**Radiological Protection**
**NEA/CRPPH/R(2013)6**
June 2013
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# The International System on Occupational Exposure

## An ALARA Success Story Relying on Strong Individual Commitments, Effective International Feedback and Exchanges, and a Robust Database

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BETTER POLICIES FOR BETTER LIVES

NEA
NUCLEAR ENERGY AGENCY

**Unclassified** **NEA/CRPPH/R(2013)6**

Organisation de Coopération et de Développement Économiques
Organisation for Economic Co-operation and Development **25-Jun-2013**

**English - Or. English**

**Nuclear Energy Agency**

NEA/CRPPH/R(2013)6
**Unclassified**

## Committee on Radiation Protection and Public Health

# THE INTERNATIONAL SYSTEM ON OCCUPATIONAL EXPOSURE

# AN ALARA SUCCESS STORY RELYING ON STRONG INDIVIDUAL COMMITMENTS, EFFECTIVE INTERNATIONAL FEEDBACK AND EXCHANGES, AND A ROBUST DATABASE - 20 YEARS OF PROGRESS

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**JT03342346**

**Complete document available on OLIS in its original format**


**English - Or. English**

Radiological Protection

# THE INTERNATIONAL SYSTEM ON OCCUPATIONAL EXPOSURE


## AN ALARA SUCCESS STORY

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EFFECTIVE INTERNATIONAL FEEDBACK AND EXCHANGES,
AND A ROBUST DATABASE**

**20 YEARS OF PROGRESS**


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NUCLEAR ENERGY AGENCY
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

## ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

The OECD is a unique forum where the governments of 34 democracies work together to address the economic, social and environmental challenges of globalisation. The OECD is also at the forefront of efforts to understand and to help governments respond to new developments and concerns, such as corporate governance, the information economy and the challenges of an ageing population. The Organisation provides a setting where governments can compare policy experiences, seek answers to common problems, identify good practice and work to co-ordinate domestic and international policies.

The OECD member countries are: Australia, Austria, Belgium, Canada, Chile, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Republic of Korea, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The European Commission takes part in the work of the OECD.

OECD Publishing disseminates widely the results of the Organisation's statistics gathering and research on economic, social and environmental issues, as well as the conventions, guidelines and standards agreed by its members.



## NUCLEAR ENERGY AGENCY

The OECD Nuclear Energy Agency (NEA) was established on 1 February 1958. Current NEA membership consists of 31 countries: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, the Netherlands, Norway, Poland, Portugal, the Republic of Korea, the Russian Federation, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The European Commission also takes part in the work of the Agency.

The mission of the NEA is:

- to assist its member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally friendly and economical use of nuclear energy for peaceful purposes, as well as
- to provide authoritative assessments and to forge common understandings on key issues, as input to government decisions on nuclear energy policy and to broader OECD policy analyses in areas such as energy and sustainable development.

Specific areas of competence of the NEA include the safety and regulation of nuclear activities, radioactive waste management, radiological protection, nuclear science, economic and technical analyses of the nuclear fuel cycle, nuclear law and liability, and public information.

The NEA Data Bank provides nuclear data and computer program services for participating countries. In these and related tasks, the NEA works in close collaboration with the International Atomic Energy Agency in Vienna, with which it has a Co-operation Agreement, as well as with other international organisations in the nuclear field.

## FOREWORD

Why, more than 20 years ago, did there emerge the need for an International System on Occupational Exposure (ISOE)? How was it created? What were the problems and their possible solutions? Who were the main stakeholders?

These are a few of the questions that the ISOE NEA Secretariat and Bureau asked Christian Lefaure, ex CEPN Deputy Director, to address in preparing a report on the history of ISOE and its progress. He had been directly involved in the brainstorming that preceded ISOE establishment, and he became the first head of the ISOE European Technical Centre, in charge of the world database development and management from 1991 to 2007.

For writing this report, he made use of his own souvenirs and documentation as well as of those of tens of ISOE participants, both from major international and regional organisations (OECD/NEA, IAEA, EC and BNL), nuclear power plant utilities and national regulatory authorities. He voluntarily focused not only on the technical aspects but also on the human components of that story.

This was done through personal interviews with many individuals who have played an important role at one moment of ISOE life, the analysis of answers to a questionnaire, and reviews of the minutes of many ISOE meetings that were held before and after the official establishment of the ISOE, along its lifespan to date.

It is thought that this memory work and all the outputs from ISOE will be useful in the future and that this collective protection of patrimony will provide tools for continuously improving working conditions in the operation of nuclear power plants.

## ACKNOWLEDGEMENTS

The ISOE wishes to express their gratitude to Dr. Christian Lefaure and Dr. Richard Doty for their important contribution to the drafting of this report.

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## COMMENTS BY THE ISOE CHAIR

As for sure, ISOE was initially set up for allowing benchmarking in terms of dose results in order to improve radiological protection performance. But for me, ISOE has primarily been a support for setting relationships with my "peers". These contacts allowed me to benefit from my colleagues' experiences, as well as to test improvement ideas both from the technical and managerial points of view. Without these exchanges and confrontation of ideas, the evolutions would have been more restricted and surely slower, as feedback experience from such a large audience covered all my demands and questions.

The health physicists (in my utility) felt often quite alone within structures not directly connected to the production process. Our colleagues and managers often perceived us as a constraint to innovation and to the search for efficiency. Thanks to these exchanges of ideas, ISOE allowed all of us to demonstrate that we also participate directly to the "performance". For convincing, 20 years ago that optimised occupational radiological protection was a source of direct benefit, we demonstrated that the first step for reducing doses came from a better organisation and therefore led to reducing needed resources and costs. That demonstration, making use of actual examples from several utilities, has greatly contributed to the integration of the health physicists to the collective production processes and structures.

Since 20 years, the society has put such a pressure on the nuclear industry that the regulatory authorities, which were initially mainly focused on nuclear safety, are now looking carefully on occupational radiological protection. The ALARA approach promoted by the ISOE has allowed us to demonstrate to them what improvement rationales are now evolving in all utilities, each at its own rhythm, according to its economic and social context.

In conclusion, the ISOE has been a tool, which has allowed us starting and comforting a step forward both at the utilities and regulatory authorities. This is obvious when looking at the significant dose results improvements and decreases that may be observed all over the world.

**Gonzague Abela**

EDF Engineering Department, Safety and Radiological Protection
ISOE Chairman, 2010-2012

# EXECUTIVE SUMMARY

## ISOE, an ALARA success story

For writing this story, the most important inputs were the accounts from many individuals having very actively participated in ISOE life at one step or another. The contacts were not always easy to make 15 or 20 years later. But in general, the questions were welcomed and the answers to the interviews and to a short questionnaire have fed this report. They have allowed a more lively description than what was forthcoming solely from the documents that have also been checked.

### *What was at stake before ISOE?*

At the end of the eighties the occupational exposure situation in the Nuclear Power Plants from many countries was not at the desired level of performance, both in terms of collective exposure (reaching annually more than 8 manSv per reactor for the US LWR) and individual exposures, exceeding regularly several tenths of mSv a year and even 50 mSv. Improvements were strongly expected and required. Favouring exchanges on problems to be solved and spreading good practices had already appeared as a promising solution and a way to implement the ALARA principle, recommended by ICRP (ICRP Report No:26) and introduced as a new requirement in the regulations of many countries.

### *Precursors of the ISOE*

In the mid-80s, some precursors of the ISOE existed,

- the Brookhaven ALARA Centre at the request of the US Nuclear Regulatory Commission "We suggested, and the NRC agreed to set up in 1984 the BNL ALARA Centre" (JB),
- the European Commission "We started to share with the EC RP experts group" (BL),
- and EDF "What will happen to our workers, when the circuits will become polluted, corroded and contaminated?" (JL) had set up international feedback systems relying on different types of databases.

The first two systems gave rise to feedback and information exchange workshops or annual meetings for the radiological protection specialists from the plants, while the third focused on benchmarking visits with peers of the best plants as pointed out through the database.

### *The NEA initiative had first been a diplomatic "bet"*

With the existing systems not being universal, either geographically or according to the reactor types, the NEAs Committee on Radiation Protection and Public Health (CRPPH) decided in 1989 to set up a pilot project, called ISOE, aiming at establishing procedures for interplant comparability and promoting international exchanges on optimisation of radiological protection. However many diplomatic problems had to be solved before launching the system.

*"How to convince the other international organizations that we were not in competition but complementary and enlarging the existing system?" (CV), "It was in fact quite difficult to convince my colleagues from the plants to participate." (CGL)*

### *Enthusiasm overcame fears and reservations*

A lot of diplomatic efforts were needed, and they allowed the positive resolution of most problems; enthusiasm overcame fears and reservations; the pilot project was therefore considered successful by the end of the 1990 and the official launching of the system was scheduled for 1991. The first ISOE Steering Committee meeting took place on the 18th of November, 1991 and the ISOE was officially launched on the 1st of January, 1992.

*"I have always seen the project driven by very enthusiastic individuals; not by governments" (CV), "In Germany, after a lot of fruitful discussions we succeeded." (PJ)*

### *Over 300 reactors have become participants*

After 20 years, the ISOE objectives of covering the world are nearly reached, with 323 operating reactors and 40 shutdown reactors participating. This has been achieved progressively with the help of very committed individuals in the different regions of the world. The system has now really become a worldwide international network, with the participation of more than three quarters of the operating reactors and many plants in decommissioning from all continents and nearly all types of commercial reactors.

"In Japan, I repeated my message again and again and they finally looked at the ISOE graphs and realized the facts." (WM)

### *ISOE, continually evolving on work and communication technologies*

One major condition of that success has been the provision of very friendly user tools for collecting, keeping and analysing all needed data for the implementation of efficient benchmarking and trends follow up. This has taken time, for example we discovered that: *"Each Latin character makes use of a single byte, while our Korean characters make use of 2 bytes each; therefore your software cannot be handled in our mother languages" (SN).*

The evolution has surely not reached its end stage. However we have demonstrated that the technical evolution of the ISOE computerised tools has always followed very quickly the commercial availability of new and improved software and communication tools. *"Now most utilities make use directly of the web for their input, but those few, which do not allow any web into their facility." (LA)*

### *The success comes from personal exchanges*

ISOE has also developed products, not directly linked to the database, such as the work management books and workshops, the ISOE symposia, radiological protection managers and regulatory authority representatives meeting in connection with symposia and, plant visits for benchmarking.

All these have provided to the ISOE members, many opportunities of working together, and establishing direct personal and individual links with several hundreds of professionals.

A survey was performed, for the 20th Anniversary, among several tens of participants. It shows that they all appreciate particularly these opportunities, both professionally and personally, both as utilities and regulatory authority representatives. Today we can say that ISOE, even more than a technical or only professional network, has become a Human Network, and this is an essential reason for its success.

*"The system, and especially the regional and international symposiums, gives now to the participants frequent and fruitful possibilities for international experience exchange. With personal contacts built on trustful relationships, the system started to improve the local radiological protection work." (CGL)*

### *ISOE "like a family of peers"*

ISOE is actually used by the participants, utilities and regulatory authorities, as a system for exchanging their experiences in order to reduce doses through ALARA implementation. This works very effectively because – *"they work with reliable peers at an international level"* – *"they work with friends in a kind of 'friendly family'"*. The result is that they all consider participating with professional and friendly colleagues to decrease occupational doses.

### *Doses have decreased at least by a factor of ten*

Within these two decades the workers' doses have been drastically reduced: the collective dose per plant is on an average roughly ten times lower than in the 80s. Of course, these results cannot be attributed solely to the ISOE, but all participants recognise that ISOE has been a major contributor to that evolution.

### *ISOE was the first, but is not anymore alone*

ISOE has been the first ALARA Network in the world; its success has been an incentive for developing others, in other domains, such as the International System on Occupational Exposure in Medicine, Industry and Research (ISEMIR of the IAEA, 2009). Many stakeholders outside its members now also recognise it as a partner and/or a potential resource; this is for example the case for the UNSCEAR.

*"It has been the first ALARA network in the world, after the ALARA principle was introduced by ICRP" (JL), "the idea has emerged for developing new networks based on the work done by ISOE." (PD)*

### *ISOE was a need and still is*

The need for ISOE became evident looking at the occupational radiological protection status in the NPPs during the 80s; ISOE remains today an evident need for the future, looking in particular at future plant decommissioning, and lessons to be learned that must be integrated into new plant designs. This has been accentuated due to the requirements for safety improvements following the Fukushima nuclear accident in 2011.

As a conclusion we will give the last words to one of the former ISOE Chairmen:

*"I decided to participate in ISOE because of the commitment of generous people working with conviction and professionalism to build together an excellent system that members could use to improve their practices and occupational dose reduction initiatives." (JYG)*

# SYNTHESE DU RAPPORT

## ISOE, une réussite pour ALARA

Ce qui a été le plus important pour écrire cette histoire, ce sont les témoignages de nombreuses personnes qui ont participé à la vie d'ISOE à une étape ou à une autre. Il n'a pas toujours été facile de reprendre contact après 15 ou 20 ans; mais en général, les questions ont été bien accueillies et les réponses, ont largement nourri ce rapport. Elles ont permis une description plus vivante que ce qui provenait de l'analyse des documents, eux aussi consultés.

### *Quels étaient les enjeux avant ISOE?*

Vers la fin des années 80, la protection contre les expositions professionnelles dans les centrales nucléaires de nombreux pays, n'était pas au niveau de performance que l'on aurait pu espérer. De ce fait les expositions collectives atteignaient des niveaux élevés (8 Homme Sievert par réacteur et par an sur le parc des réacteurs à eau légère aux USA) et les expositions individuelles dépassaient régulièrement plusieurs dizaines de mSv par an, voire 50 mSv. Des améliorations étaient fortement souhaitées et requises. Favoriser les échanges sur les problèmes à résoudre et diffuser des bonnes pratiques était considéré comme des voies prometteuses. Il s'agissait de favoriser la mise en œuvre du principe ALARA recommandé par la CIPR dans sa publication 26 en 1976 et introduit depuis peu comme une obligation réglementaire dans de nombreux pays.

### *Les précurseurs d'ISOE*

Quelques précurseurs d'ISOE existaient déjà vers le milieu des années 80 :

- Le Centre ALARA de Brookhaven, soutenu par les autorités Américaines (Nuclear Regulatory Commission) « *nous l'avions suggéré et la NRC avait accepté de créer le Centre ALARA à Brookhaven en 1984* » *(JB),*
- la Commission Européenne « *Nous échangions nos expériences entre experts en radioprotection avec la Commission* » (BL),
- et EDF « *Que va t il arriver à nos travailleurs lorsque nos circuits vont être pollués, corrodés et contaminés ?* » (JL).

Tous trois avaient créé des systèmes d'échanges de retour d'expérience internationaux qui s'appuyaient sur différents types de bases de données. Les deux premiers systèmes donnaient lieu à des réunions des radioprotectionnistes des centrales, tandis que le troisième avait pour objectif de faciliter des visites d'« inter comparaisons» dans les meilleures centrales.

### *L'initiative de l'AEN de l'OCDE a tout d'abord été un pari*

Les systèmes existants n'étaient pas mondiaux et ne comprenaient pas tous les types de réacteurs. Le Comité de Protection Radiologique et de Santé Publique de l'AEN de l'OCDE a donc décidé en 1989 de créer un projet pilote, appelé ISOE, pour mettre en place des procédures permettant l'inter comparaison des centrales et de promouvoir des échanges internationaux sur l'optimisation de la radioprotection. Mais avant de lancer le système il a fallu régler de nombreux problèmes diplomatiques.

*« Comment convaincre les autres organisations internationales que nous ne venions pas les concurrencer, que nous étions complémentaires et que nous allions élargir les systèmes existants ? »(CV), « c'était en fait assez difficile de convaincre mes collègues des centrales de participer ». (CGL)*

### *L'enthousiasme a permis de surmonter peurs et réserves*

Une intense activité « de diplomatie » a été nécessaire pour résoudre positivement ces problèmes ; l'enthousiasme a permis de surmonter peurs et réserves ; le succès du projet pilote a été reconnu fin 1990 et le lancement d'ISOE a été programmé pour 1991. Le premier Comité de Direction d'ISOE a eu lieu le 18 Novembre 1991 et ISOE a été officiellement lancé le 1er Janvier 1992.

*« J'ai toujours vu ce projet piloté par des « individus » très enthousiastes, pas par les gouvernements » (CV), « En Allemagne, après de nombreuses discussions fructueuses nous avons réussi ». (PJ)*

### *Plus de 300 réacteurs participent maintenant*

20 ans après, l'objectif d'ISOE de couvrir le monde est presqu'atteint : 323 réacteurs en fonctionnement et 40 réacteurs à l'arrêt définitif participent au système. Cela a été obtenu progressivement, grâce à l'action de personnes très motivées dans les différentes régions du monde. Le système est vraiment devenu un réseau mondial, avec la participation de plus des ¾ des réacteurs en fonctionnement de tous continents et tous types de réacteurs.

*« Au Japon, j'ai répété mon message encore et encore et finalement ils ont regardé les graphiques d'ISOE et pris conscience de la réalité ». (WM)*

### *ISOE a continuellement évolué avec les nouvelles technologies de la communication*

Une condition du succès a été le développement d'outils conviviaux pour collecter, stocker et analyser toutes les données utiles aux inter-comparaisons et au suivi des évolutions. Cela a pris du temps, et nous avons découvert, par exemple, au bout de dix ans que : *« Chaque caractère latin n'utilise qu'un byte, alors que nos caractères Coréens utilisent deux bytes; de ce fait votre logiciel, ne peut pas être utilisé avec nos langues maternelles ». (SN)*

Cette évolution n'est surement pas terminée. Nous avons en effet démontré que les outils informatisés d'ISOE ont toujours suivi très rapidement l'apparition commerciale de nouveaux logiciels et outils de communication plus performants. *« Maintenant, la plupart des exploitants utilisent internet pour entrer leurs données, mis à part ceux qui ne permettent pas les connexions avec le web dans leurs installations ». (LA)*

### *Le succès est venu des échanges entre personnes*

ISOE, ce sont aussi les publications sur la gestion du travail, les séminaires, symposiums, et journées pour les managers de radioprotection ou celles pour les autorités réglementaires, les visites de centrales pour l'inter comparaison. Tout cela a fourni aux participants, de nombreuses occasions de travailler ensemble et d'établir des relations directes et personnelles avec des centaines d'autres professionnels.

L'enquête qui a été réalisée pour ce vingtième anniversaire, auprès de dizaines de participants, montre que tous apprécient particulièrement ces occasions d'être ensemble à la fois professionnellement et personnellement, qu'ils travaillent chez les exploitants ou les Autorités. Aujourd'hui l'on peut dire qu'ISOE, plus encore qu'un réseau professionnel et technique, est devenu un Réseau Humain, et c'est la clef de son succès.

*« Le système, et en particulier les symposiums régionaux et internationaux, fournit maintenant aux participants des possibilités fréquentes et riches en échanges d'expérience internationaux.*

*Le système a vraiment commencé à améliorer la radioprotection de terrain, grâce aux relations de confiance qui se sont établies dans les contacts personnels ». (CGL)*

### *ISOE "comme une famille de pairs"*

ISOE est utilisé par les participants, qu'ils soient exploitants ou Autorités, comme un système d'échanges de retour d'expérience pour réduire les expositions en appliquant le principe ALARA. Et cela marche effectivement parce que – *« Ils travaillent à un niveau international avec des collègues fiables » – « Ils travaillent avec des amis dans une sorte de famille amicale ».*

### *Les doses ont diminué au moins d'un facteur dix*

En vingt ans les doses des travailleurs se sont réduites très fortement : la dose collective par réacteur est en moyenne dix fois plus faible que dans les années 80. Bien sûr, ces résultats ne peuvent être attribués en totalité au seul système ISOE, mais tous les participants reconnaissent qu'ISOE a contribué de façon majeure à cette évolution.

### *ISOE a été le premier, mais n'est plus le seul aujourd'hui*

ISOE a été le premier réseau ALARA dans le monde ; son succès a donné une impulsion pour en créer d'autres, dans d'autres domaines, comme par exemple en 2009 le Système ISEMIR (Système International pour les Expositions professionnelles en Médecine, Industrie et Recherche) créé par l'AIEA. Beaucoup d'autres organisations reconnaissent ISOE comme partenaire et/ou une ressource potentielle. C'est en particulier le cas de l'UNSCEAR.

### *ISOE correspondait à une besoin, cela est toujours vrai*

La nécessité de créer le système ISOE, est apparue en regardant l'état de la radioprotection dans les centrales dans les années 80 ; ISOE reste aujourd'hui une nécessité pour le futur, en particulier si l'on tient compte des démantèlements à venir et des leçons à intégrer dans la conception des futures installations. Ces exigences ont été accentuées avec l'accroissement des exigences en matière de sureté suite à l'accident de Fukushima en 2011.

En conclusion, nous donnerons le « dernier mot » à un précédent président d'ISOE :

*« J'ai décidé de participer à ISOE, à cause de l'implication de personnes généreuses, qui travaillaient avec conviction et professionnalisme à construire ensemble un excellent système que ses membres pouvaient utiliser pour améliorer leurs pratiques et mettre en œuvre des initiatives pour réduire les doses professionnelles ». (JYG)*

# 1. INTRODUCTION

For writing this story, the most important inputs were the accounts from many individuals having very actively participated in the ISOE life at one step or another. The contacts were not always easy to make 15 or 20 years later. But in general, the questions were welcomed and the answers to the interviews and to a short questionnaire have fed this report. More than 50 individuals have answered these requests one way or another. Some have followed ISOE birth and premises; some have not seen the first steps of ISOE but have participated later on or are still participating. Some have been able to provide pictures, drawings or relevant publications. All their accounts are part of the collective memory of that important adventure shared during the last two decades by many individuals all over the world. They have allowed a more lively description than the one that would have come solely from documents, which have also been checked. This report provides excerpts of their interviews verbatim and written answers.

This report is divided into three parts:

Chapter 2: Why ISOE?

Chapter 3: What has been the evolution of ISOE?

Chapter 4: How has ISOE been perceived and is now perceived?

# 2. WHY ISOE?

What were the reasons that led to setting up the ISOE? Who made the decision? What were the problems to be solved before launching it?

## 2.1 What was at stake before ISOE

What was the situation in terms of occupational exposure in the Nuclear Power Plants (NPPs) during the eighties? Was the situation satisfactory? What was the regulatory requirements context?

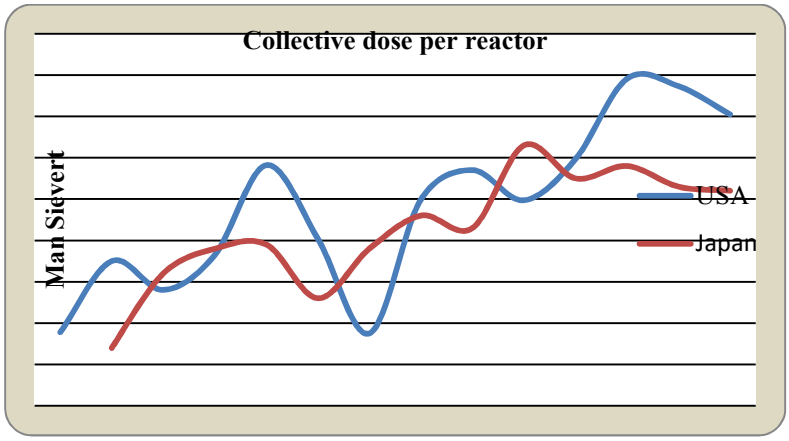
### *2.1.1 An undesirable situation in the 80s*

Of course, it was unanimously expected that the peaceful use of nuclear energy remains as much as possible without risk for the public and for the workers, but this was not so obvious, as there were some red lights.

On the one hand, the Three Mile Island (TMI) experience in the US (28 March 1979) had shown that nuclear safety was not as sure as expected; a large population had been evacuated, fortunately with very little exposure of members of the public.

On the other hand the increase of maintenance work due to the ageing of plants and the back-fitting (modification) works following the TMI experience had led to high collective doses, in particular in the country where the oldest LWR had been built: the US. In that country the collective dose per LWR unit and per year (in normal operations), reached nearly 8 manSv at the beginning of the eighties.

**Figure 1: Data from NUREG 0713 1985, in the US, Minister of International Trade up to 1974 and Technology Agency after 1974 in Japan**




At the same time the European Trade Unions were more sensitive to the impact of this maintenance and back-fitting works on the **increase of individual doses** for those "**itinerant (outside) workers"** going from one plant to another and regularly exceeding several tenths of mSv a year and even 50 mSv.[1]

1. This is corroborated by US data, in NUREG 0713 Volume 8. Table 5.5 shows that nearly 400 workers exceeded 50 mSv in 1980 in nuclear power facilities and Table 5.4a shows that those exceeding 50 mSv correspond to less than 10% of those exceeding 20 mSv.

The Chernobyl accident occurred on April 26th 1986; it raised nuclear safety and its improvement as a major public concern. The impact of these requested improvements on occupational exposure therefore became an important topic of concern for the nuclear community and the regulatory authorities.

### *2.1.2 A promising tool: the ALARA principle*

The optimisation principle, so called ALARA (As Low As Reasonably Achievable), has been formally integrated by the International Commission on Radiological Protection (ICRP) as the core of a radiological protection system in its publication 26 in 1977 (ICRP, 1977). That principle was recommended by ICRP as a reasonable way for managing radiological risk corresponding to low doses. Under the no threshold linear relationship between exposure and risk, the risk coefficient of developing a fatal cancer was estimated in 1986 at 1% per manSv. This was already questioned at the end of the 80s due to re-estimation of the exposures of the survivors from Hiroshima and Nagasaki; this led to a risk coefficient of 4% per manSv in the ICRP 60 recommendation (1990) (ICRP, 1991).

*With the ICRP 26 coefficients, the above mentioned annual collective dose of 8 manSv per reactor would have led to one calculated fatal radiation-induced cancer every 12.5 years, while with the ICRP 60 coefficients it would correspond to one calculated fatal cancer every third year among the population of workers.*

During the 80s, practical recommendations were developed for the implementation of the ALARA principle: the Cost-Benefit Analysis was developed in *ICRP* Publication *37 (ICRP, 1983)* and finally the procedure and programme appeared in ICRP 55 in 1989 (ICRP, 1989). In that context, one can say that a major issue in the nuclear field was a growing pressure to put into practice the ALARA principle as the cornerstone of occupational radiological protection.

During that period, three notable groups in the world were working on ALARA programme development: the Brookhaven National Laboratory (BNL) ALARA Centre in the US, the National Radiological Protection Board (NRPB) in the UK and the Centre d'Evaluation pour la Protection dans le domaine Nucléaire (CEPN) in France. The first group was focusing mainly on practical feedback experience in the nuclear field, while the other two were developing a conceptual approach that led to the issuance by the European Commission of the book "ALARA from theory towards practice" in 1991 (EC, 1991). Meanwhile most regulatory authorities had promulgated national regulations including ALARA implementation as an important part of the legal requirements.

***At the end of the eighties the occupational exposure situation in the Nuclear Power Plants of many countries was not as desired, both in terms of collective dose (reaching annually more than 8 manSv per reactor for the US LWR) and individual doses, exceeding regularly several tenths of mSv a year and even 50 mSv. Improvements were strongly expected and requested. Exchanging information on problems to be solved and spreading good practices had already appeared as a promising solution and a way to implement the ALARA principle, recently recommended by ICRP and introduced as a new requirement in most regulations. What had then already been done for improving the situation? What were the precursors to ISOE? What systems did they set up?***

## *2.2 The precursors to ISOE*

The Brookhaven National Laboratory ALARA Centre, the European Commission and Electricité de France (EDF) appear to have been such precursors. They were probably not the only ones, but these three have had a direct and important impact on the establishment of the ISOE.

### *2.2.1 The US experience with Brookhaven ALARA Centre in the USA*

Most of the oldest LWRs in the world were built in the USA quite early: there were 7 in 1969, 44 in 1975, and 68 in 1980. As we have seen in Figure 1, the collective dose per commercial light water reactor was up to 8 manSv per year:

*"However, annual collective doses of 10 and more manSv in a year at individual reactor sites have been frequent and doses of the order of 30-40 manSv in a year have not been uncommon." (NEA, 1986)*

This was widely due to high dose maintenance jobs corresponding to the ageing of the plants. For example the first steam generator replacement at Surry 2 in 1979 cost 21.41 manSv for a three loop reactor. This was considered as undesirably high by the US regulatory body, the NRC (Nuclear Regulatory Commission). John Baum, from the Brookhaven National Laboratory (BNL), who organised the BNL ALARA Centre, indicated that:

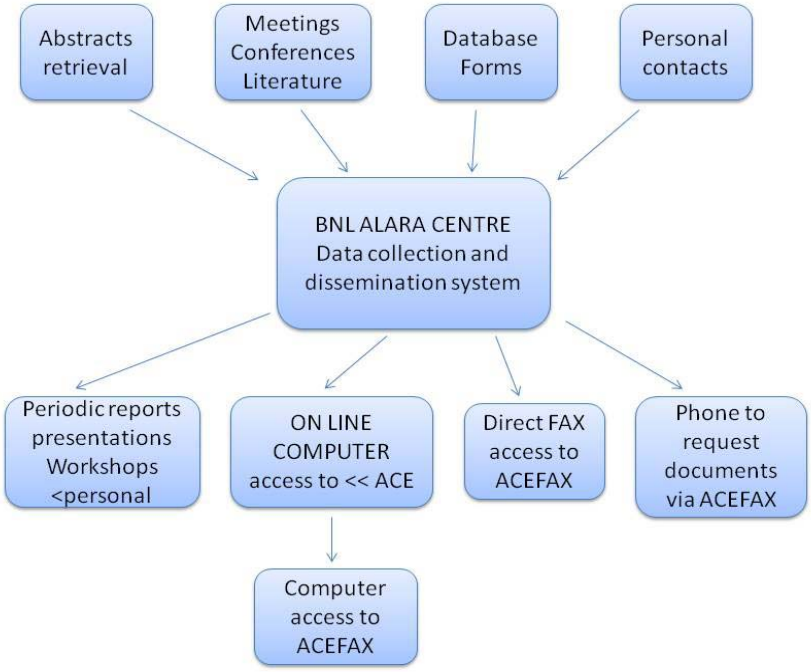
*"The NRC was very concerned because US plants had the largest collective doses per plant of any developed country. We suggested, and the NRC agreed to* ***set up in 1984 the BNL ALARA Centre*** *to monitor dose-reduction efforts in the US and abroad and to focus the industry's attention on ALARA. We performed then a number of studies of the problems at U.S. plants, and held the first International Symposium at BNL in 1984." (NUREG, 1985, 1990, 1995). "During the ALARA Centre life we organized three international workshops (1984, 1989 and 1994). They were designed to bring together nuclear reactor radiation protection specialists from as many countries as possible, to exchange information on dose control practices and equipment. We invited the international community as we had so much to learn from them. The three seminars gave rise to NUREG reports."*

Moreover, BNL ALARA Centre, under the management of Tasneem Khan, set up several bibliographical databases, such as High-Dose Jobs and Related Techniques of Dose Reduction, which for example gave rise to a set of "High-Dose Job Dose-Reduction Data Sheets". With the evolution of communication technologies these data sheets and all ALARA Centre reports were made accessible (1992) through a direct or computerised fax system (see figure 2).

During the decade where it existed, the BNL ALARA Centre was very efficient in producing around one hundred very informative reports on dose reduction techniques and dose management tools. It had started to build a kind of a net for the professionals mainly in North America (with both utility and regulatory authority representatives), but also with the participation of some European radiological protection managers.

We can say that with no doubt the ALARA centre input has largely contributed to the American LWRs dose decrease during the late 80s (from 8 manSv to 3.3 and 2 manSv respectively per LWR in 1990 and 1995).

**Figure 2: BNL ALARA Centre data collection and dissemination system**




### *2.2.2 The European Commission Club of Radiological Protection Experts*

While the U.S. ALARA Centre, at the request of the NRC, facilitated ALARA implementation in North America, the European Commission's department responsible for legal initiatives for the health protection of workers was facing a similar evolution of the collective dose trends, even with younger reactors and therefore decided to take a specific initiative.

At the beginning of the 80s the Radiation Protection Division from the Directorate General for Health from the European Commission was advised by the "Advisory Committee for Health and Safety at Workplace" a tri partite Committee composed of trade unions, employers, and regulatory authority representatives, as well as by an expert group set up under Article 31 of the Euratom treaty.

> *"The committees informed us about occupational exposures trends in NPP and provided us feedback from surveys performed in particular in Germany, showing the increase of individual and collective doses for contract workers going from plant to plant during the outages in the LWR. The partial published information available showed also big differences of collective doses between plants for the same type of intervention or job. The Unit head, Hans Eriskat, thought it should be worthwhile to give to all European NPP radiation protection managers, the opportunity to better implement ALARA in discussing regularly with each other, and in performing benchmarking analyses on exposures per job. For the start of this idea into practice our Division addressed European BWR and PWR plant managers, proposing a platform for information exchanges under the auspices of the CEC without any regulatory authority participating." (Klaus Schnuer)*[2]

2. Klaus Schnuer is still member staff of the European Commission, was in charge of the EC club up to its end.

This was a totally unusual and pragmatic initiative from the Commission: to set up a club of utilities under EC auspices without any official representation of the Member States regulatory autho-rities, to facilitate free speech and exchanges between participants. That freedom could be considered as a precondition for real improve-ments and ALARA implementation on the spot. The "club" started in 1981.

The EC club

On the first invitation the majority of European light water power plant managers answered positively including those from countries which were not members of the European Union such as Sweden, Switzerland, Finland, Spain and Hungary. Only some years after the first start of the project, the French EDF also participated as doses were considered at that time as medically private information by the French regulatory body.

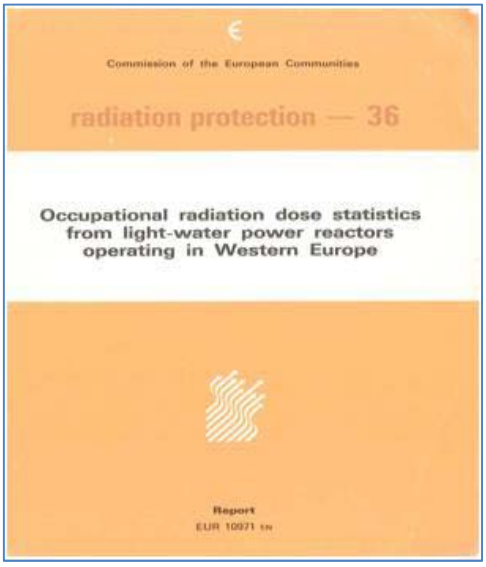
*"Collecting doses and radiological protection experiences started with the EC RP experts group. In Sweden we were well prepared with our common dose register." (Bengt Löwendahl)*[3]

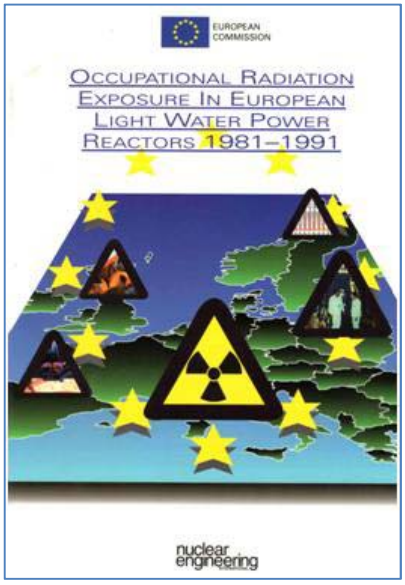
*"The job related dose project was based on three pillars. Reporting and recording of workers dose data from selected jobs and departments, a yearly meeting and a publication of results. A questionnaire was developed and since 1982 distributed to the utilities for the collection of the dose data. An annual meeting was organized with plants representatives for discussing the data collection results and for exchange of information following one or two presentations on specific topics (steam generator or main cooling pumps inspection or repair, pool cleaning, etc.). A report was distributed to each participant showing all data per plant, statistical analysis and the given presentations. The existence of that database showed at the beginning the problem of multiple different dose recording systems and classifications of jobs. Year after year, the systems became more harmonized, allowing for better inter-comparisons." (Klaus Schnuer)*

That "club" played an important role among European utilities for more than 10 years, with its yearly meetings and reports (CEC, 1987 and Nuclear Engineering, 1994); its final publication was in 1994 a special issue of Nuclear Engineering: "Occupational Radiation Exposure in European Light Water Power Reactors 1981-1991". With that club, the European LWRs radiological protection managers got used to working together. One may also note that from the beginning the annual meetings were open to observers from the OECD/NEA and the IAEA.

3. Bengt Löwendahl was Radiological Protection Manager, Oskarshamn NPP, Sweden.

**Figure 3: the two EC publications**




### *2.2.3 The Electricité De France worldwide PWR database*

By the end of the seventies, into the beginning of the 80s, the French PWRs collective doses were among the best; and that was mainly due to the relatively "young age" of most French reactors as well as to the integration into their design of many modifications from the US plants.

However, some EDF[4] managers, looking at the Westinghouse PWR type results, were afraid about the future evolution of French doses. They wished to understand more what happened, and what were the actual components of the doses. At that time people thought that doses came mainly from the level of the dose rates, i.e. from the corrosion and contamination of the primary circuit.

> *"But then how to explain that crazy situation from Ringhals NPP in Sweden with higher dose rates by 50% to those of Fessenheim having collective doses lower by 30%?" (Alain Brissaud)*[5]

Therefore, EDF management set up a worldwide database (at the end of the 70s, beginning of the 80s) on collective doses for each reactor and organised many benchmarking site visits to plants with good results. The collection of data as well as its analysis and some benchmarking visits were subcontracted to CEPN (see above 2.1.2), the French ALARA specialists' team led by Jacques Lochard[6], who confirms that the main questions to be answered to were:

> *"What will happen to our workers, when the primary circuits will become polluted, corroded and contaminated? What lessons can we learn from foreign experiences? CEPN demonstrated in analyzing EDF and world PWRs doses and dose rates in the database that* ***dose rates*** *were absolutely* ***not the only major component explaining the doses.*** *" (Jacques Lochard) (Lochard and Pagès, 1984)*[7]

From these results CEPN demonstrated that the time spent in radiation fields was also essential, and can be modified through the preparation and planning of the work, training of the workers, modification of the tools, etc… all that is today called **"Work Management"**. It

4. Electricité de France, the French utility.
5. Alain Brissaud, ex. EDF health physicist.
6. Jacques Lochard, CEPN Director, ICRP Committee 4 chair, ex. CRPPH chair.
7. This study has been presented at IRPA 6th in Berlin 1984.

became clear that acting on the exposure time has also to be considered, in particular during the operating and dismantling life of the plants, as a **major component of the ALARA programmes**. That has been all along the ISOE lifespan to date a driving force of the system.

**In the mid 80s some precursors to ISOE, – the Brookhaven ALARA Centre at the request of the US Nuclear Regulatory Commission, – the European Commission – and EDF, had set up international feedback systems relying on different types of databases. They were dealing either with annual doses, doses per job, or occupational radiological protection techniques and radiological risk management. The first two systems gave rise to complementary feedback exchange workshops or annual meetings for the radiological protection specialists from the plants, while the third focused on benchmarking visits with peers of the best plants as pointed out through the database.**

## 2.3 The establishment of a new ISOE system under NEA auspices

As previously seen, several data collection and exchange systems dealing with occupational exposure in NPPs already existed in the mid 80s, both in North America and Europe. However, they were **only devoted to LWRs**, and none of them covered the other types of reactors such as CANDU, VVER, RBMK, or GCR; and even if they were all open to wide international contacts, in reality they were mainly focused on their world region.

### *2.3.1 Nuclear safety and occupational exposure: the NEA group of experts (1986)*

Therefore in the mid-eighties, under the impulse of Osvaldo Ilari,[8] the OECD/NEA, CRPPH[9] established an expert group, mainly focused at the beginning on the potential "*unbalanced impact on the risks to workers in NPPs, of the new nuclear safety requirements requested by regulators, in particular post-TMI*". The Group, chaired by Lucien Fitoussi from the IPSN,[10] collected data from many countries and institutions (USA, Japan, Italy, Switzerland, Canada…) and concluded that the critical issue of dose increase in NPPs came jointly:

- from the increase of "in service inspections" for checking the integrity of the systems,
- from the increase of maintenance jobs due to the ageing of the plants, and
- from the plant back-fitting (modification) jobs. They pointed out that the existing dose recording system and data collection did not allow checking accurately the impacts of each reason, but for some specific high dose jobs. They also noted that "current data indicate significant differences in worker exposure levels from reactor to reactor and country to country".

They provided the CRPPH with recommendations for the radiological protection community, and among them are the following two:

- To favour the development of standardised electronic dosimetry and automatic data management systems for the determination of task related doses. To assess and record task related dose data. **To establish procedures aimed at inter-plant comparability.**
- **To promote an international exchange of information on occupational exposure data and optimisation (ALARA) procedures**. To evaluate the potential role played by different design, operation and safety philosophy approaches… in the discrepancies among these data.

8. Staff member of the NEA secretariat from 1976 to 1997.
9. CRPPH: Committee on Radiation Protection and Public Health.
10. IPSN: Institut de Protection et de Sureté Nucléaire.

### *2.3.2 Implementing a pilot project (1989)*

The CRPPH Steering Committee endorsed these recommendations in April 1986 and the Secretariat was requested to develop a proposal. Christer Viktorson,[11] a new NEA secretariat staff member, was appointed partly for that purpose. He proposed at the CRPPH Steering Committee meeting in 1987 a programme for the "establishment of a mechanism for international co-operation in the field of occupational exposure" (NEA, 1987); this was followed by a detailed programme description in the CRPPH Steering Committee in 1988 and the decision to set up a pilot project in the CRPPH Steering Committee in 1989 for demonstrating the interest in such a system.

*"At this time I arrived at the NEA I was lucky to be in an enthusiastic team led by Jean-Pierre Olivier and Osvaldo Ilari. These two leaders were able to mobilize significant energy, not only within the Secretariat but also in member countries to do things thought to be impossible for a small international organization. They put me in contact with a small scientific organization in France called CEPN. This organization became later one of the main drivers behind the Information System on Occupational Exposure (ISOE) together with the US Brookhaven National Laboratory (BNL). I started to work with CEPN and BNL and rapidly we developed the embryo for the international exchange." (Christer Viktorson) (NEA, 2009)*

### *2.3.3 The precursors were immediately involved*

From the beginning, the CRPPH Steering Committee recommended co-ordinating international efforts in order to gain experience from each other. Since 1986, the IAEA showed its interest, the EC informed about its Group of experts, and the NRC about the ALARA Centre. In 1987-1988, both CEPN and the BNL ALARA Centre were involved in the brainstorming, while in its 1989 decision to set up the pilot project the CRPPH Steering Committee recommended co-ordinating it with the EC.

### *2.3.4 A lawyer may also be a poet: the story of the ISOE acronym*

In 1988, the proposal was to call the system "NEA Occupational Exposure Information System:" OEIS. This was not well sounding and it was important for all those involved to find a good acronym. This was to be the first image of the system and so important for selling the idea.

"We needed to find a name for the system, it took quite long time, finally the name came from Patrick Reyners, legal advisor of the NEA who was heavily involved in writing the terms and conditions. He found a name, International System on Occupational Exposure and said: look at the acronym ISOE; is it not good?" (Christer Viktorson)

Everyone was immediately happy with the acronym and name. Therefore they were endorsed during the CRPPH Steering Committee meeting in 1989, where they appeared officially in the documents.

### *2.3.5 The objectives of the ISOE pilot project*

They are described in a document prepared between March and June 1989:

- To make available to the participants a broad and regularly updated data base on occupational exposure at nuclear power plants and on methods to improve the protection of workers;
- To make available to the participants a system for easy access to information concerning organisations and experts having knowledge and experience on occupational radiation protection problems and dose reduction techniques; and

11. Christer Viktorson, NEA staff member from 1986 to 1994.

- To make available to the participants a mechanism for regular dissemination of updated information on these issues, including evaluation and analysis of data assembled.

Since the already existing systems were not universal either geographically or according to the reactor types, the NEA CRPPH decided in 1989 to set up a pilot project called ISOE aiming at establishing procedures for inter-plant comparability and promoting international exchanges on optimisation of radiological protection. However many problems had to be solved before launching the system.

## *2.4 ISOE birth: enthusiasm has overcome fears and reservations*

When the CRPPH endorsed the project, many reservations and fears appeared here and there. The other international organisations were not convinced that ISOE would not duplicate their systems; the utilities were not used to work in a system with representatives of regulatory authorities. These concerns had to be taken into account and resolved during negotiations.

### *2.4.1 The premises*

Immediately, in 1987-1988, when the CRPPH asked for a proposal, a brainstorming group was set up with Oswaldo Ilari, Christer Viktorson from the NEA staff and Jacques Lochard and myself from CEPN.

*"We can say that the four of us have designed the main features of the system; in other words we prepared the ISOE intellectual settings." (Jacques Lochard)*

This quickly led to a proposal where the system would rely on **an international non-anonymous database** with annual collective doses for each reactor as well as job collective doses completed with dose rate indicators and worker exposure times. This would be completed by a second database with precise descriptions of each reactor component and way of operating (chemistry…) and a third database with sheets for each interesting problem in terms of occupational radiological protection. The other characteristics of the proposal were: – the **members** should be mainly the **utilities**, but also the **regulatory authorities** and eventually the **vendors** (such as Framatome, or Westinghouse…); – the **NEA** should act as a **secretariat** and during the pilot phase as chair; – the database should be run by **CEPN** acting as **Technical Centre** for the system.

In October 1988 the French representatives at CRPPH announced that France was ready to propose one Technical Centre.

*"At the right beginning we did not have in mind to have more than one Technical Centre (CEPN), but soon, having contacted the NRC (as well as all the regulatory authority participants in the CRPPH), they told us then that they had a system run by BNL ALARA Centre. We entered then in contact with John Baum, and BNL proposed itself as a second Technical Centre for North America." (Christer Viktorson)*

By the end of 1988, John Baum had joined the brainstorming group, and proposed to set up two more databases dealing with dose reduction techniques according to its experience. Therefore it was mentioned in the June 1989 proposal that *"the project is supported by two Technical Centres, the CEPN in France, and the BNL in the USA"*, the first being in charge of the dose database management, the second of dose reduction techniques.

America and Europe discussing

During the same time the brainstorming group was then expanded to utility representatives from eight countries (Canada, Finland, France, Japan, Spain, Sweden, the United Kingdom and the United States) as well as CEC and IAEA representatives. Two expert meetings were held, one in September 1988 at the NEA, and one in January 1989, hosted by EDF in France.

### *2.4.2 Challenges to be faced*

*"The first steps of ISOE were difficult and often short but steady,(however)… we got the time we needed to design, redesign, negotiate and convince. It may be worth recalling some of the challenges we had in the setting up of this system." (Christer Viktorson) (NEA, 2009)*

It was necessary to convince the other international organisations that the project was not in competition with their systems; to convince the regulatory authorities and utilities that it would be of benefit being in and exchanging information in the same network. The "main diplomat" in that period was Christer Viktorson, who made quite a number of business trips in the Member States and to International Organisations to promote the ISOE concept.

#### *2.4.2.1 "We are not in competition!"*

*"This is something we have had to deal with: how to convince others that we were not in competition but complementary to and enlarging the existing systems. We wrote a formal letter to the European Commission and IAEA." (Christer Viktorson)*

**IAEA** from the beginning (at the April 1986 CRPPH meeting) expressed its interest in the NEA initiative; however, NEA is supposed to be legitimate for only the OECD countries, while IAEA has officially a legitimacy to cover all UN Member States. Therefore ISOE started with OECD countries only and became a worldwide system when an agreement between both organisations was signed in September 1993 (see letter in Annex-1) giving to each organisation the role of co-secretariat for running the system and in addition giving to the IAEA the role of Technical Centre for the non-OECD countries. Since 1993, the co-operation has always been excellent between the two members of the co-secretariat through the individual commitments of their successive representatives, even if the burden remained more directly on the NEA Secretariat.

As for the **EC**, the problem was different; the EC was already running a system (see 2.2.2 supra) with similar objectives at the European level. So not only the EC, but also the "club members" did not want to duplicate their efforts and their participation in different networks. Here too an agreement was raised, and that quite quickly, as Klaus Schnuer participated from the beginning in the expert groups and told them that if the ISOE would make use of the CEC database format and if it provided annually to the EC all European data (allowing the EC to continue to perform its analyses and run the European Club), then EC would support ISOE. This was officially announced by the Division head at the European Commission, Hans Eriskat, at the 1991 CRPPH meeting and was formalised through an agreement letter during the first semester of 1992 (see letter in annex 2). That agreement was also a requirement from the European members of the EC club:

*"For 10 years I had participated and supported the system of occupational exposure of the European Union, operated in Luxembourg. It was my motivation to get the existing data transferred to an international level and so save all the efforts for generating them. After a lot of fruitful discussions we succeeded to have about the same questionnaire for the data retrieval in ISOE than in the EC and work could be continued with an extended platform." (Peter Jung)*[12]

*"We got the opportunity to extend our EC-system to be international. For Swedish BWR owners it was important because we were only able to compare us with the German. With ISOE we were able to get data from USA and Japan." (Bengt Löwendahl)*

12. Peter Jung, Radiological Protection Manager, Philipsburg NPP, Germany.

### *2.4.2.2 "We, drivers and policemen in the same cars?"*

#### *Great honors are great burdens (pour vivre heureux vivons cachés)!*

As a guarantee that the provided data would not be used against the providing utility, the EC decided within its club of utilities that all data would be made anonymous in the database that would be given back to all providers. Each one knowing its identifying number would be able to find its own data and see where it was situated among the others and then discuss status with others at the yearly meeting. This was not anymore possible in the proposed system:

> *"To start ISOE it has been necessary negotiating with the European utilities two major changes with regards to the previous CEC database system. First, the data should not be anymore anonymous. In a worldwide system, representatives of all plants will never be altogether; therefore, to perform real benchmarking it should be necessary to provide "data per plant" with names of the plants. Secondly, the club was not anymore restricted to utilities only but intended to be open to regulatory authorities." (Klaus Schnuer)*

The two conditions were perceived by the European utilities as contradictory and therefore unacceptable, this can be formulated as "we, non anonymous drivers and policemen in the same cars?"

#### *Working "hands to hands" with our inspectors: are you kidding?*

> *"An answer: confidentiality, first. We saw early on, that a fruitful exchange of detailed information could only be achieved if we could guarantee confidentiality of the data. This meant that the operators would only be willing to exchange detailed information if the system only disseminated it to their peer operators, and not for open distribution. We could manage this by sophisticated database management." (Christer Viktorson) (NEA, 2009)*

As Christer Viktorson explained, some utilities in Germany, the US and Japan were concerned about hearing from their regulatory authorities: *we are the regulatory body, we have the right and even the duty to know everything*. Fortunately,

> *"we had an excellent understanding and support from the major regulatory authorities and the strong support from EDF, the French utility, who provided the first chairman of ISOE (Philippe Rollin) and invited all the experts to Lyons and the Châlons CETIC facility in January 1989 (see supra 4.1), with the presence of a top manager, Laurent Stricker. That support was an opportunity facilitating to convincing of the German utilities. However it has been necessary to multiply the visits and negotiations with different organisations such as VGB in Germany, NUMARC[13] in the US. It was a success with VGB, but it was not so easy to have direct contacts with utilities in the US, and quite impossible in Japan where the only contact was NUPEC[14] a government agency." (Christer Viktorson)*

The major argument we found to push the utilities to that co-operation was that we would set up an international computerised database, which would give them access to all data, not anonymous, and therefore would enable them to perform benchmarking and to contact their colleagues directly.

During the negotiations it was also possible to rely on several utilities. EDF has already been mentioned (but at that time no authority in France was taking care of operational doses) and as well the Swedish utilities:

> *"As we in Sweden already had a very close relationship between the utilities and the regulatory body we were very well prepared for something like ISOE. We were a couple of enthusiastic people from both sides ready to be involved in the idea of ISOE. We saw the opportunity to get*

13. NUMARC has been merged into NEI (Nuclear Energy Institute) when this organisation was created in 1994.
14. NUclear Power Engineering Corporation, now JNES.

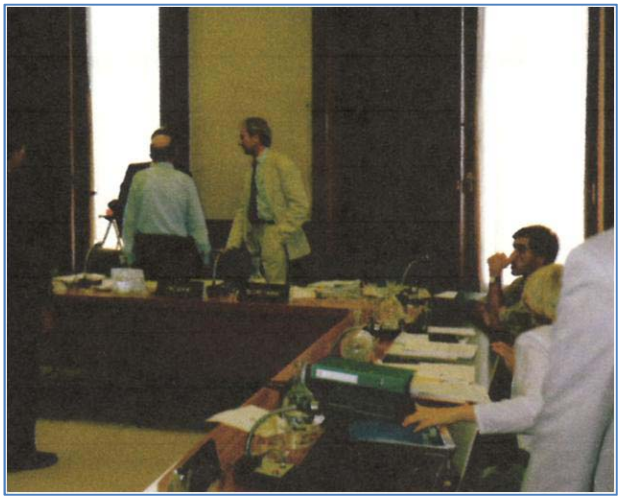
*more information and a possibility to share experiences. It was a base for getting the ALARA concept down to the floor." (Bengt Löwendahl)*

### *2.4.3 Enthusiastic individuals succeeded and ISOE was launched at the end of 1991*

In conclusion we shall say with Christer Viktorson: "I have always seen the project driven by very enthusiastic individuals; not by governments."

So the negotiations, relying on enthusiastic individuals, allowed overcoming the fears and reservations, at least in Europe, Canada, and Mexico, where, quite from the beginning all utilities were ready to participate in such a network. A few years later, most utilities in non-OECD countries also became active members. We will see later on (see infra 5 and 6) how the Japanese and Korean utilities, became in turn active ISOE members, when the language problem was solved. As for the US utilities, the situation remains complex even now.

So during 1989, 1990 and the beginning of 1991 a lot of diplomatic efforts were provided and they succeeded with the official launching of ISOE at the end of 1991.



Osvaldo Ilari, Christer Viktorson, Frank Levy at the ISOE launching meeting in 1991

**A lot of diplomatic efforts were needed. They allowed the positive resolution of most problems; enthusiasm overcame concerns and reservations; the pilot project was considered successful by the end of 1990; and the official launching of the system was scheduled for 1991. The first ISOE Steering Committee meeting took place on the 18th of November, 1991 and ISOE was officially launched on the 1st of January, 1992.**

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# 3. WHAT HAS BEEN THE EVOLUTION OF ISOE?

## 3.1 ISOE: A spider net covering now nearly all NPPs in the world

All of ISOEs first participants shared the expectation that the system should aim at covering the world as a whole, as well as all types of reactors. This was an important incentive for their personal commitment. And more or less that is what happened. The number of participating reactors that started at 169 operating reactors in 1992, has been more than doubled to 323 operating reactors plus 40 shutdown reactors, while data from the remaining reactors are most often provided by their regulatory authorities but in India and Argentina. The database comprises therefore 401 operating reactors and 81 units in cold-shutdown or some stage of decommissioning in 29 countries, covering about 91% of the world's operating commercial power reactors. How has that result been reached?

### 3.1.1 A regional type of organisation to efficiently cover the world

To be efficient in covering the world has induced a regional type of organisation. This appeared very quickly as a need. As already said, initially there was the idea to have a single worldwide Technical Centre that would have been CEPN; but at a time when the internet was not developed and even emails were not so widely used, and where most exchanges were performed making use of diskettes or paper questionnaires, it appeared necessary to set up other regional Technical centres in North America and Asia to collect the data and distribute the database.

During the first ISOE Steering Committee (1991) meeting, Jacques Lochard officially agreed that CEPN would become the European Technical Centre under my responsibility, while John Baum agreed that BNL ALARA Centre would become the North American Technical Centre. The Japanese representative promised then to create an Asian Technical Centre, and until that time to participate through the other two Technical centres. It was also agreed that the financing of the system should be at the regional level.[15]

The financing capacity rapidly had an impact: CEPN succeeded in finding regular resources among all European participants (both utilities and regulatory authorities all around Europe), while BNL did not (neither from American utilities nor from the NRC). This had two consequences. First CEPN was able to develop very quickly the software and the database (see later chapter), which were made available in their first version in 1992. Second BNL was obliged to resign in 1993.

*"After the pilot project, we found that we needed more support from NRC and industry. We got little from the industry and the NRC did not come through with any additional; so we reluctantly phased out our participation. The nuclear industry has its other information exchanges through NEI, EPRI, INPO, Westinghouse, Health Physics Society, etc. So I wasn't surprised that they did not want to contribute to a NRC related activity." (John Baum)*

The question then was "what organisation will become NATC?" None of the existing North American organisations was ready to do it, therefore ISOE agreed with the proposal from David Miller[16] to create a specific organisation to become NATC. He started to act as Technical Centre in 1993, and that became official with the creation of a legal entity, which

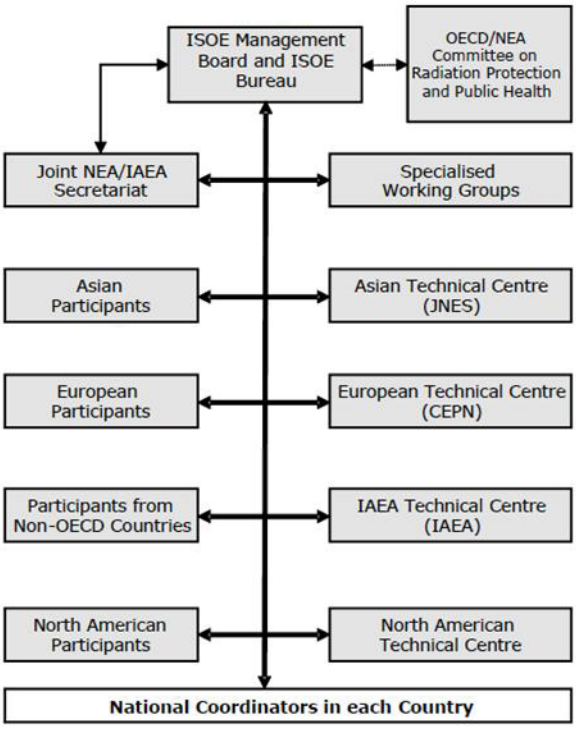
15. ISOE terms and conditions article 8: a) the activities of ISOE shall be financed on a regional basis. Therefore the expenditure resulting from the participation in ISOE by each Regional Technical Centre shall be borne by the Participating Utilities and Regulatory Authorities in the corresponding region. c) Each Participant shall bear all the costs of its own activities for the participation in ISOE.
16. In 1991, David Miller from Clinton (and later the Cook) NPP in the US and Professor at the University of Illinois, was involved in developing a relational database for the plant, and therefore was invited by Osvaldo Ilari to make a presentation at the February 1992 NEA workshop on work management. He became aware of the ISOE through NEA contacts.

existed in 1994 and started to be funded by the NRC and US utilities at the University of Illinois since 1995.

> *"When funding for the U.S. effort was not enough (after the pilot project) David became the U.S. Centre. We gave him all our old reports, etc. I think because David is a nuclear power Health Physicist, (the utilities) felt more comfortable with that arrangement." (John Baum)*

In 1992 the Asian Technical Centre was set up by NUPEC and following the agreement between IAEA and NEA, the IAEA became the fourth Technical Centre in 1993 for taking care of all non-OECD member States. In 1998, the IAEA became a co-secretariat with NEA; and since 2004 there exist national co-ordinators in each participating country.

**Figure 4: ISOE organisation**




### *3.1.2 The NPPs world is now widely covered*

Even if from the beginning all OECD world regions (Europe, America and Asia) were represented at least by regulatory authorities or institutions close to them, not all utilities became immediately members of that "club".

*1990-1992: the launching period*

During the launching period, as a result of the negotiation between NEA and the EC, and following all the efforts from Christer Viktorson (see above 2.4.2.2), most nuclear power plants from the European Union and associated countries (in the European 1990 context) became quite immediately official participants in ISOE. This covered ***Belgium, Finland, France, Germany, Spain, Sweden, Switzerland, and the Netherlands.*** The French EDF provided the first ISOE chair: Philippe Rollin. However, despite the continuous efforts from the UK regulatory body, the British GCRs never agreed to participate.

The ***Canadian*** utilities were also immediately participating actively (Arif Khan from Ontario Hydro was the first Vice chair). The ***Japanese*** utilities also became official members,

even if their contacts with the system were, for a long time, mainly through NUPEC; an Agency from the regulatory body.

No US utility was participating at that time and this remained the case up to the official launching of a formal NATC.

In Europe we shall mention an interesting lesson learned from that period:

*"For Germany we succeeded in that the ISOE questionnaire was also used for the annual official reporting to the Authority. This was a breakpoint for the acceptance of the system in the German utilities." (Peter Jung)*

This has also been the case in many European countries such as Spain, Sweden, and Switzerland, and we shall remain surprised that such a procedure has not widely spread to other countries.

At the end of the period at the Steering Committee meeting in 1992 it was stated that:

*"it would be of benefit to the present ISOE participants if the system could be broadened to include participation from as many countries as possible operating commercial NPPs."*

Therefore the Steering Committee supported the agreement between NEA and IAEA to bring all non-OECD countries NPPs into ISOE through an IAEA Technical Centre. It was also stated that these non OECD NPPs would participate in the system without participating in the financial burden of software development and other charges. This has allowed a wide extension of the system during the second period.

### *1993-1996 a first wave of participants through the IAEA*

During that period, following the action of IAEA, and particularly of Monica Gustafsson,[17] all NPPs from the ex-eastern bloc, and potential candidates to join the European Union became participants of the ISOE: this was successively the case of ***Hungarian, Czech, Lithuanian, Slovenian, Slovakian*** and ***Romanian*** nuclear power plants.

Other countries belonging to the IAEA region progressively became members of the ISOE. This has been the case for ***Mexico, the Republic of China, Korea, South Africa*** *and* ***Brazil.***

During that period, the NATC action allowed the number of US utilities participating to grow from 0 to 25 units in 1996.

### *1996-2003 the second wave through the IAEA from the ex Soviet Union*

During that period, the IAEA succeeded in bringing into ISOE the NPPs from the ***Russian Federation*** and some other close countries: ***Armenia, Ukraine, and Bulgaria***.

At the end of the period another country belonging to the IAEA region, ***Pakistan,*** also became a member of the ISOE. It has been the last totally new participating country.

Some modifications have occurred in the regional Technical centres' responsibilities according to the new membership to the OECD of several countries who first belonged to the IAEA Technical Centre and who were moved to another Technical Centre. That has been the case for Korea in 1993, Mexico in 1994, the Czech Republic and Hungary in 1996, the Slovak Republic in 2002, and Slovenia in 2011.

### *Since 2004-*

Since then the only evolutions in terms of formal participation from the plants have been:

17. Monica Gustafsson, coming from the Swedish Vattenfall utility, joined the IAEA in 1994 and was immediately in charge of the IAEA TC.

- That of the US utilities reaching in 2012, 70 reactor units among 104 participating in the system. However contrary to most other participants the US units do not yet enter the data by themselves. It was and is still considered as a task for NATC.
- Newly commissioned plants beginning commercial operation in the above mentioned countries became participants immediately, while those units that were definitely shutdown became members of a new database dealing with units in decommissioning.

### *3.1.3 A turn in Korean and Japanese participation*

Another more qualitative evolution has been the much more active participation in ISOE of all Korean and Japanese utilities as a result of efforts by Seong Na[18] and Wataru Mizumachi.[19]

Seong Na discovered ISOE when he became head of its IAEA Technical Centre in 1998. Very quickly he became enthusiastic and favoured the development of an interface between the ISOE software and Korean utilities (the KISOE system), and he has been even more active since going back to Korea in 2002.

*"To motivate the utilities to establish an ALARA programme in the Republic of Korea, I emphasized the importance of the role of ISOE as well as its proactive leadership to collect and disseminate live information." (Seong Na)*

Wataru Mizumachi participated for the first time in 2003 at an ISOE Steering Committee meeting; he showed a great enthusiasm for the ISOE, allied with an important sense of humour and colourful poetic images. Through ISOE he was aware of the lagging dose results of Japanese plants since 1992, when they were relatively good both for PWR and BWR to the beginning of the 21st century when they became relatively poor (in particular for the BWR) in comparison with the others, which had drastically improved their situation.

*"I talked about that situation with the presidents of ten Japanese utilities. Their answers were as follows "I was reported our dose is the best in the world. Why do you talk ill of us?" I repeated my message again and again and they finally looked at the ISOE graphs and realized the facts." (Wataru Mizumachi)*

Following these individual initiatives, through a lot of other initiatives that will be developed in the next chapter, the Korean and Japanese utilities became directly involved in ISOE, both in providing the data to the ISOE database, participating in workshops and so on.

### *3.1.4 Still some restrictions*

*Some countries' NPPs are still expected to become participants*

There have been several attempts to welcome the commercial nuclear reactors from Argentina (PHWR) and India (PHWR and BWR) as well as the GCR units from the UK. They have not been successful up to now. LWR from Taiwan are not yet participating either.

*The contractors cannot be ISOE official members*

The contractors are important partners of the nuclear facilities either as vendors or as providing their workforce during in-service inspections, and maintenance and back-fitting jobs. Therefore many of them have shown their interest in ISOE right from the beginning. The

18. Seong Na was IAEA TC head from 1998 to 2002 and then being back in Korea he became regulatory body vice chair in the ISOE bureau.
19. Wataru Mizumachi was chair elect of ISOE in 2004; since 2001 he was Director General of the Safety Information Research Centre of NUPEC (NUclear Power Engineering Corporation) and General Manager of ISOE Asian Technical Centre. He was ISOE chair from 2006 to 2008.

question of setting for them a third category of participants (at least for the main vendors such as Westinghouse, Framatome, Siemens, Mitsubishi…) besides the utilities and regulatory authorities was raised at the 4th ISOE Steering Committee meeting in 1994. A decision was taken at the 5th ISOE Steering Committee meeting in 1995 not to create that third category. The Steering Committee members decided that, even if these contractors have a lot of experience in managing occupational radiological protection, there was a risk of manipulation and confusion between commercial stakes and workers' protection; therefore the contractors were not accepted to be members of the system, nor allowed access to the database.

However a solution was quickly found to allow their experience to be taken into account and shared: their active participation in ISOE workshops and symposia was largely favoured.

*Regulatory authorities do not have access to all data*

As previously said (see 2.4.2.2) this was a major condition for the participation of most European utilities to the system. They wanted to continue working, at least partly, in a club. However relying on the fact that each regulatory authority is to require whatever data it needs in its own country, the Spanish and Swiss regulatory authorities requested in 1994 to get the right to access all data in the data base. After a large discussion their access to the ISOE 3 data was largely denied, and the access to dose per jobs and tasks in the ISOE 1 database remained denied.

**After 20 years, the ISOE objectives of covering the world are nearly reached, with 323 operating reactors and 40 shutdown reactors participating. This has been achieved progressively with the help of very committed individuals in the different world regions. The system has now really become a worldwide international network, with nearly all operating plants and many in decommissioning and nearly all types of commercial reactors, being members of the system.**

## *3.2 ISOE continually evolving on work and communication technologies*

The first three years of ISOE life were mainly devoted to the setting up of the database and of the needed procedures and tools for running the system, collecting the data, keeping them, analysing them… There were a lot of technical problems to be solved; therefore this chapter will be devoted to the evolution of techniques and its impact on the evolution of the ISOE system and life. It will not be devoted to only the first three years, but as improving communication tools has been a constant and recurrent concern of the system, the chapter will address it globally.

### *3.2.1 Could we imagine such a network more than 20 years ago?*

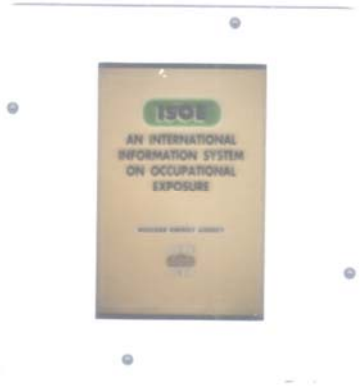
We are so accustomed today to the modern means of communication. Who can now imagine life without mobile phones, e-mails, searches on the internet, exchanges making use of web forums and working without very fast and powerful personal computers?

- We cannot even imagine a network functioning without all these tools!

But 25 years ago, most of these working and communication tools did not exist or just as promises, not commercialised and not powerful.

When starting the 20th anniversary report, I asked John Baum to provide me with some material from the beginning and he sent me by post 20 film slides we prepared for the very first ISOE presentations. That led me to think about the interaction between the evolution of working and communication technologies and the "technical success" of ISOE. What was far is now close, what took so long is now done more quickly.

**Figure 5: ISOE slide, from the beginning of the 90s**




Those, who worked 20 years ago and before, can remember very well how long it took preparing a presentation with slides. First, you had to write your paper by hand, give it to a secretary who typed it, then you circulated copies to colleagues in your team, or outside sending them by post; all remarks came as handwritten notes, and after several retypings you were ready to prepare your slides. Again you drew them by hand and sent them to a technician, who redid them by hand, but beautifully; when they were ok you sent them to a professional printer, and when the printing was ok you sent them to a photographer who made the slides on films. One way or another it took between one and two months. Nowadays when going to a meeting, you spend two hours in the plane or train and that is enough for you to prepare, on your personal computer, some "power points" that you will project when you arrive at the forum. During the way back you will type, on the same PC, the minutes of your meeting.

At the same time, electronic dosimetry allowing connecting dose to tasks and jobs, was seldom or only recently installed in some NPPs. When it was, the collection of data often remained more focused on individual doses than on doses for a task. Therefore the data to be put in the database were not so easy to collect.

The office computers, up to the end of the 70s, were totally devoted to scientific programmes; they were not at all used to support office automation. The first Apple Macintosh computer appeared in 1984 with 128K of RAM. The PC was introduced for jobs in offices and the IBM PC followed it with some delay, and computers became quite user-friendly when equipped with Windows, in particular Windows NT in 1993!

As for the internet, it became commercial only between 1996 and 1998.

**We cannot discuss ISOE history without putting into perspective the evolution of all these techniques and their immediate use by the system.**

### *3.2.2 Technical situation within the Precursors*

As already stated, when the European Commission set up its "club", they immediately decided to create a numerical database with doses per plant and jobs. Marco Ferrario, at the ISPRA EC Centre, developed the database software. He made use of the Oracle system as it existed at the beginning of the 80s, not working on PC, not user-friendly, not customised, not useable by non-specialists. Therefore the electronic database was not accessible to the participants; they had only paper copies of it. The only evolution came from EDF when it provided the EC with data on diskettes at the end of the 80s. Reversely all questionnaires were sent on paper. The "network" existed mainly through the annual meetings to which members were able to come.

As for BNL, the data, namely libraries of documents and sheets, were assembled in various databases and periodically disseminated to several hundred interested participants

through a variety of publications and at technical meetings. Since January 1992, after some software developments, on-line access was also provided to persons with fax machines.

Before ISOE the precursors made use of paper at the beginning of the 80s, this was completed by Fax (BNL but only in 1993) and diskettes (EDF to EC). The output was always on paper, without any possibility of making queries of the database: there existed no real search tool and even less possibility to do benchmarking… ***None of the precursors was able to provide ISOE with adequate software to collect, distribute and analyse all expected data.***

### *3.2.3 Why not create a start up? The EXALOG experience*

What about the available tools on the market? Did they allow creating and running the three expected databases (ISOE 1, 2 and 3), allowing each member to perform benchmarking analyses adapted to its need? Frank Lévy, software developer at CEPN/ETC, recalls the answer we gave at that time:

> *"Windows was not widely spread everywhere and we made use of computers with Microsoft MS-DOS. A few DBMS (database management systems) such as Oracle and Ingres were already commercialized; however, they were very expensive, heavy and difficult to run, some features not relational and not easily customizable."*

We can say that no DBMSR (R for relational), was able to meet our expectations. But we were totally confident in the capacity of the technology to evolve in a way that would allow us to develop software meeting ISOE needs.

**Figure 6: The Exalog key**

No DBMSR software on the market? **Let us develop it by ourselves**! That is the reason why in 1990 Jacques Lochard, myself, with Dominique Gillaizeau and Frank Lévy, the two CEPN software developers, joined another software developer, Alain Janssoone, to create a start up called EXALOG for developing the DBSMR support: the EXADATA system. In parallel we developed the ISOE software under EXADATA, making use of all new EXADATA functions as soon as they were developed by EXALOG on our request.


The Exalog key

### *3.2.4 ISOE has always been fast reacting to the evolution of technologies*

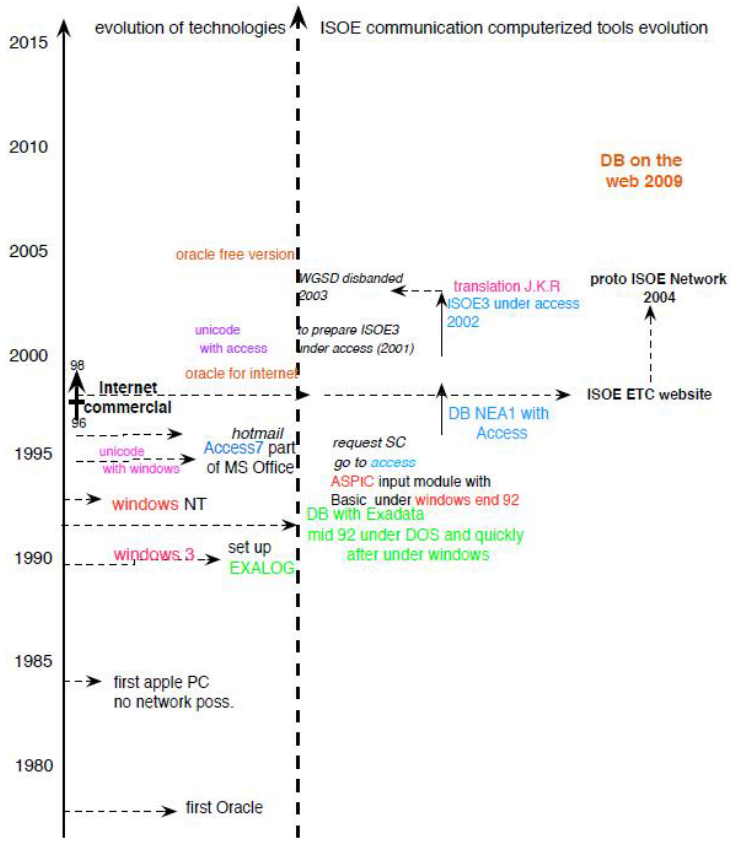
The history of the ISOE software is summarised in the following graph and put in parallel with the evolution of technologies. One can see that most technological evolutions, as soon as they were commercialised, were quickly integrated into the ISOE tools.

ISOE was launched in November 1991. We developed the first ISOE software under EXADATA for managing NEA1 data (now ISOE 1) and distributed it by February 1992. It needed users to be trained for using it and to get a special key. After a few training sessions it was decided to develop separately, an input module under Windows called ASPIC. We made it available at the end of 1992 (NUPEC developed in 1993 a look-alike ASPIC in Japanese). It did not need any license, nor training, and started immediately to be widely used, with the help of user manuals, by the European utilities and most IAEA participants.

Then, as soon as the Access DBMS developed by Microsoft was integrated into MS Office in 1995 i.e. made available all over the world on most computers, we transferred, at the request of the 5th Steering Committee, the database and its management to Access. We developed therefore MADRAS under Access both for ISOE 1 (1997) and later ISOE 3 (2002). This was an opportunity for developing radiological protection predefined analyses in so-called “push buttons”, which immediately became useful to many participants, and gave rise to many “brothers” during the following years at the request of the participants.

One major improvement that was made possible by the integration of Unicode in Access 2000, was the possibility to translate all the screens and libraries in Japanese, Korean, and Russian. Our Korean colleagues made this possible in 2003. After that the Steering Committee Working Group on Software Development (WGSD) led by Wolfgang Pfeffer from GRS in Germany was disbanded.

**Figure 7: Respective evolutions of technologies and ISOE tools**



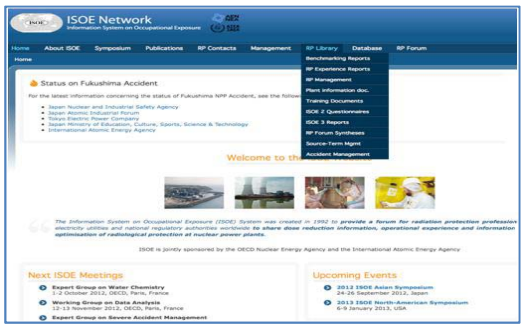

DB = database ; PC = personal computer
SC= Steering Committee ; MS = microsoft ; J.K.R =Japanese, Korean, Russian

Was it finished? NO, some new developments on the Oracle DBMSR have allowed managing the access to a database through the internet since 2000, and a restricted version was made available for free in 2005.

As already said, the internet itself became supported by commercial servers only between 1996 and 1998; the ETC website was open in 1997, and an ISOE web was prepared and has been run by ETC since 2004; it is the so-called ISOE Network. But with the increasing role played by the internet worldwide and the evolution of Oracle that became compatible with the internet, in 2004 the bureau requested the transfer again of the database and its management under Oracle. This would allow a direct access to the updated database at any time without waiting for a release; this would also allow sending the input data directly through the web and facilitating the follow-up of the different QA steps.

**Figure 8: ISOE Network web site**

NEA software developers performed that new transfer. The database has been since 2010 located on the NEA server, and its access is very strictly restricted. Since 2009 the questionnaires are also available on the web for the data input by the NPPs.




Lucie d'Ascenzo from CEPN ETC, webmaster of the ISOE website, and administrator of the world database considers that last development as very successful:

*"After three years most utilities make use directly of that new type of input system, except for those utilities which do not allow any web into their facility."*

Let us come back now to the non-Latin characters problem which was "hidden" for more than one decade.

### *3.2.5 Sorry, English is not our mother language*

The first time we (Osvaldo [Italian], Christer [Swedish] and myself, [French]) had a meeting with colleagues from Japan at the NEA for describing to them the ISOE project and database and for requesting of them the participation of all Japanese utilities in that exchange, the discussion was not so easy. Their conclusion was *"sorry, we cannot positively answer you; English is not our mother language"*.

And then for around ten years, ISOE had no direct contact with Japanese utilities. The regulatory body provided regularly all data dealing with annual collective dose per plant and eventually unit from Japan, through NUPEC, which has become the Asian Technical Centre.

No Japanese utility had access to the ISOE database, and as we said NUPEC developed its own ASPIC-like input module to be able to provide ETC with ad-hoc data. During that whole period there was no end user of the ISOE software and database in Japan, or in Russia, China or Korea. We prepared translations of the libraries dealing with each screen, but it did not work.

***No one understood that for "their" software, "ours" were not understandable***. And that remained the situation up to when Seong Na worked at the IAEA, running the IAEA ISOE TC. He came back one day to the WGSD and told us:

"Each Latin character makes use of a single byte, while our characters as well as Japanese or Russian and Chinese, make use of either 1 or 2 bytes each; therefore your software cannot handle any translation of screens, menus… in our mother languages."

Seong Na

Our colleagues could have said to us:

***Sorry, your one-byte software language is not our mothers' two-byte software languages***

Fortunately Unicode had developed useful translation software and integrated into Access in 2000/2002; therefore, it was possible to modify our codes in order to be able to provide the questionnaires in these countries, making use of their own languages: this was done by 2003. Now all Japanese and Korean utilities provide their data directly through the web system (which is not yet the case for Russian utilities).

Of course referring to our previous remarks it is also worthwhile to mention that nowadays, each individual has in his office personal computers, most of them having access to the web, while all the NPPs are equipped with electronic dosimeters and have set up software allowing the analysis of dose per job (and in many cases following the ISOE breakdown).

**One major condition of the ISOE success has been the provision of very user-friendly tools for collecting, retaining and analysing needed data for the implementation of efficient benchmarking and trends follow-up. This has taken time and has surely not reached its end stage. However we have demonstrated that the technical evolution of the ISOE computerised tools has always followed very quickly the commercial availability of new and improved software and communication tools. This has been a necessary condition for the ISOE success; however, it is not sufficient for explaining the actual impact of the network.**

## *3.3 ISOE: from a technical to human Net*

From the beginning human relationships were fundamental in ISOE (enthusiasm of the ISOE "ambassadors", tradition of "being together" at the annual EC meetings or at BNL symposia). However, ISOE itself at the beginning was more focused on technical aspects than on a human relational network; but it has evolved very quickly from a database to a real human network. This can be illustrated through the evolution of ISOE products**.**

### *3.3.1 Building the core technical tool*

The first three years of ISOE were mainly technical and devoted to the setting up of the database software, and of the procedures to collect data and distribute them. These were the main topics discussed by the Steering Committee during its three first meetings (1991 to 1993). The last symposium from BNL took place in 1989 and the next one was expected for 1994. ISOE was building its core technical tool. ISOE was not at all a room for direct experience exchanges. One important and appreciated output from the database was the first annual report (1993) that we prepared at ETC, analysing trends and comparing situations between the countries, the world regions, the types of reactors… ETC prepared the following annual reports alone up to 1997 when it was decided that they would be prepared by the secretariat and bureau.

There were very few direct contacts at that time except at the Steering Committee meetings where mainly European radiological protection managers met with regulatory authority representatives. ISOE 3 was supposed to favour direct exchanges, but the database started slowly, filled with 20 new questionnaires per year, and that number has decreased to less than 5 formal exchanges now.

### *3.3.2 Obstacles to be removed for enabling real benchmarking*

Our French experience with running the EDF database had showed that inter-comparisons were the most interesting when the reactors (here all PWR from Framatome) belonged to the same generation.

Obviously one very interesting point ISOE could have addressed is the opportunity to find within a group of similar reactors, those with the lowest doses and then to do more detailed

analysis trying to understand why they are so good (short outages? small total exposed workforce? low dose rates? …), and finally to contact the radiological protection managers from these units to learn more about their "good practices".

To create groups of similar reactors we imagined **the concept of sister unit groupings,** making use of their technical characteristics, for each vendor both in PWR, in BWR and later on in CANDUs and VVER… The sister unit groups were set up consensually between 1996 and 1998 within WGDA (Working Group on Data Analysis) created by the Steering Committee in 1994. It then became possible to analyse one reactor's doses with regards to doses at units in its own sister group and eventually doses at units in similar sister groups.

*"The ability to benchmark with sister plants was of great value and shows the importance of the ISOE system as an international organisation." J-Y Gagnon*[20]

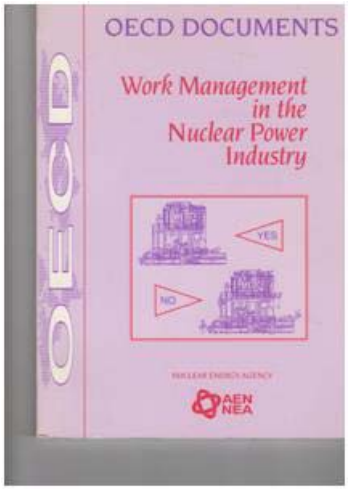
Another problem to be solved was that 53% of the annual dose data were provided at the level of the plant not of the unit, even if outages doses were unit related. That was due to the dosimetric software systems, which were based on individual doses, not necessarily related to the unit they worked in. To perform benchmarking, it was necessary to define rules allowing splitting the non-outage doses on the plant between the different units.

### *3.3.3 An increasing role of work management*

By the mid 80s the role of work management in occupational radiological protection became a major topic (see above 2.3). In parallel to the setting up of ISOE, NEA, following the impulse of *Osvaldo Ilari*, in 1992 organised a workshop on work management in occupational dose control in NPPs.[21] It pointed out that a fourth word "Commitment" had to be added to the three "Time, Distance, Shielding", which were often used to characterise radiological protection. Later in 1992, CRPPH was requested to set up a group on work management and commitment and asked ISOE to take care of that.

Therefore ISOE set up in 1994 an Expert Group on Work Management, which quite soon decided to prepare a report on those topics describing good practice examples from all over the world. The Group chaired by *David Miller*, issued that book by the end of 1995. It was later published by NEA (NEA, 1997) and, as it was very well received, translated into German and Spanish by the ISOE participants and Russian and Chinese by the IAEA.

A second NEA Seminar relying on the topics discussed in that book was organised in November 1995 and the book was used as material for many presentations all over the world.




Due to the very good impact of that first book, *Wataru Mizumachi (when he became chair of ISOE in 2006)* initiated, with the help of Caroline Schieber[22] as vice chair of a new working group, the development of an updated version of the book. NEA published this second version, which included new examples, in 2009 in English and French. Those who participated in these two successive Expert Groups as well as those who received the end

20. Jean-Yves Gagnon, is a manager and has been the ALARA Co-ordinator of Gentilly-2 NPP in Canada; He was the WGDA chair from 2000 to 2004 and ISOE chair from 2004 to 2006.
21. NEA workshop on "Work management in occupational dose control in NPPs", 4-6 February 1992, Paris.
22. Caroline Schieber, from CEPN ETC, performed many studies on these work management topics for EDF. She has been the head of the ISOE ETC since 2006.

products attest that it has been an important step forward in the ISOE life; many participants in their answers to the ISOE 20th anniversary questionnaire considered them as particularly efficient.

*"In the beginning we got more data from ISOE. Better compiling and presentation. Later matters like ALARA and work management became of vital interest for us; The work management study was also directly related to the project of spreading the ALARA message in the former Soviet countries (It may have been IAEA projects, but it was in my mind initiated by ISOE)." (Bengt Lowendahl)*

*"The meetings for developing the first Work Management Handbook were very challenging." (Peter Jung)*

*"Some foreign colleagues (in particular Japanese) were having difficulties with the ALARA concept and on the way to use it, to implement it. We were able to have very good conversations with them and provide them with a lot of examples on how to more effectively implement the ALARA concept, making use of ISOE, in particular the work management book." (Rick Doty)*[23]

*"The publication 'Work Management to Optimise Occupational Radiological Protection at Nuclear Power Plants' was a very practical collection of good practices to improve the management of occupational exposures at nuclear power plants." (Teresa Labarta)*[24]

*"From the IAEA point of view, it was important to make such material available in the languages, which health physicists, regulators, managers and others could understand." (Monica Gustafsson)*

*"The ISOE-wide activity that impressed me the most was the development of the second edition of the ISOE publication on work management. This activity captured the attention and interest of the ISOE membership, and was something to which the community was motivated to contribute as a whole. The development of this report provided a clear opportunity for the ISOE membership across all four ISOE regions to contribute their specific technical expertise and real-world examples." (Brian Ahier)*[25]


Wataru Mizumachi as chair of a session on work management in a symposium

That initiative, even if implemented by small groups, allowed the development of a real network of individuals with personal contacts all over the world.

23. Rick Doty was Radiation Protection Manager at the Susquehanna NPP, in the US.
24. Teresa Labarta is a member of the CSN.
25. Brian Ahier from Health Canada joined the NEA staff from 2005 to 2010 and was ISOE joint secretariat during that period.

### 3.3.4 Promoting direct exchanges between participants

#### 3.3.4.1 From small groups in the topical sessions

Developing professional personal contacts was a request from the Steering Committee members; mainly European colleagues expressed it at the 1993 meeting. Therefore a one-day topical session, built with the example of the EC annual meetings, was organised at the occasion of the next Steering Committee meetings. It allowed all participants to learn and exchange information on two topics per year for three years.

Fuel failures and Steam Generator Replacements in 1994

Electronic dosimetry and chemical decontamination in 1995

Primary water chemistry, and ALARA training and tools in 1996

This was a plus, but this remained targeted to a quite restricted audience, slightly enlarged with regards to the Steering Committee members. Therefore as soon as workshops and symposia appeared the topical sessions were suppressed.

#### 3.3.4.2 To a large audience in the symposia and workshops

In 1997 NATC took up the experience and role of both BNL ALARA Centre Workshops and of the Westinghouse Rem Seminars.[26] It organised the first NATC ALARA symposium in Orlando (Florida, USA); other symposia were organised every year by NATC in the US followed that first symposium. These symposia became a core NATC action in North America (see in Annex 6 the list of all symposia).

European and Asian members were invited as well as ETC, ATC, NEA and IAEA.


Welcoming all participants to the symposium there was now a need for big parking lots

It was not surprising that few European and Asian representatives participated for cost and time reasons. As said, the ISOE 3 database on problems to be solved and solutions to be considered was not well used. That was pointed out in the global Critical Review performed in January 1997, after a decision from the Steering Committee in 1996. This was a major problem for the survival of ISOE: the major objective of promoting international exchange of experiences on ALARA solutions to radiological protection problems was not sufficiently accomplished.

Therefore, coming back from Orlando, ETC immediately proposed following the NATC example and recommended organising every second year a 3 day symposium. The first one was run in 1998 in Malmö, Sweden, jointly organised with EC. It was a great success. As proposed, other symposia have been held every second year in a different nuclear country in

26. Rem seminars open to all LWR representatives were organised at Westinghouse (Pittsburgh) from 1978 to 1997, when they were replaced by the ISOE NATC symposia.

Europe. Of course these symposia on both sides of the ocean were mainly devoted to plant radiological protection experts, but they were also open to all regulatory authorities and vendor representatives.

A few years later, ATC decided to organise such ALARA workshops in Japan. The first one took place in Hamaoka in 2005. It was also a success. Since then, one workshop is organised every year in Asia, either in Japan or in Korea. In 2009 the IAEA Technical Centre also organised one symposium in Vienna.

Looking at the answers to the questionnaire, we can tell that these workshops are now unanimously presented as the basic element of the ISOE's success. This is the opinion of both utilities', regulatory authorities', Technical Centres', and international organisations' representatives. This is the forum where it is possible to exchange experiences with other international professionals you trust. I will not quote all those who have said that, but only a few:

*"One major ISOE output are the ALARA Symposia which not only give participants opportunities to share experience but also give them a forum to discuss and organize further follow-up activities like the planning and organization of benchmarking visits between different utilities." (Jean Yves Gagnon)*

*"The system, and especially the Symposia, gives to the participants frequent and fruitful possibilities for international experience exchange. With personal contacts built on trustful relationship the system starts to improve the local RP work." (Carl Goran Lindvall)*[27]

*"I am impressed by most of the events and think all were of quality – from the 2011 meeting in Cambridge, which was an excellent meeting, as was the 2012 ISOE meeting in Florida." (Willie Harris)*[28]

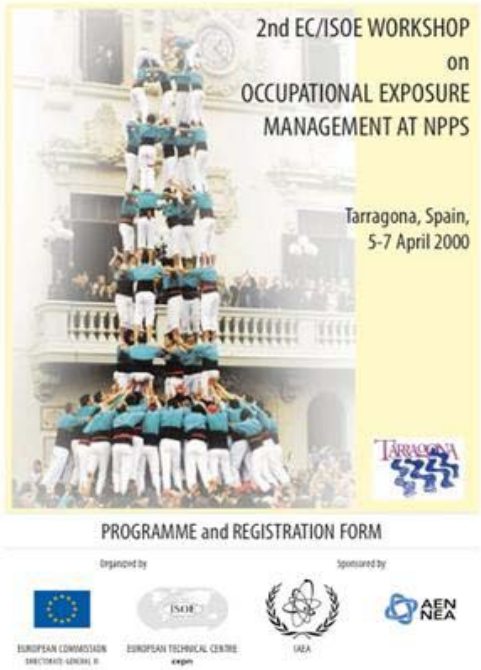
*"I have been impressed at many ISOE conferences and meetings about the enthusiasm of the participants in discovering future practices in operational RP."(Borut Breznik)*[29]

*"For me personally the international ISOE workshops, with a lot of substantial discussions and experience exchange on radiation protection techniques, concepts but also politics, were a very helpful output." (Peter Jung)*

*"I am impressed by the International ISOE ALARA Symposia, because they joined in the same place many experts over the world, presenting successful cases." (Marcos de Amaral)*[30]

27. Carl Goran Lindvall is Radiation Protection Manager from Barsebäck Swedish NPP. He was the ISOE chair from 2002 to 2004.
28. Willie Harris is Radiation Protection Manager at Exelon Corporation in the US. He is the ISOE chair-elect since 2010.
29. Borut Breznik is Radiation Protection Manager of Krsko NPP in Slovenia. He was the ISOE chair from 2000 to 2002.
30. Marcos de Amaral is Radiation Protection Manager from Angra NPP in Brazil.


ETC: A bridge between us




ETC: Team work

Essen ETC 2006 working in small groups

### 3.3.5 *Human being "rules" are quite universal*

With the organisation of such symposia, the objective of feedback exchange of good ALARA experiences was partly reached at regional levels both in America, in Europe, and in Asia. However the objective of the worldwide network was not fully reached as any real exchange between world regions occurred, neither through frequent use of ISOE 3, nor through many individuals crossing oceans for attending the workshops.

The idea of distinguishing the best presentations came from America. Let us present the following conversation[31] between Ted Lazo,[32] myself, David Miller, and Wataru Mizumachi:

*Ted: "The concept of awards is typically American. David from the beginning you multiplied the awards in your own workshops, and the common idea here, in Europe, is: this is typically American, we do not need such behaviour, it will not work."*

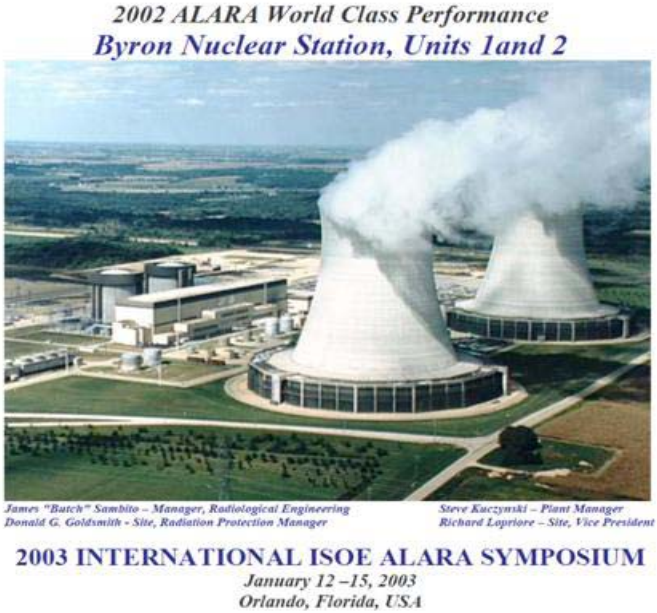
*David: "Yes, it works well in North America; but why don't you try it? There is no reason it will not work elsewhere."*

*Christian: "Yes why not? David convinced me, I think that it is a good idea and may be a way to set up some worldwide exchanges, by selecting in each region the best papers to be invited for presentation in the other regions."*

*Wataru: "Absolutely, every utility joins their regional symposium. They all make good presentations. If we select the best paper and if the author is automatically invited to the next International Symposium, this will provide an even better motivation. I am so enthusiastic with that idea!"*

*Ted: "Let's do it then!"*

So, this was done for the first time at the Orlando NATC symposium in 1999, and the three distinguished papers were presented again at the Tarragona (Spain) ETC symposium in 2000. As well, the distinguished paper from Hamaoka in 2005 came to Essen in Germany in 2006. And since then, it has continued regularly from one symposium to the next. So it works well, and one can say that human "rules" and feelings are quite universal.




Y. Kashimoto, Shikoku Electric Power Co, Japan; the author of the first distinguished paper from Hamaoka ATC symposium in Japan 2005 at Essen in Germany for the 2006 ETC symposium

31. To be more simple and pedagogical, that conversation is a mix of several discussions that took place at different times from 1997 to 2004 and different locations (in the US, in Europe and Japan). However, all has been said.
32. Ted Lazo is NEA staff member since 1993.

### *3.3.6 Possibility to meet sometimes without the regulatory authorities*

But where to exchange what you do not necessarily want to share fully with your regulatory body when you are working in plants? Very often in the US there are meetings of the radiological protection managers from the plants in the PWR or BWR groups. ETC and the IAEA TC have taken that experience into account by proposing new solutions. ETC has supplemented its symposia with an added day devoted to only radiological protection managers.

Then the question was: why not give a similar opportunity to the regulatory authorities? Therefore ETC, since its Lyon symposium in 2004, has allowed for radiological protection managers' and regulatory authority representatives' meetings in parallel. And this works very well.

*"The organization of ISOE symposia by the ETC has been consistently superb. The recent European Symposium in Prague was very good. Most of the radiological protection managers' days have been well attended, with enthusiastic participation." (Guy Renn)*[33]

*"The European Symposium in Turku and the Asian Symposium in Kyoto were very well organized with professional agendas. The radiological protection managers' days were also very well organized with tremendous number of participants." (Vasile Simionov)*[34]

An ISOE Radiological Protection Managers' day

*"I personally appreciate very much the Symposia, with special mention for the regulatory meetings, and the meetings of the Management Board. They offer the opportunity to discuss in an open way, topics of interest." (Teresa Labarta)*[35]

19. Guy Renn is Radiation Protection Manager from the Sizewell NPP, first PWR in the UK, and the single British plant participating in the ISOE.
34. Vasile Simionov is Radiation Protection Manager from the Cernavoda NPP in Romania; he was ISOE chair from 2008 to 2010.
35. Teresa Labarta is a member of the Spanish regulatory body.

An ISOE Regulatory Authority Representative's day

The IAEA has set up the VVER and RBMK group mainly for Russian speaking radiological protection managers (health physicists group). This worked very well for a few years, but is not supported anymore by IAEA. As said Vadim Glazounov:[36]

*"From the point of view of all my Russian colleagues, the Group has been very useful, and we are disappointed it does not exist anymore; we should appreciate any initiative for setting up again such a Group."*

*"We performed a dose rate measuring program for 3 years. We analyzed the differences in dose rate and we tried to explain the reasons of the differences. It was really beneficial for all the participants. Unfortunately the Group stopped its work, I do not know why." (Gabor Volent)*[37]

### *3.3.7 Peers visits in plants through ISOE*

The benchmarking site visits, relying on a plant selection making use of the ISOE database, and finding contact persons in that database or after personal contacts during an ISOE workshop, were started in 1994 at the initiative of David Miller. They are now also organised by ETC and ATC.

They give rise to reports that, because of the topics covered, are available either for the utilities only, or also to regulatory authorities or even the public.

### *3.3.8 New sub-networks and groups for spreading ALARA culture in the non-OECD countries and in particular ex eastern bloc NPPs*

When Monica Gustafsson arrived at IAEA, her experience in the nuclear field helped in speeding the process. She organised with ETC in December 1994 a meeting for representatives of the first ISOE participants through the IAEA.

36. Vadim Glazounov is head of department on optimisation of occupational exposure during maintenance and repair work in Russian NPPs at VNIIES (the Russian utilities Technical Support).
37. Gabor Volent works at Paks NPP in Hungary; he used to be the Radiation Protection Manager.

December 1994

Quite soon, she reached the conclusion that in many countries, the radiological protection culture was not sufficiently focused on ALARA. There was a need to elaborate, with the help of a group of experts, a strategy relying on ISOE and EC experiences, to spread as much as possible that culture among the non-OECD countries NPPs.

The VVER/RBMK health physics group meeting in Bulgaria, 2003

Spreading that culture was also a kind of a prerequisite for an active participation in the ISOE system. That strategy mixed training sessions for radiological protection managers, information for plant managers and regulatory authorities, and the setting up of groups of health physicists from the VVER and RBMK plants in Europe, and other groups in Asia. The IAEA Department of Technical Co-operation provided funds to support the participation of NPPs and regulatory authority staff representatives in that programme.

*"Two regional IAEA/TC projects on 'Improving Occupational Radiation protection in Nuclear Power Plants, one (1997-2004) in Central and Eastern Europe and in the republics of the former Soviet Union; the other in the Asian Region (1999-2007?)' have allowed us to implement the programme:*

*An ALARA awareness workshop for plants managers took place in Vienna in 1998. Two regional training courses for radiological protection managers and their colleagues were held with the help of the EC, one in Prague in 1997 and one in St. Petersburg in 1999. Workshops were also organised for regulators.*

*Following the example of the BWR and PWR radiological protection managers groups in the US a VVER/RBMK health physics group met annually from 1997 to 2004 going from one country to another.*

*Then, IAEA financially supported individuals' participation in the ISOE Workshops, enabling these ISOE participants to present a communication." (Monica Gustafsson)*

Through all these means of support, personal relationships were established between radiological protection managers from many countries under the IAEA Technical Centre responsibility and an active participation of those countries in ISOE became the rule.

**ISOE has developed many products, not directly linked to the database, such as the work management books and workshops, the ISOE symposium, the radiological protection managers' and regulatory authorities' groups/days, the benchmarking plant visits… All these have provided to ISOE members, many opportunities for working together, and establishing direct personal and individual links with several hundreds of colleagues. The survey we performed, for the 20th Anniversary, among several tens of participants, shows that they all appreciate particularly these opportunities, both professionally and personally, both as utility and regulatory authority representatives. Today we can say that ISOE even more than a technical or only professional network has become a Human Network, and this is an essential reason for its success.**


Gerhard Frasch: ALARA: the core of the ISOE symposium

David Miller as a speaker

## REFERENCES

NEA (1997) *Work Management in the Nuclear Power Industry*, OECD/NEA, Paris.

# 4. HOW HAS ISOE BEEN PERCEIVED, AND IS NOW PERCEIVED?

## 4.1 Participants find what they were expecting and even more: results of a survey

In order to get some feedback from those who were and are still involved in the ISOE system, a questionnaire was sent (see annex 3) to nearly 70 individuals. Ten individuals who have played an important specific role in the setting up and operation of the ISOE system have also been interviewed directly, with more specific questions.

The sample cannot be considered as representative of all ISOE participants. All successive secretariat and Technical centre members have been contacted and quite unanimously have answered, as well all successive ISOE chairs from utilities that have been contacted ([38]) and have answered. The others were mainly individuals from utilities belonging to most regions: Europe, North America and non-OECD. The regulatory authorities were contacted in smaller numbers due to the short time I had at my disposal; I had to make choices and I have privileged the members of the "utilities". The few regulatory authority answers were very similar to one another, so it may be not too penalising not to have more. The main missing answers should then be those of the Asian utilities members. A few individuals I would have contacted due to their contribution to ISOE are now deceased; I would here mention Arif Kahn, the first vice chair from Ontario Hydro, Bjorn Walström from Loviisa NPP, and Philippe Colson from EDF.

The following table summarises the main messages arising from the answers and in particular from those of the utilities' representatives. The percentage which appears in each square should be interpreted as "x% of the answers have spontaneously described ISOE as___", which does not mean that the other individuals do not agree with that, but it is not what came to their mind immediately and spontaneously, for defining ISOE. We also can say that in some cases it was so obvious that there was no need to tell it.

**Table 1: Synthesis of answers to the ISOE 20 years survey**

| | All | Utilities |
|---|---|---|
| **ISOE is a system for experience exchanges through** | 100% | 100% |
| Symposia | 97% | 94% |
| ISOE 1 database analysis | 69% | 82% |
| **ISOE assists with ALARA implementation and dose reduction** | 72% | 65% |
| **ISOE is effective and perennial through** | 56% | 88% |
| Its international component | 47% | 41% |
| Personal relationships, and even friendships | 44% | 53% |
| Flexible relationships between Utilities and Authorities | 36% | 24% |

### *4.1.1 ISOE is actually a system for experience exchanges*

Looking at that table, it is satisfying to see that ISOE is actually perceived by all participants, whatever their origin, as a support for feedback experience exchanges: in particular utilities' representatives said that it is a forum where they can find "co-operation", "mutual aid and understanding", where they can "identify initiatives" and "share" experiences dealing with "on the floor problems".

The main "tools" mentioned were 1) the symposia quite unanimously but by very few individuals that participated in ISOE only before the first symposium, and 2) the dose database, which is explicitly mentioned by more than 80% of the utilities' representatives

38. Except for Philippe Rollin from EDF, the first ISOE chair for whom we did not find an address.

even if it was difficult to access and analyse it at the beginning due to the software being perceived as not user friendly enough. We have already described the reactions to the symposia (see above 3.3.4.2). We will now provide some feedback on the database:

The database is considered as a "powerful" tool allowing a "rigorous approach" to perform "qualified data analysis". The major benefit for the utilities is being able to perform "benchmarking" on similar jobs through a "harmonised system" with similar units belonging to the "sister unit groups" and then being able to find "contact persons" in these units. This has been mentioned many times. I will let Ted Lazo give his conclusion on that:

*"The symposia are essential for the success of ISOE. They are the place where people meet, exchange really; they share there; it is the place where individual commitment is now coming from. But the ISOE 1 database remains the glue; it is the place where NP's and regulatory authorities work together on a regular basis."*

### *4.1.2 These exchanges aim at occupational dose reduction through ALARA implementation*

"Assisting with ALARA and occupational dose reduction", even if mentioned by a large majority of participants, is not always spontaneously mentioned by the utility representatives (65%). One may consider that occupational dose reduction, being the core of the radiological protection manager's work, was implicit for them, and therefore some did not even think to mention it. As for ALARA it is a little bit different, I think that the ALARA culture even if widely spread now, has still to be more integrated in order to correspond to day-to-day life.

### *4.1.3 ISOE is perceived by its members as really effective*

Why is there such a discrepancy between the utility answers, nearly 90% consider ISOE as effective, while the whole sample provides only 56% noting that ISOE is effective. This is mainly because the representatives of the international organisations did not consider themselves as entitled to make a judgment on those topics: they are not end users. So the important percentage is the very satisfying one from the utilities representatives.

As participants said "we learned a lot", and "exchanging good practices was very effective", "useful", "fruitful"; it has led to many "improvements", and "developing action plans". All these have had a "direct impact on the occupational dose trends". This has also been facilitated by the translation into several languages of much ISOE material, in particular by IAEA.

*"ISOE represents an "on the job training" opportunity, where we learn from the experience of other utilities with tremendous operating experience in radiation protection fields." (Vasile Simionov)*

#### *4.1.3.1 ISOE favours work with reliable peers at the international level*

As already said, ISOE has become a human network relying mainly on individual relationships.

This has been characterised by many participants as having given them the opportunity for working with their "peers", in a totally "professional manner" within a set of "reliable", "open minded" and "trustful" relationships.

*"ISOE provides opportunities for information exchange with our peers, to benchmark our performance, to learn from the experience of others." (Guy Renn)*

*"From a professional point of view it is a human network, with personal relationships allowing exchanges in a more flexible manner than during all official circumstances including the official regulatory authorities meetings." (Oliver Couasnon)*[39]

As already mentioned **the ISOE output on work management** has been considered of utmost importance. This has been **expressly mentioned by one third of the utilities'** representatives, **with a request from several that such a book should be regularly updated and issued**.

The fact that the system is at **the international level** is even more important when the end user is quite isolated, *i.e.* when there is only one or two plants in a country. Then it is mentioned as very important (see Guy Renn account in Annex 2). Conversely, countries with a very large fleet of reactors are less enthusiastic:

***"****We remain too provincial, too focused on the US feedback experience exchanges, so international "sharing" still can be optimized." (Rick Doty)*

### *4.1.3.2 ISOE favours work with friends in a kind of a "nineteenth hole" family,*

Starting with peers' professional relationships, ISOE evolved quickly into a "fraternity", where the keywords are "conviviality", and "friendship", making use several times of the wording "ISOE is now a kind of a family", and we should say not restricted to the single representatives of the same "sister unit group".

The world becomes a large family

*"ISOE is not only a network for sharing practical radiation protection experience, but for building friendships, I particularly remember my first ISOE Annual Meeting and Symposium, in Tokyo and Hamaoka, Japan in 2005. The meeting and symposium, all augmented by the exceptional hospitality and cultural events organized by our Japanese hosts, proved the start of many lasting friendships." (Brian Ahier)*

The importance of these friendships have been enhanced by all the comments received on the role played by the "après le match" times, what the French call the "third half" in rugby and the British the "nineteenth hole" in golf. Most often these times were played with beers or sharing other socio-cultural events, and this has also allowed talented artists to implement their art (see picture hereafter). Most of the collected anecdotes were dealing with these periods of time, which can hardly be recorded.

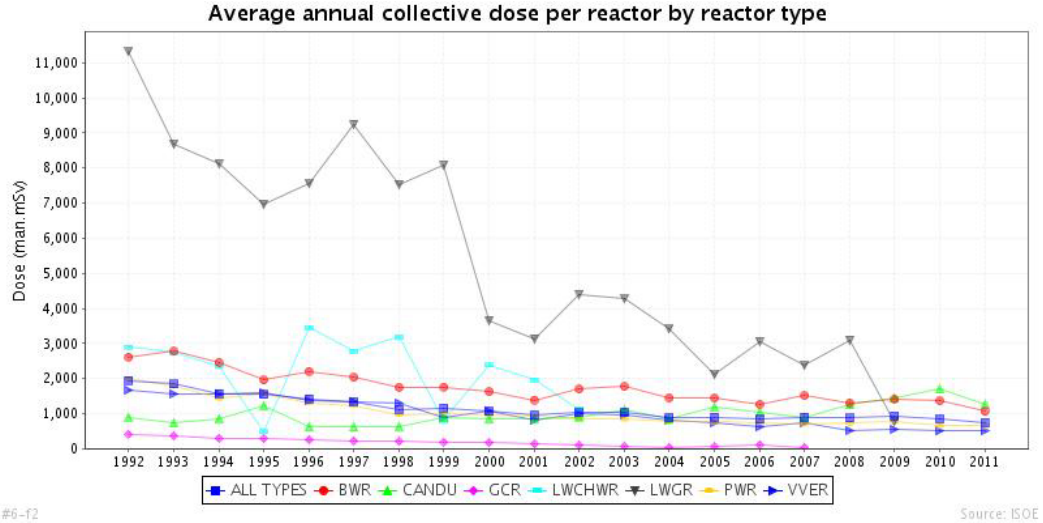
39. Olivier Couasnon works with the French regulatory body ASN, after having been at IRSN the technical support of ASN.


Lucie d'Ascenzo, Christian Lefaure and Pascal Crouail from ETC, picture from Bjorn Walström Loviisa NPP, Finland.

*4.1.3.3 Professionalism, friendship and talent have in part led to the actual decreasing trends in occupational radiological doses in the NPPs*

Looking at the collective dose trends, since ISOE was launched, there is obviously a drastic dose reduction in all kinds of NPPs. This is true both for the annual collective doses, which are now lower on average than one man Sv per reactor (see graph 4 hereafter) for all types of reactors (nearly ten times lower than the LWR in the States at the beginning of the 80s); and for dose per job. For example the above mentioned Steam Generator Replacement accrued less than 0.2 manSv for a 2 loop unit (Doel 2, Belgium) SGR in 2004.

**Figure 9: 1992 to 2011 collective dose per unit trends per reactor type**



Doel 2 (Belgium) th e best SGR in the world in 2004

We cannot attest that these improvements come only from ISOE influence; we should at least also take into account the evolution of technology; however, taking into account the large coverage of ISOE and all the feedback from its participants, we can be sure that ISOE has played a major role in these evolutions.

As a conclusion to that paragraph on ISOE effectiveness, let Peter Jung express his feelings:

*"For me personally, working at a nuclear plant site, it was very challenging to work in an international family of experts, getting new aspects outside the national view. Sharing experience with experts of other countries and learning of their radiological protection policies was very helpful and motivating. For the company it was a way to open itself to international relationships, to get benefit from the results of the dose statistics and evaluations, and to see its performance in the range of international developments."*

### *4.1.4 It was not so difficult working with regulatory authorities*

Finally we will check what has happened regarding the concerns that we described during the beginning stages of ISOE. Are they totally "fears from the past" now? Not totally, as we have said that the regulatory authorities still do not have access to the whole ISOE 1 database. However, no one made any negative comment on the interaction between regulatory authorities and the system. On the contrary, it has, of course, been mentioned as positive by all regulatory authorities, and most representatives of international organisations. Being in a system under the leadership of international organisations with the presence of regulatory authorities may still continue being a "brake" for some utilities. What is more interesting, however, is that nearly one fourth of the utilities' representatives have explicitly joined that group of enthusiasts:

*"As we in Sweden already had a very close relation between the utilities and the regulatory body we were very well prepared for something like ISOE. We were a couple of enthusiastic people from both sides ready to be involved in the idea of ISOE." (Bengt Lowendahl)*

*"The occupational radiological protection from NPPs and its regulators created a two-ways community." (Borut Breznik)*

When we were discussing the creation of ISOE, another international organisation was set up: the World Association of Nuclear Operators (WANO launched in 1989), which of course does not include regulatory authorities. Its main objective is quite different from those of ISOE; it is summarised on the WANO website as follows: "Following the tragic accident at the Chernobyl nuclear generating station, nuclear operators worldwide were determined to work together to ensure such an accident could never happen again". Occupational radiological protection is followed by WANO through a set of simple indicators that do not allow in depth

analysis and benchmarking. In some utilities, plant managers may still consider that there is no need for belonging to the two systems in parallel, even if their radiation protection managers are totally convinced that both are worthwhile. There remain therefore some efforts to be pursued as clearly stated by Carl Göran Lindvall:

*"The system is today established on the expert level but it must be more recognized on the management level. We, experts, have had the professional help of the system for many years but it has to be clearly shown for the top-level management that it also saves time and money."*

**ISOE is actually used by the participants as a system for exchanging their experiences in order to reduce doses through ALARA implementation. This works very effectively because – they work with reliable peers at an international level, – they work with friends in a kind of "*nineteenth-hole family*". The result is that they consider all participants as professional and friendly colleagues in leading to the decrease of occupational doses.**

### *4.2 Should ISOE BECOME an example and a goal for others?*

We can say that ISOE has been one of the first such networks in the world whatever the area. In a sense, we were kind of pioneers. Monica Gustafsson, who came from the medical sector to the nuclear field confirmed she had never seen (or heard about) such an approach in the medical sector, to take care of feedback experience and to share it with others. And Jacques Lochard said that:

*"It has been the first ALARA network in the world, after the ALARA principle was introduced by ICRP."*

*"For me ISOE is the first real network in radiological protection, the first ALARA network for facilitating ALARA implementation on the spot, both at a world level and a regional level." (Edward Lazo)*

*"As a consequence of the added values developed by ISOE, it is not surprising that the idea for developing new networks based on the work done by ISOE has emerged at different levels."(Pascal Deboodt)*[40]

The ALARA networks in Europe (EAN), Europe and Central Asia (RECAN), Asia (ARAN), and Latin America (REPROLAM) appeared respectively in 1996, 2002, 2007 and 2012. All of these are mainly focused on occupational exposure, while the European Medical ALARA network that was set up takes care of both occupational and patient exposures. Another example of such dissemination of ideas is the Information System on Exposure in Medical, Industrial and Research areas (ISEMIR) set up by the IAEA in 2007 with a clear reference to ISOE.

*"The fact that many ALARA networks exist to allow this type of exchange demonstrates the efficiency of this type of mechanism for sharing good radiation protection practice and identifying and addressing lessons learned and areas for improvement, in a collegial and professional manner." (Brian Ahier)*

I got the chance of chairing the first co-ordination meeting of all these networks at the occasion of the IRPA meeting in Glasgow (2012). The need for exchanging at that level was expressed by all of the networks' representatives.

As it was written in the minutes of the 2009 CRPPH meeting, since it has been launched, ISOE has become a potential resource for a broader radioprotection community than its members. This has been the case for CRPPH itself, which has several times requested ISOE to set up a working group (Work Management 1994) or to participate in a working group such as the Expert Group on Occupational Exposure (EGOE 2007).

This is also the case for UNSCEAR, with whom an agreement was signed in 2011 by the ISOE chair, Gonzague Abela. In that agreement ISOE promises to provide UNSCEAR with dose

40. Pascal Deboodt was member of the IAEA staff and the ISOE joint secretary from 2005 to 2009.

data concerning NPPs that UNSCEAR will make use of for its periodical United Nations publications on dose data.

This has also been the case with the International Action Plan on Occupational Radiation Protection (IAPORP) that took place from 2004 to 2011 under the auspices of both IAEA and ILO (UN International Labour Organization), which made use of the ISOE experience for promoting ALARA networking.

## 5. CONCLUSIONS

Thirty years have passed since ISOE precursors appeared and provided their experience to the future ISOE. Concerns and reservations were overcome by enthusiasm and 20 years have passed since ISOE was launched. ISOE is still strongly alive and has progressively covered most of the NPPs in the world. After a few years, the ISOE that was mainly focused on collecting and analysing doses became a full system for experience exchange and benchmarking. Its human component became prominent through personal contacts and friendships among peers from radiological protection at the plants and regulatory authorities.

There remains some progress to be made: a) two nuclear countries are not yet covered, b) resolving all issues related to the access of regulatory agency personnel to ISOE 1 is still not complete, c) some utilities do not yet provide their data directly via the web, and d) some plant managers are not yet convinced of the usefulness of the network. However, ISOE has totally demonstrated its effectiveness in widely facilitating the sharing of good practices, improving an ALARA culture and therefore directly contributing to the reduction of collective and individual doses (by nearly a factor of 10).

The future is not without clouds, the stakes are important in terms of occupational exposures both in decommissioning and resultant from the design of new plants. The refurbishments that will be performed following the Fukushima event will require further efforts for maintaining exposures as low as reasonably achievable. ISOE will therefore remain a very useful ALARA tool during the next decades. Enthusiastic individuals will continue finding their place in the system during those years.

**Appendix 1.:**

**Letter of agreement from the IAEA to the OECD/NEA**

Attachment 1

INTERNATIONAL ATOMIC ENERGY AGENCY
AGENCE INTERNATIONALE DE L'ENERGIE ATOMIQUE
МЕЖДУНАРОДНОЕ АГЕНТСТВО ПО АТОМНОЙ ЭНЕРГИИ
ORGANISMO INTERNACIONAL DE ENERGIA ATOMICA

WAGRAMERSTRASSE 5, P.O. BOX 100, A-1400 VIENNA, AUSTRIA
TELEX: 1-12645, CABLE: INATOM VIENNA, FACSIMILE: (+43 1) 234564, TELEPHONE: (+43 1) 2360

IN REPLY PLEASE REFER TO
PRIERE DE RAPPELER LA REFERENCE

DIAL DIRECTLY TO EXTENSION
COMPOSER DIRECTEMENT LE NUMERO DE POSTE

613-N4.49.2/N5.41

1993-09-21

Dear Mr. Uematsu,

This is in response to the letter from Mr. Thompson of 30 June, 1993 regarding the proposed Arrangement between the OECD Nuclear Energy Agency (NEA) and the International Atomic Energy Agency (IAEA) on co-sponsorship by the IAEA of the NEA Information System on Occupational Exposure.

I am pleased to confirm that the terms of the Arrangement are acceptable to the IAEA. As indicated, it is understood that the Arrangement under these terms will remain in effect for a trial period of two years from the date of this letter.

Yours sincerely,

B.A. Semenov
Deputy Director General
Head of the Department of
Nuclear Energy and Safety

Mr. Kunihiko Uematsu
Director General
OECD Nuclear Energy Agency
Le Seine St. German
12 boulevard des Iles
F-92130 Issy les Moulineaux
France

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**Appendix 2.:**

**Letter of agreement from the CEC to the OECD/NEA**

Letter from Mr. L.J. Brinkhorst to Dr. K. Uematsu

Brussels, 16 March 1992

Dear Director General,

I refer to the contacts between our organisations to establish the terms and conditions for the liaison and co-operation between the Information System on Occupational Exposure (ISOE) and the analogous System operated by the CEC.

For this purpose, the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development and the EURATOM concur on the following (in accordance with the additional protocol No. 1 of 14 December 1960 Convention concerning the OECD):

1. The two Parties, on a base of reciprocity, will carry out a regular exchange of information and documentation on their respective information systems.

2. Each Party will invite the other Party to be represented by radiation protection experts to participate in meetings it organises in connection with its own information system.

3. Each Party will make all the necessary arrangements to ensure that the respective systems are compatible.

4. The two Parties will arrange for the collection of data from participants in Europe, on behalf of both systems, to be carried out by the Centre d'Etude sur l'évaluation de la protection dans le domaine nucléaire (CEPN) in Fontenay-aux-Roses, which will operate under directives commonly agreed by the two Parties.

5. Each of the two Parties will contribute, as appropriate, to the operation of the System of the other Party and will encourage further participation in the two systems in Europe.

6. Both Parties will review the terms of the present Agreement, whenever appropriate and no later than 3 years after it comes into force.

7. Each Party can withdraw from the present Agreement by giving six months' notice to the other Party.

I would like to propose that this letter and your response are considered as the Agreement establishing the relations between the CEC and which will come into force as from the date of your response.

I am convinced that these arrangements will help to further develop the co-operation between our organisations in the field of radiation protection of workers.

Your sincerely,

L.J. Brinkhorst

This is a translation into English of a letter sent by the CEC Director General DG XI "Environment, Nuclear Safety and Civil Protection."

**Appendix 3.:**

**20th Anniversary survey**

Here are now a few questions;

Your name:

Why do (did) you participate in the ISOE system?

What has motivated your personal commitment in running the system?

How has it been useful for you, for your company (utility representative) or country (regulatory body )?

IF you were asked for a particularly “efficient” output of ISOE what should it be?

IF you were asked for a particular ISOE event that has impressed you what should it be? Why?

If you were asked to select 3 keywords (expressions) corresponding to what is ISOE, what should they be?

1/ 2/ 3/

Are they some anecdotes ISOE related, or related to one (several) ISOE participant(s) you would like to share with us?

PS if you want to tell more than the answers to these few questions, tell me I will call you (give me your phone number)

IF YOU HAVE PICTURES PLEASE SEND THEM

## Appendix 4.:

## Testimonies from different participants

**ISOE is an example in other domains by Pascal Deboodt (IAEA, ISOE secretariat 2005-2009)**

*The Information System on Occupational Exposure (hereafter ISOE) was the first – and is probably still the only one – having been able for bringing utilities and regulatory authorities "around the same table" for discussing issues related to occupational radiation protection. But, in addition to this challenge, ISOE was able to manage the interests of both partners without bringing in danger nor its philosophy, nor its working methodology. ISOE has to be considered as a robust network providing valuable information and having given rise to strong reduction of the occupational doses as for example, the collective dose during the replacement of steam generators. The material made available through the ISOE database has also positively impacted on the discussion of many occupational issues. Although mainly concerning the Utilities, some conclusions drawn from the yearly ISOE Symposium for example are really useful in other areas.*

*As a consequence of all added values developed by ISOE, it is not surprising that the idea for developing new networks based on the works done by ISOE has grown at different levels. An example of putting fruitfully into practice this idea is the Information System on Exposure in Medical, Industrial and Research areas (ISEMIR) set up by the IAEA in 2007.*

*Briefly summarized, the ISOE network illustrates clearly that – in addition to the added value for the ISOE members themselves – occupational exposure and radiation protection programs could take advantage of what is produced by ISOE and as such, ISOE is to be considered as an efficient catalyst for the development of a safety culture in many areas where Occupational Exposure has to be managed and optimized.*

**My memories from ISOE by Carl Göran Lindvall (Barsebäck NPP radiological protection manager in Sweden, ISOE chair 2002-2004)**

*The first years were characterized by the SOFTWARE PROBLEMS, with the restricted access and limitations in how to create questionnaires and new versions before you had learn how to use the first one, it was in fact quite difficult to convince my colleagues to participate and to see the systems future possibilities. But a few of us had a strong feeling that this could be something and we continued.*

*With the extension of ISOE from a pure dose registration system to a full system for experience exchange and Benchmarking, it has been possible to see a much broader engagement.*

*The system, and especially the Symposia's, now gives the participants frequent and fruitful possibilities for international experience exchange. With the personal contacts built on trustful relationships the system has started to improve the radiological protection work locally.*

*The system is today established on the expert level but it must be more recognised on management level. We, experts, have had professional help of the system for many years but it has to be clearly shown for the top-level management that it also saves time and money.*

*New build plants and decommissioning issues must come in more clearly as these two subjects are as important for public acceptance and for the radiological protection teams as the operational phase.*

**Favouring information access was our duty, by Monica Gustafsson (IAEA Technical Centre 1994-1998 and Secretariat 1998-2004)**

*"As to the keywords I would now add "Information access". From the IAEA point of view, it was important to make material available in the languages, which health physicists, regulators, managers and others could understand. Thus we provided interpretation during most, if not all, events. Reports from meetings etc. were translated, e.g. "Work Management in*

*the Nuclear Power Industry, published by OECD/NEA, which was translated into Russian and Chinese. We supported translation and distribution of RADIOR. As you may remember, an IAEA Working material on Self-assessment of Occupational Radiation Protection in Nuclear Power Plants was finalized in 2002 and translated."*

**ISOE is an opportunity to demonstrate more engagement with Europe by the UK, by Guy Renn (Sizewell PWR radiological protection manager in the UK)**

*ISOE provides opportunities for information exchange with our peers, to benchmark our performance, to learn from the experience of others. This experience can be good practices, lessons learned or events. Participation in ISOE was very helpful to us in our early days of commissioning and operation; we were the only PWR in a fleet of gas reactors so access to LWR experiences and networks was invaluable.*

*From the beginning ISOE members were very willing to share their experiences, to help and to welcome us to the ISOE "club". I am very grateful for this invaluable support and want to reciprocate this assistance by being an enthusiastic member of ISOE. UK has a reputation of being reluctant members of European organizations; this is an opportunity to demonstrate more engagement by UK.*

*For us, as a single NPP member it has provided numerous pieces of useful operating experience, via ISOE symposium presentations, via benchmarking reports, via ISOE 3 reports and from contacts made at ISOE meetings. The ISOE database has given us benchmark data that has been useful when benchmarking our results and when dealing with our regulator.*

*The ISOE database and in particular MADRAS analyses are very good; the graphs can be generated very easily and quickly and provide good data to support the program.*

**The community was motivated to contribute as a whole to the publication on Work Management, by Brian Ahier (NEA secretariat from 2005 to 2010)**

*During my term at NEA, I had opportunity to participate in many ISOE meetings, technical working groups and symposia, as well as direct interactions with the ISOE Bureau and technical centres. The ISOE-wide activity that impressed me the most was the development of the second edition of the ISOE publication on work management. This activity, conceived and promoted by one of the ISOE Chairs, Mr. Mizumachi (JNES, Japan), captured the attention and interest of the ISOE membership, and was something to which the community was motivated to contribute as a whole. While there was still an important role for the Secretariat and technical centres to "pull it all together", the development of this report provided a clear opportunity for the ISOE membership across all four ISOE regions to contribute their specific technical expertise and real-world examples. This practical and widely-read document was a concrete example of the strength of the ISOE network, and the contribution it could make to operational radiation protection in the context of broader industry work.*

*The ISOE mechanisms for sharing experience and best practice amongst a wide range of participants is a particularly efficient output, be it through symposia, ISOE Network or the shared output of the ISOE technical centres. The fact that many ALARA networks exist to allow this type of exchange demonstrates the efficiency of this type of mechanism for sharing good radiation protection practice and identifying and addressing lessons learned and areas for improvement, in a collegial and professional manner.*

**ISOE is the Committee to make the Nuclear Power Plants "clean", by Wataru Mizumachi (NUPEC, ATC head and ISOE chair 2006-2008)**

*In 2001, I became Director General, Safety Information at the Research Centre of NUPEC (NUclear Power Engineering Corporation) and automatically General Manager of ISOE Asian Technical centre. At that time there has been no Chairman of ISOE from Asia and I was asked to become the chairman. I became the 7th Chairman of ISOE in 2006.*

*In 1992 Japanese Average Occupational Dose Rate became the lowest in the world, and US NRC people, French Authority people and other countries members visited Japan to study how Japanese NPSs reached so low doses. They found how clean they were Japanese Reactor Buildings. I guided them and almost every people said there were no dust in reactor buildings. The site managers said "we requested you to wear the over-shoes because your shoes were too dirty for the clean reactor buildings".*

*Then we were completely satisfied on the dose; the other made a lot of efforts and most Japanese people did not realized we were now in the bad group.*

*I talked about that situation to the presidents of ten Japanese utilities. Their answers were as follows "we were reported that our dose is the best in the world. Why do you talk ill of us?" I repeated again and again my message and they finally look at the ISOE graphs and realized the facts.*

*Therefore organized every year some benchmarking trips to US and Europe making use of ISOE members that were so beneficial and our doses are now recovering. While I was the chairman of ISOE, I proposed to set the International ISOE symposium in Asia. This International Symposium is now continuing every year and so successful. As for these Asian ISOE Symposiums, every Asian utility comes and they all make very good presentations. We select the best paper. The best paper is automatically invited to the next International Symposium, which made the good motivation.*

*Last October the world population exceeded 70 billion, which indicates that we need a lot of energy. Then the clean NPPs are essential for the world. ISOE roles will become bigger and bigger.*

**Appendix 5.:**

**Historical evolutions, ISOE structures and representatives**

***NEA Secretariat***

| | |
|---|---|
| Osvaldo Ilari | 1976-1997 |
| Christer Viktorson | 1989-1993 |
| Edward Lazo | 1993-1998 |
| Stefan Mundigl | 1998-2004 |
| Brian Ahier | 2005-2010 |
| Halil Burçin Okyar | 2010-on going |

***IAEA Secretariat and Technical Centre***

| | |
|---|---|
| Monica Gustafsson | 1994-2004 |
| Seong Na | 1998-2002 |
| Pascal Deboodt | 2005-2009 |
| John Hunt | 2009-2010 |
| Jizeng Ma | 2010-on going |

***ISOE Bureau Chairs***

| | |
|---|---|
| Philippe Rollin | 1992-1994 |
| David Miller | 1994-1998 |
| Pio Carmena | 1998-2000 |
| Borut Breznik | 2000-2002 |
| Carl Göran Lindvall | 2002-2004 |
| Jean Yves Gagnon | 2004-2006 |
| Wataru Mizumachi | 2006-2008 |
| Vasile Simionov | 2008-2010 |
| Gonzague Abela | 2010-2012 |
| Willie Harris | 2012-2014 |

**Appendix 6.:**

**ISOE symposia since 1997**

| Year | Symposium location | Organiser |
|---|---|---|
| 2012 | Fort Lauderdale, USA | NATC |
| | Prague, Czech Republic | ETC |
| | Tokyo, Japan | ATC |
| 2011 | Fort Lauderdale, USA | NATC |
| 2010 | Cambridge, United Kingdom | ETC |
| | Gyeongju, Republic of Korea | ATC |
| | Fort Lauderdale, USA | NATC |
| 2009 | Vienna, Austria | IAEATC |
| | Aomori, Japan | ATC |
| | Fort Lauderdale, USA | NATC |
| 2008 | Tsuruga, Japan | ATC |
| | Turku, Finland | ETC |
| 2007 | Fort Lauderdale, USA | NATC |
| | Seoul, Republic of Korea | ATC |
| 2006 | Essen, Germany | ETC |
| | Yuzawa, Japan | ATC |
| 2005 | Fort Lauderdale, USA | NATC |
| | Hamaoka, Japan | ATC |
| 2004 | Lyon, France | ETC |
| 2003 | Orlando, USA | NATC |
| 2002 | Portoroz, Slovenia | ETC |
| 2001 | Anaheim, USA | NATC |
| 2000 | Tarragona, Spain | ETC |
| 1999 | Orlando, USA | NATC |
| 1998 | Malmö, Sweden | ETC |
| 1997 | Orlando, USA | NATC |