centres with representatives of non-destructive testing companies and of their clients, as well as with representatives of monitoring device manufacturers, training companies and trade unions. In such an arena, where no decision has to be taken, where no "institutional" stake is directly at work, each stakeholder can listen to the "free speeches" of the others; as they generally 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.

[13] SMOPIE: Strategies and Methods for Optimisation for of Protection against Internal Exposures of Workers from Industrial Natural Sources.
[14] European Accident and Incident Data Exchange

Finally, one important criterion for measuring EAN success has been and is still the willingness of the participants to financially support its coordination since the EC has decided not to do it anymore.

3.3 The Radiation Emergency Medical Preparedness and Assistance Network (REMPAN)[15]: a worldwide -topical network

A new concept of international cooperation in radiation emergencies was implemented after the Chernobyl accident. The WHO established in 1987 a network of medical and research institutions specialized in the various fields of medical and public health response to radiation emergencies, which was in fact developed during the 90's. Today, more than 20 years after, the WHO Radiation Emergency Medical Preparedness and Assistance Network (**REMPAN**) became a 42-centre global worldwide network that maintains regular communication before, during and after emergencies.

Besides medical assistance upon a Member State's request in case of radiation emergency, REMPAN's key objectives include building national preparedness capacity. This task is implemented in the network's centres by development of guidelines and recommendations, providing forum for professional discussions and delivering information to medical community, as well as providing professional training through education of medical and public health workers involved in emergency response, and conducting emergency exercises. The centres of the network contain a unique knowledge and expertise.

4. Dissemination and extension to new shapes and scopes

4.1 An international policy for supporting the development of other world-regions ALARA networks

The success of the European ALARA Network led the first IAEA International Conference on Occupational Radiation Protection (Geneva 2002) to recommend the setting up of such ALARA networks in the other regions of the world. Therefore the IAEA/ILO[16], within their International Action Plan on Occupational Radiation Protection (IAPORP- 2003-2009), have devoted one action to that support. Up to now two such networks have been launched with a financial support of the IAEA through its regional cooperation projects.

The first one, the **RECAN** (Regional European and Central Asian ALARA Network) was set up in 2005 within the European and Central Asia region. More than 20 countries are participating to its activities. Its Steering Committee met for the first time in February 2006. Eight country representatives are nominated to manage the network. RECAN has already organised three regional workshops in Lithuania, Croatia and Romania. The last two were devoted to "ALARA in medicine" and "Problems in implementing practical optimisation". As in the case of the EAN, they have led to sets of recommendations, which have been widely spread into the different countries. RECAN has its own website and newsletter. The second one, the **ARAN** (Asian Region ALARA Network) is more recent (December 2007); it has been set up with the participation of the East Asian Countries and Pacific ones (like Australia). The first workshop will be held in November 2008 in Japan and will be devoted to ALARA and Non Destructive Testing activities.

The IAEA intends to favour the setting up of such ALARA networks in other world regions such as Latin America, English speaking Africa, French speaking Africa, Middle East…

[15] More information on REMPAN is available on the website: www.who.int/ionizing_radiation/a_e/rempan

[16] ILO: International Labour Organisation (an Agency from the United Nations)

Of course each region has its own specificities, both in terms of general development, types of uses of ionising radiations, radiation protection infrastructures and risk management culture. Therefore it appears important for each network to set up its own infrastructure, way of working, type of relationships between the members, products, …

4.2 The Emergence of new types of networks in radiation protection at the level of world regions.

Over the last five years other types of networks putting together different types of stakeholders have been set up.

Some of them are devoted to a specific topic covering all uses of ionising radiations: this is the case in Europe for **ESOREX** (European Study on Occupational Radiation Exposure 1997) and **EUTERP** (European Training and Education in Radiation Protection Platform, 2006) which have been established with the support of the European Commission with respectively the objective of providing the European stakeholders with reliable information on occupational radiation monitoring, reporting and recording of dosimetric results in European countries; and favouring harmonisation in the field of education and training systems for radiation protection experts and better integrating radiation protection education and training systems into general vocational training and education infrastructures. This is also the case in Europe of the self supported **ERPAN** (European Radiation Authority Network 2006), which aims at promoting communication between national regulatory bodies at the level of inspectors… in order to promote the ALARA principle…

Some others are totally devoted to the management of the radiological risk in a specific domain as it is the case in Asia for the **Asian Network of interventional cardiologists focussing on radiation protection** (2007), which makes use of a web forum and produces newsletters. This is also the case for the **NORM ALARA Network** (2007) in Europe, which is supported by the European Commission to promote ALARA implementation within the NORM industries.

Finally, some regional cytogenetic biodosimetry networks have been established and supported by WHO, which is now supporting the development of a global biodosimetry laboratories network for radiation emergencies (**BioDoseNet 2007**).

4.3 The emergence of local stakeholders networks: the French example

Many qualified experts in radiation protection working in the non-nuclear sector (research, industry, …) where the radiological risk is often not seen as a priority, feel quite lonely on the spot. Therefore since a few years in France, they have set up local inter-sectors networks relying both on the e-mail exchanges, internet forums and regular meetings with all types of concerned stakeholders in their region: labour physicians, qualified experts, radiographers, lawyers, environmental associations, local administration and trade unions representatives… These networks have quickly proved their efficiency and are now considered as important tools for exchanging feedback experiences, discussing the actual impacts of evolution of regulations, benefiting from workplace analysis case studies. For the same reasons there are also local groups of radiation protection professionals belonging to the same sector of activity, for example from all hospitals in a City such as Paris. The number of participants to these networks is increasing quite rapidly; as well the number of networks themselves is increasing. However, the setting up of a network is not always easy, due to the lack of time and resources. Therefore, being convinced of their efficiency in spreading a good radiation protection culture, the French regulatory body is looking for finding ways, relying on committed individuals and institutions, of facilitating new networks in regions where they do not yet exist.

4.4 Two generations of networks

Looking at Table 2 one can see that the first generation of networks, those mainly dealing with the scientific aspects of radiation protection and technical measurements evolution, were set up at the national level (and then gathered in worldwide networks of national associations); while the second generation of networks, mainly dealing with practical exchange of experience for dose management, have been "directly" set up at a regional level both internationally and locally within a country. Therefore the geographical bases of these two generations are very different: the second generation being more "applied" is more focussed on the specificities of their contexts, has led to smaller geographical bases.

Therefore, the total number of the first generation networks is a small, direct multiple of the number of countries making use of ionising radiation, and soon became relatively stable, while the total number of the second generation networks is still increasing at an exponential rate, and will continue at least during the next decades.

It is also clear from Table 2 that there is no "best shape" for a network:

- Should it be focused on one sector of activity only, allowing the emergence of scale effects, or covering many sectors allowing mutual feeding? It depends…
- Should it be focused on one risk? Or several risks? It depends…

It depends on the specificities of the problems to be solved; on the human and financial resources available; on the ease of communications according to the objectives (geographical neighbourhood, community of language…); and therefore each situation will lead to an adapted answer.

Table 2: Examples of the existing networks in 2008 according to their geographical and sectorial bases.

	Worldwide	**World regions**	***National***	**Local**
Intersectorial	*IRPA (1964)*	EAN (1996), RECAN (2005), ARAN (2007) ESOREX (1997) EUTERP (2006) Red internacional de radioproteccion (2002) ERPAN (2006)	*Health Physicists societies (50's 60's...)*	Local radiation protection stakeholders from all sectors (France 21st century; others?)
Sectorial	*IOMP (1963)* ISOE (1991) REMPAN (1987)	Asian Network of interventional cardiologists in radiation protection (2007) NORM ALARA network in Europe (2007)	*Medical Physicists societies (50's 60's...)*	Local radiation protection stakeholders from one sector (France 21st century; others?)

In italics the associations and networks created from the fifties to the eighties; i.e. the first generation.
In normal the networks created during the nineties and the first decade of the 21st century; i.e. the second generation.

5. Lessons learned from the second generation of networks

These networks are quite successful, and are still growing (number of networks, their scopes and formats, number of participating countries or institutions, number of topics addressed, number of recommendations implemented, etc). One may wonder about the reasons of this success; to answer that question it is worth analysing the lessons learned from the first networks of the second generation-

experiences. They may be summarised with a few words: Personal links and communication - enthusiasm - flexibility - collective efficiency. However one can notice the existence of constraints and limits for each type of network.

5.1 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 "bypasses", as it does not have to follow formal or administrative procedures. It brings together members of a worldwide community such as within ISOE, or the Asian Cardiologists network; it results in individuals belonging to many types of stakeholders within the world's regions (e.g. ALARA Networks or the local networks of radiation protection stakeholders). It gives the opportunity to all these individuals to express their needs and to listen to each other.

5.2 Enthusiasm

Experience shows that enthusiasm appears to be a real keyword for 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 to try to find together solutions to these problems. Therefore, enthusiasm is much more evident within all network actions favouring a bottom-up approach (workshops, work in small groups, web forum, panels. etc) than actions initiated through a top-down approach (databases, formal tools, etc).

5.3 Flexibility

The network appears to be much more flexible at the international level than any other type of organisation between institutions. This is particularly the case of EAN, which is quite independent, and can easily show its interest in new topics and involve representatives from new stakeholders according to the selected topic. No permission has to be requested; no formal rules have to be followed. Initiatives are easily taken, at least in a first step, for promoting new workshops, new groups, new sub-networks, new web pages, etc. Of course, the main constraint remains, at a moment or another, the financing of some actions.

5.4 Collective efficiency

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

5.5 Constraints and Limits of the networks

The second generation of networks aims at involving different types of stakeholders in the decision making-process. They then have to cope with a restriction of stakeholder participation due to their availability and for financial reasons; that is in particular often the case the workers themselves in the case of occupational exposure or for small companies representatives in the NDT sector, or representatives from small offices and clinics in the medical sector. The problem is then to find adequate resources and time; it is also to find an optimal size for a region both at international and national level, which will allow direct contacts through meetings and workshops. Another solution is to put more emphasize on the forum and web exchanges, however then, personal links, enthusiasm, flexibility and collective efficiency are not so easy.

Even when there are no such restrictions, it remains difficult to ensure that the output of the network will be made available to all concerned parties.

Therefore the actions of the networks remain totally complementary to the top down actions of the official institutions through political and managerial decisions as well as regulations.

6 . Conclusion: Towards worldwide networks of networks at all levels

During the nineties and later on, as an answer to the evolution of socio political demand, and thanks to the technological communication means, a second generation of radiation protection networks has grown up. They are set up on different geographical bases from worldwide networks to very local ones; they sometimes cover a specific topic (training for example) or a specific domain (cardiology for example), they are more often multi-topic and multi-sectorial; they always rely on communication and exchanges through direct contacts, most often complemented by emails, web sites and forum…

It should not be reasonable to envisage a single network of networks covering everything. However, it would be sensible to avoid duplications; thus the future is open not only to the emergence of new networks and new types of networks everywhere, but also to the spontaneous establishment of adapted links between the networks and creating then several networks of networks at all levels both geographical, topical and sectorial.