Unclassified **NEA/CRPPH/R(2012)4**

Organisation de Coopération et de Développement Économiques
Organisation for Economic Co-operation and Development **06-Sep-2013**

English - Or. English

Nuclear Energy Agency

NEA/CRPPH/R(2012)4
Unclassified

Committee on Radiation Protection and Public Health

Occupational Exposures at Nuclear Power Plants
Twentieth Annual Report of the ISOE Programme, 2010

Halil Burcin OKYAR (halilburcin.okyar@oecd.org)
NEA/RP

JT03344051

English - Or. English

Radiological Protection

Occupational Exposures at Nuclear Power Plants

Twentieth Annual Report of the ISOE Programme, 2010

NEA/CRPPH/R(2012)4

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

Throughout the world, occupational exposures at nuclear power plants have steadily decreased since the early 1990s. Regulatory pressures, technological advances, improved plant designs and operational procedures, ALARA culture, and experience exchange have contributed to this downward trend. However, with the continued ageing and possible life extensions of nuclear power plants world wide, ongoing economic pressures, regulatory, social and political evolutions, and the potential of new nuclear build, the task of ensuring that occupational exposures are as low as reasonably achievable (ALARA), taking into account operational costs and social factors, continues to present challenges to radiation protection professionals.

Since 1992, the Information System on Occupational Exposure (ISOE), jointly sponsored by the OECD Nuclear Energy Agency (NEA) and the International Atomic Energy Agency (IAEA), has provided a forum for radiological protection professionals from nuclear power utilities and national regulatory authorities world wide to discuss, promote and co-ordinate international co-operative undertakings for the radiological protection of workers at nuclear power plants. The objective of ISOE is to improve the management of occupational exposures at nuclear power plants by exchanging broad and regularly updated information, data, and experience on methods to optimise occupational radiation protection.

As a technical exchange initiative, the ISOE programme includes a global occupational exposure data collection and analysis programme, culminating in the world's largest occupational exposure database for nuclear power plants, and an information network for sharing dose reduction information and experience. Since its launch, the ISOE participants have used this system of databases and communications networks to exchange occupational exposure data and information for dose trend analyses, technique comparisons, and cost-benefit and other analyses promoting the application of the ALARA principle in local radiological protection programmes.

The 20th Annual Report of the ISOE Programme (2010) presents the status of the ISOE programme for the year 2010.

"...the exchange and analysis of information and data on ALARA experience, dose reduction techniques, and individual and collective radiation doses to the personnel of nuclear installations and to the employees of contractors are essential to implement effective dose management programmes and to apply the ALARA principle." (ISOE Terms and Conditions, 2008-2011).

2010 ISOE International Symposium
Cambridge, UK

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

Since 1992, the Information System on Occupational Exposure (ISOE) has supported the optimisation of worker radiological protection in nuclear power plants through a world wide information and experience exchange network for radiation protection professionals at nuclear power plants and national regulatory authorities, and through the publication of relevant technical resources for ALARA management. This 20th Annual Report of the ISOE Programme (2010) presents the status of the ISOE programme for the calendar year 2010.

ISOE is jointly sponsored by the OECD/NEA and the IAEA, and its membership is open to nuclear electricity utilities and radiation protection regulatory authorities world wide who accept the programme's Terms and Conditions. The current ISOE Terms and Conditions for the period 2008-2011 came into force on 1 January 2008. At the end of 2010, the ISOE programme included 66 participating utilities in 29 countries (316 operating units; 44 shutdown units), as well as the regulatory authorities of 27 countries. The ISOE occupational exposure database itself included information on occupational exposure levels and trends at 392 operating reactors, covering about 90% of the world's operating commercial power reactors. Four ISOE Technical Centres (Europe, North America, Asia, and IAEA) manage the programme's day-to-day technical operations.

Based on the occupational exposure data supplied by ISOE members for operating power reactors, the 2010 average annual collective doses per reactor and three-year rolling averages per reactor (2008-2010) were:

	2010 average annual collective dose (man·Sv/reactor)	**Three-year rolling average for 2008-2010 (man·Sv/reactor)**
Pressurised water reactors (PWR)	0.66	0.72
Pressurised water reactors (VVER)	0.51	0.53
Boiling water reactors (BWR)	1.29	1.33
Pressurised heavy water reactors (PHWR/CANDU)	1.70	1.47
All reactors, including gas-cooled (GCR) and light water graphite reactors (LWGR)	0.81	0.85

In addition to information from operating reactors, the ISOE database contains dose data from 80 reactors which are shutdown or in some stage of decommissioning. As these reactor units are generally of different type and size, and at different phases of their decommissioning programmes, it is difficult to identify clear dose trends. However, work continued in 2010 to improve the data collection for such reactors in order to facilitate better benchmarking. Details on occupational dose trends for operating reactors, and reactors undergoing decommissioning, are provided in Chapter 2 of the report.

While ISOE is well known for its occupational exposure data and analyses, the programme's strength comes from its objective to share such information broadly amongst its participants. In 2010, the ISOE Network website (www.isoe-network.net) continued to provide the ISOE membership with a comprehensive web-based information and experience exchange portal on dose reduction and ISOE ALARA resources.

The annual ISOE International ALARA Symposia on occupational exposure management at nuclear power plants continued to provide an important forum for ISOE participants and for vendors to exchange practical information and experience on occupational exposure issues. The 2010 ISOE International ALARA Symposium, organised by the European Technical Centre, was held in Cambridge, United Kingdom. The technical centres also continued to host regional symposia, which in 2010 included the ISOE North American Regional ALARA Symposium in Fort Lauderdale, FL, United States, organised by the North American Technical Centre in co-operation with EPRI, and the ISOE Asian Regional ALARA Symposium in Gyeongju, Republic of Korea, organised by the Asian Technical Centre in collaboration with KHNP and KINS. These symposia provide a global forum to promote the exchange of ideas and management approaches for maintaining occupational radiation exposures as low as reasonably achievable.

Of importance is the support that the technical centres supply in response to special requests for rapid technical feedback and in the organisation of voluntary site benchmarking visits for dose reduction information exchange between ISOE regions. The combination of ISOE symposia and technical visits provides a means for radiation protection professionals to meet, share information, and build links between ISOE regions to develop a global approach to occupational exposure management.

The ISOE Working Group on Data Analysis (WGDA) continued its activities in support of the technical analysis of the ISOE data and experience, focusing largely on the integrity and consistency of the ISOE database.

Principal events in the ISOE participating countries are summarised in Chapter 5 of this report. Details of ISOE participation and the programme of work for 2011 are provided in the Annexes.

SYNTHESE DU RAPPORT

Depuis 1992, le programme ISOE (système d'information sur les expositions professionnelles) facilite la mise en œuvre de l'optimisation de la radioprotection des travailleurs dans les centrales nucléaires par le biais d'un réseau d'échange d'information et d'expériences entre les responsables de la radioprotection des centrales nucléaires et les représentants des autorités réglementaires du monde entier ainsi que par la publication de produits techniques spécifiques pour la mise en œuvre d'ALARA. Ce vingtième rapport annuel du système ISOE (2010) fait le point sur le programme ISOE à la fin de l'année 2010.

ISOE est conjointement sponsorisé par l'AEN de l'OCDE et l'AIEA, et est ouvert à l'adhésion d'exploitants des centrales nucléaires de production d'électricité et des autorités réglementaires de radioprotection qui acceptent les conditions de mise en œuvre du programme. Les conditions de mise en œuvre actuelles pour la période 2008-2011 sont entrées en vigueur le 1er janvier 2008. À la fin de 2010, 66 exploitants de 29 pays participaient au programme ISOE (316 réacteurs nucléaires en fonctionnement; 44 réacteurs arrêtés) ainsi que les autorités réglementaires de 27 pays. La base de données ISOE contient des informations sur les expositions professionnelles et leurs tendances pour 392 réacteurs en exploitation, représentant ainsi près de 90 % de l'ensemble des réacteurs de puissance en fonctionnement dans le monde. Quatre centres techniques ISOE (Europe, Amérique du Nord, Asie et AIEA) gèrent au jour le jour les opérations techniques du programme.

Sur la base des données sur les expositions professionnelles fournies par les membres ISOE, la dose collective moyenne par réacteur annuelle pour 2010 et la dose collective par réacteur moyennée sur trois ans (2008-2010) des réacteurs en fonctionnement étaient de :

	Dose collective moyenne annuelle 2010 (homme·Sv/réacteur)	**Dose collective moyennée trois ans pour 2008-2010 (homme·Sv/réacteur)**
Réacteurs à eau pressurisée (REP)	0.66	0.72
Réacteurs à eau pressurisée (VVER)	0.51	0.53
Réacteurs à eau bouillante (REB)	1.29	1.33
Réacteurs à eau lourde pressurisée (PHWR/CANDU)	1.70	1.47
Tous les réacteurs, y compris les graphite-gaz (GCR) et les réacteurs à eau graphite (RBMK)	0.81	0.85

La base de données ISOE contient également des données concernant les doses collectives de 80 réacteurs en arrêt à froid ou en phase de démantèlement. Etant donné que les réacteurs présents dans la base de données sont de type et de taille différents, et qu'ils sont généralement à des phases différentes de leurs programmes de démantèlement, il est difficile de mettre en évidence des tendances sur l'évolution des expositions. Toutefois, un travail pour améliorer la collecte de données pour ces réacteurs en vue de faciliter les comparaisons a continué en 2010.

Bien qu'ISOE soit connu pour ses données et ses analyses des expositions professionnelles, la force du système provient de son objectif de partager largement ces informations parmi ses participants. En 2010, le site internet du Réseau ISOE (www.isoe-network.net) a continué de fournir aux membres ISOE une information complète ainsi qu'un portail d'échange d'expérience sur la réduction des doses et sur les documents ALARA.

Les symposiums ISOE ALARA annuels internationaux sur la gestion des expositions professionnelles dans les centrales nucléaires constituent des rendez-vous importants permettant aux participants ISOE et aux entreprises exposantes d'échanger des informations et des bonnes pratiques sur les expositions professionnelles dans les centrales nucléaires. Le symposium international ISOE ALARA de 2010, organisé par le centre technique européen ISOE, s'est tenu à Cambridge, Royaume-Uni. Les centres techniques continuent également à organiser des symposiums régionaux : en 2010 un symposium a été organisé par le centre technique ISOE d'Amérique du Nord en coopération avec l'EPRI à Fort Lauderdale aux Etats-Unis et un symposium a été organisé par le centre technique asiatique à Gyeongju en Corée du Sud. Ces symposiums perpétuent la tradition de fournir un large forum pour promouvoir les échanges d'idées et d'expériences de gestion en vue de maintenir les expositions professionnelles aussi basses que raisonnablement possibles.

L'appui offert par les centres techniques en réponse aux demandes spéciales de retour d'expérience technique, et pour l'organisation de visites de type benchmarking afin d'échanger entre les régions ISOE des informations sur les réductions des doses revêt une importance croissante. L'organisation conjointe de symposiums ISOE avec des visites techniques fournit aux professionnels de la radioprotection un intéressant forum pour se rencontrer, discuter et partager des informations, construisant ainsi des liens et des synergies entre les régions ISOE pour développer une approche globale de l'organisation du travail.

Le groupe de travail ISOE sur l'analyse des données (WGDA) a poursuivi ses activités d'appui pour l'analyse technique des données et de l'expérience, en se focalisant principalement sur l'intégrité et la cohérence de la base de données ISOE.

Les principaux événements qui ont eu lieu dans les pays participants à ISOE sont résumés dans le chapitre 5 de ce rapport. Les détails concernant la participation et le programme de travail d'ISOE pour 2011 sont fournis dans les annexes.

1. STATUS OF PARTICIPATION IN THE INFORMATION SYSTEM ON OCCUPATIONAL EXPOSURE (ISOE)

Since 1992, ISOE has supported the optimisation of worker radiological protection in nuclear power plants through a world-wide information and experience exchange network for radiation protection professionals from utilities and national regulatory authorities, and through the publication of relevant technical resources for ALARA management. The ISOE programme includes a global occupational exposure data collection and analysis programme, culminating in the world's largest database on occupational exposures at nuclear power plants, and a communications network for sharing dose reduction information and experience. Since the launch of ISOE, participants have used these resources to exchange occupational exposure data and information for dose trend analyses, technique comparisons, and cost-benefit and other analyses promoting the application of the ALARA principle in local radiation protection programmes, and the sharing of experience globally.

ISOE participants include nuclear electricity utilities (public and private), national regulatory authorities (or institutions representing them) and ISOE Technical Centres who have agreed to participate in the operation of ISOE under its Terms and Conditions (2008-2011). Four ISOE Technical Centres (Asia, Europe, North America, and IAEA) manage the day-to-day technical operations in support of the membership in the four ISOE regions (see Annex 3 for country/technical centre affiliation). The objective of ISOE is to make available to the participants:

- broad and regularly updated information on methods to improve the protection of workers and on occupational exposure in nuclear power plants;
- a mechanism for dissemination of information on these issues, including evaluation and analysis of the data assembled, as a contribution to the optimisation of radiation protection.

Based on feedback received by the ISOE Secretariat as of December 2010, the ISOE programme included: 66 participating utilities[1] in 29 countries, covering 316 operating units and 44 shutdown units, and the regulatory authorities of 27 countries (3 countries participate with 2 authorities). Table 1 summarises total participation by country, type of reactor and reactor status as of December 2010. A complete list of reactors, utilities, and authorities officially participating in ISOE at the time of publication of this report is provided in Annex 3.

In addition to exposure data provided annually by participating utilities, participating authorities may also contribute with official national data in cases where some of their licensees are not ISOE members. The ISOE database thus includes occupational exposure data and information of 472 reactor units in 30 countries (392 operating; 80 in cold shutdown or some stage of decommissioning), covering about 90% of the world's operating commercial power reactors. The ISOE database is made available to all ISOE members, according to their status as a participating utility or authority, through the ISOE Network website and on CD-ROM.

1. Represents the number of lead utilities; in some cases, plants are owned/operated by multiple enterprises.

Table 1: The official ISOE participants and the ISOE database (as of December 2010)[2]

Operating reactors: ISOE participants							
Country	**PWR**	**VVER**	**BWR**	**PHWR**	**GCR**	**LWGR**	**Total**
Armenia	–	1	–	–	–	–	1
Belgium	7	–	–	–	–	–	7
Brazil	2	–	–	–	–	–	2
Bulgaria	–	2	–	–	–	–	2
Canada	–	–	–	22	–	–	22
China	5	–	–	–	–	–	5
Czech Republic	–	6	–	–	–	–	6
Finland	–	2	2	–	–	–	4
France	58	–	–	–	–	–	58
Germany	11	–	6	–	–	–	17
Hungary	–	4	–	–	–	–	4
Japan	24	–	30	–	–	–	54
Korea, Republic of	16	–	–	4	–	–	20
Mexico	–	–	2	–	–	–	2
The Netherlands	1	–	–	–	–	–	1
Romania	–	–	–	2	–	–	2
Russian Federation	–	15	–	–	–	–	15
Slovak Republic	–	4	–	–	–	–	4
Slovenia	1	–	–	–	–	–	1
South Africa, Republic of	2	–	–	–	–	–	2
Spain	6	–	2	–	–	–	8
Sweden	3	–	7	–	–	–	10
Switzerland	3	–	2	–	–	–	5
Ukraine	–	15	–	–	–	–	15
United Kingdom	1	–	–	–	–	–	1
United States	26	–	22	–	–	–	48
Total	**166**	**49**	**73**	**28**	**–**	–	**316**
Operating reactors: Not participating in ISOE, but included in the ISOE database							
Country	**PWR/VVER**		**BWR**	**PHWR**	**GCR**	**LWGR**	**Total**
Pakistan	1		–	1	–	–	2
United Kingdom	–		–	–	18	–	18
United States	43		13	–	–	–	56
Total	**44**		**13**	**1**	**18**	–	**76**
Total number of operating reactors included in the ISOE database							
	PWR/VVER		**BWR**	**PHWR**	**GCR**	**LWGR**	**Total**
Total	**259**		**86**	**29**	**18**	–	**392**

Table 1: The official ISOE participants and the ISOE database (as of December 2010) (*continued*)

Definitively shutdown reactors: ISOE participants							
Country	**PWR/VVER**	**BWR**	**PHWR**	**GCR**	**LWGR**	**Other**	**Total**

2. The list of the official ISOE participants at the time of publication of this report is provided in Annex 3.

Bulgaria	4	–	–	–	–	–	4
Canada	–	–	2	–	–	–	2
France	1	–	–	6	–	–	7
Germany	3	1	–	1	–	–	5
Italy	1	2	–	1	–	–	4
Japan	–	2	–	1	–	1	4
Lithuania	–	–	–	–	2	–	2
The Netherlands	–	1	–	–	–	–	1
Russian Federation	2	–	–	–	–	–	2
Slovak Republic	2	–	–	–	–	–	2
Spain	1	–	–	1	–	–	2
Sweden	–	2	–	–	–	–	2
Ukraine	–	–	–	–	3	–	3
United States	2	1	–	1	–	–	4
Total	**16**	**9**	**2**	**11**	**5**	**1**	**44**
Definitively shutdown reactors: Not participating in ISOE but included in the ISOE database							
Country	**PWR/VVER**	**BWR**	**PHWR**	**GCR**	**LWGR**	**Other**	**Total**
United Kingdom	–	–	–	22	–	–	22
United States	8	5	–	1	–	–	14
Total	**8**	**5**	**–**	**23**	**–**	**–**	**36**
Total number of definitively shutdown reactors included in the ISOE database							
	PWR/VVER	**BWR**	**PHWR**	**GCR**	**LWGR**	**Other**	**Total**
Total	**24**	**14**	**2**	**34**	**5**	**1**	**80**

Total number of reactors included in the ISOE database							
	PWR/VVER	**BWR**	**PHWR**	**GCR**	**LWGR**	**Other**	**Total**
Total	**283**	**100**	**31**	**52**	**5**	**1**	**472**

Number of **participating countries**	**29**
Number of **participating utilities**[3]	**66**
Number of **participating authorities**[4]	**27**

3. Represents the number of lead utilities; in some cases, plants are owned/operated by multiple enterprises.
4. Three countries participate with two authorities.

2. OCCUPATIONAL DOSE STUDIES, TRENDS, AND FEEDBACK

A key element of the ISOE is the tracking of occupational exposure trends from nuclear power facilities world wide for benchmarking, comparative analysis, and experience exchange amongst ISOE members. This information is maintained in the ISOE Occupational Exposure Database which contains annual occupational exposure data supplied by participating utilities (generally based on operational dosimetry systems). The ISOE database includes the following data types:

- Dosimetric information from commercial NPPs in operation, shutdown or in some stage of decommissioning, including:
  - annual collective dose for normal operation;
  - maintenance/refuelling outage;
  - unplanned outage periods;
  - annual collective dose for certain tasks and worker categories.
- Plant-specific information relevant to dose reduction, such as materials, water chemistry, start-up/shutdown procedures, cobalt reduction programme, etc.
- Radiation protection related information for specific operations, jobs, procedures, equipment or tasks (radiological lessons learned):
  - effective dose reduction;
  - effective decontamination;
  - implementation of work management principles.

Using the ISOE database, ISOE members can perform various benchmarking and trend analyses by country, by reactor type, or by other criteria such as sister-unit grouping. The summary below provides highlights of the general trends in occupational doses at nuclear power plants.

2.1 Occupational exposure trends: Operating reactors

Figures 1 and 2 show the trends in annual average and three-year rolling average collective dose per reactor, by reactor type, for 1992-2010. In general, the average collective dose per operating reactor unit has consistently decreased over the time period covered in the ISOE database, with the 2010 averages maintaining the levels reached in last few years. In spite of some yearly variations, the clear downward dose trend in most reactors has continued, with the exception of PHWRs, which have shown a slight increasing trend since the lows achieved over the 1996-1998 time period.

With respect to 2010, a summary of average annual collective doses by reactor type is provided in Table 2. Exposure trends over the past three years for participating countries and by technical centre regional groupings, expressed as average annual and three-year rolling average annual collective doses per reactor are shown in Tables 3 and 4, respectively. These results are based primarily on data reported and recorded in the ISOE database during 2010, supplemented by the individual country reports (Chapter 5) as required. Figures 3 to 7 provide a detailed breakdown of the 2010 data in bar-chart format, ranked from highest to lowest average dose. In all figures, the "number of units" refers to the number of reactor units for which data has been reported for the year in question.

Figure 1: Average collective dose per reactor for all operating reactors included in ISOE by reactor type, 1992-2010 (man·Sv/reactor)

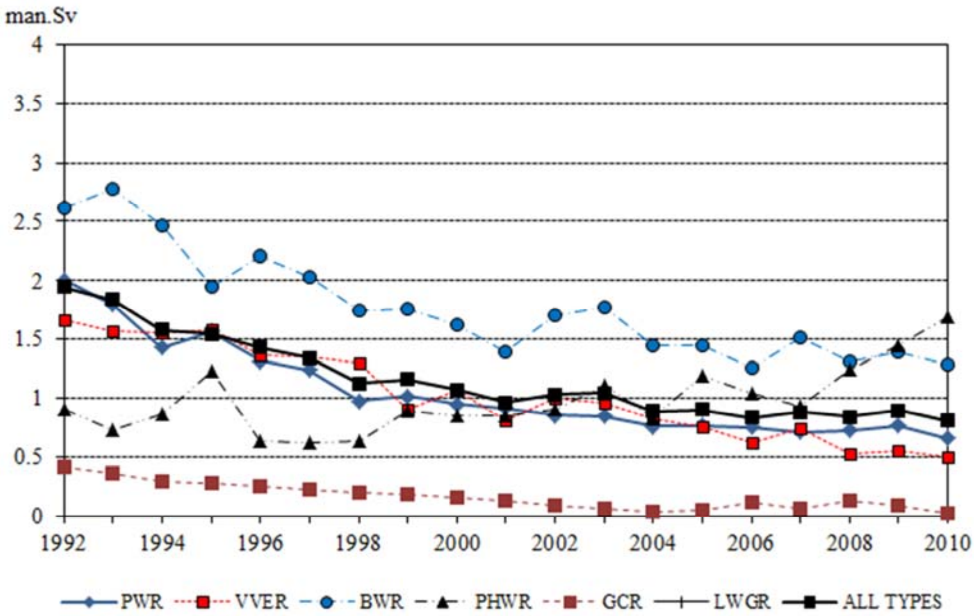


Figure 2: Three-year rolling average per reactor for all operating reactors included in ISOE by reactor type, 1992-2010 (man·Sv/reactor)

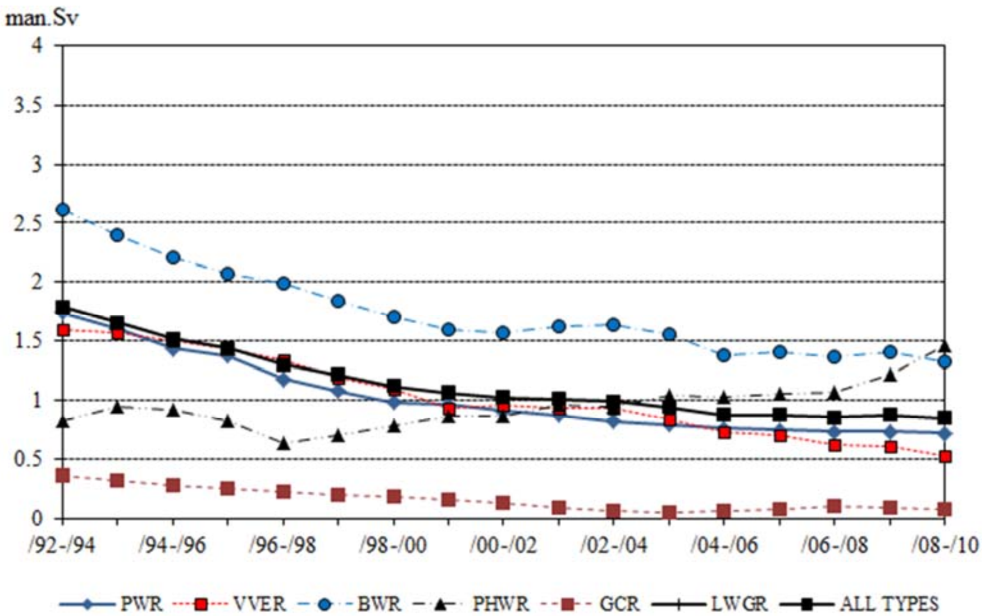


Table 2: Summary of average collective doses for operating reactors, 2010

	2010 average annual collective dose (man·Sv/reactor)	Three-year rolling average for 2008-2010 (man·Sv/reactor)
Pressurised water reactors (PWR)	0.66	0.72
Pressurised water reactors (VVER)	0.51	0.53
Boiling water reactors (BWR)	1.29	1.33
Pressurised heavy water reactors (PHWR/CANDU)	1.70	1.47
All reactors, including gas-cooled (GCR) and light water graphite reactors (LWGR)	0.81	0.85

Table 3: Average annual collective dose per reactor, by country and reactor type, 2008-2010 (man·Sv/reactor)

	PWR			VVER			BWR		
	2008	2009	2010	2008	2009	2010	2008	2009	2010
Armenia				1.24	0.55	0.77			
Belgium	0.39	0.36	0.30						
Brazil	0.74	1.04	0.50						
Bulgaria				0.27	0.28	0.43			
Canada									
China	0.54	0.54	0.44						
Czech Republic				0.13	0.15	0.12			
Finland				0.78	0.38	0.81	0.46	0.59	0.45
France	0.66	0.70	0.62						
Germany	0.62	1.05	0.61				1.19	1.01	0.88
Hungary				0.33	0.44	0.37			
Japan	1.64	1.61	1.51				1.42	1.32	1.23
Korea, Republic of	0.49	0.47	0.45						
Mexico							4.69	2.08	5.01
The Netherlands	0.27	0.24	0.62						
Pakistan	0.59	0.23	0.61						
Romania									
Russian Federation				0.69	0.80	0.65			
Slovak Republic				0.16	0.17	0.11			
Slovenia	0.15	0.65	0.85						
South Africa, Republic of	0.75	0.74	0.52						
Spain	0.29	0.72	0.33				0.50	2.31	0.52
Sweden	0.56	0.92	0.46				0.85	1.41	0.93

Table 3: Average annual collective dose per reactor, by country and reactor type, 2008-2010 (man·Sv/reactor) (*continued*)

	PWR			VVER			BWR		
	2008	**2009**	**2010**	**2008**	**2009**	**2010**	**2008**	**2009**	**2010**
Switzerland	0.46	0.36	0.53				1.16	1.14	1.25
Ukraine				0.65	0.72	0.66			
United Kingdom	0.26	0.34	0.27						
United States	0.68	0.66	0.55				1.23	1.49	1.35
Average	**0.73**	**0.77**	**0.66**	**0.52**	**0.56**	**0.51**	**1.31**	**1.39**	**1.29**

Data provided directly from country report, rather than calculated from the ISOE database: UK (2008, 2009, 2010: GCR).

BWR dose in 2009 for Japan includes Hamaoka 1 and 2 which have been decommissioning since 18 November 2009.

BWR dose in 2010 for Japan does not include Fukushima Dai-ichi Units 1-6.

	PHWR			GCR			LWGR		
	2008	**2009**	**2010**	**2008**	**2009**	**2010**	**2008**	**2009**	**2010**
Canada	1.36	1.39	1.69						
Korea, Republic of	0.59	2.21	2.18						
Lithuania							3.10	0.79	
Pakistan	3.70	1.86	2.47						
Romania	0.34	0.24	0.39						
United Kingdom				0.14	0.09	0.03			
Average	**1.25**	**1.45**	**1.70**	**0.14**	**0.09**	**0.03**	**3.10**	**0.79**	

	2008	**2009**	**2010**
Global average	**0.84**	**0.90**	**0.81**

	Europe			Asia			North America			IAEA		
	2008	**2009**	**2010**	**2008**	**2009**	**2010**	**2008**	**2009**	**2010**	**2008**	**2009**	**2010**
PWR	0.60	0.71	0.56	1.17	1.15	1.08	0.68	0.66	0.55	0.59	0.65	0.52
VVER	0.26	0.25	0.25							0.67	0.72	0.64
BWR	0.91	1.26	0.86	1.42	1.32	1.23	1.42	1.52	1.55			
PHWR				0.59	2.21	2.18	1.36	1.39	1.69	1.46	0.62	0.48
GCR	0.14	0.09	0.03									
LWGR										3.10	0.79	

All Lithuanian reactors were shutdown in 2010.

See Annex 3 for the country composition of the four ISOE regions.

Table 4: Three-year rolling average annual collective dose per reactor, by country and reactor type, 2006-2008 to 2008-2010 (man·Sv/reactor)

	PWR			VVER			BWR		
	/06-/08	**/07-/09**	**/08-/10**	**/06-/08**	**/07-/09**	**/08-/10**	**/06-/08**	**/07-/09**	**/08-/10**
Armenia				0.96	0.86	0.86			
Belgium	0.35	0.34	0.35						
Brazil	0.78	0.94	0.76						
Bulgaria				0.37	0.32	0.32			
Canada									
China	0.56	0.58	0.51						
Czech Republic				0.15	0.15	0.13			
Finland				0.66	0.50	0.65	0.72	0.55	0.50
France	0.66	0.66	0.66						
Germany	0.83	0.90	0.76				1.11	1.06	1.03
Hungary				0.38	0.41	0.38			
Japan	1.36	1.53	1.59				1.40	1.40	1.33
Korea, Republic of	0.54	0.52	0.70						
Mexico							2.97	3.17	3.93
The Netherlands	0.38	0.25	0.38						
Pakistan	0.37	0.44	0.72						
Romania									
Russian Federation				0.77	0.80	0.71			
Slovak Republic				0.23	0.19	0.15			
Slovenia	0.63	0.56	0.55						
South Africa, Republic of	0.76	0.74	0.67						
Spain	0.39	0.50	0.35				1.69	2.32	1.11
Sweden	0.49	0.63	0.65				1.02	1.12	1.06
Switzerland	0.40	0.40	0.45				1.08	1.13	1.18
Ukraine				0.93	0.85	0.68			
United Kingdom	0.28	0.22	0.29						
United States	0.74	0.66	0.63				1.38	1.43	1.36
Average	0.73	0.74	0.72	0.63	0.61	0.53	1.36	1.40	1.33

Table 4: Three-year rolling average annual collective dose per reactor, by country and reactor type, 2006-2008 to 2008-2010 (man·Sv/reactor) (*continued*)

	PHWR			GCR			LWGR		
	/06-/08	/07-/09	/08-/10	/06-/08	/07-/09	/08-/10	/06-/08	/07-/09	/08-/10
Canada	1.09	1.23	1.49						
Korea, Republic of	0.66	1.20	1.66						
Lithuania							2.84	2.09	1.94
Pakistan	3.50	2.63	2.68						
Romania	0.38	0.29	0.33						
United Kingdom				0.11	0.10	0.09			
Average	1.08	1.22	1.47	0.11	0.10	0.09	2.84	2.09	1.94

	/06-/08	/07-/09	/08-/10
Global average	**0.85**	**0.87**	**0.85**

	Europe			Asia			North America			IAEA		
	/06-/08	/07-/09	/08-/10	/06-/08	/07-/09	/08-/10	/06-/08	/07-/09	/08-/10	/06-/08	/07-/09	/08-/10
PWR	0.61	0.64	0.62	1.02	1.12	1.13	0.74	0.66	0.63	0.63	0.67	0.66
VVER	0.28	0.26	0.25							0.81	0.79	0.68
BWR	1.02	1.13	1.08	1.40	1.40	1.33	1.38	1.43	1.36			
PHWR				0.66	1.20	1.66	1.09	1.23	1.49	1.72	1.17	1.11
GCR	0.11	0.10	0.09									
LWGR										2.84	2.09	1.94

Calculated from the ISOE database, supplemented by data provided directly by country (see Table 3 notes).

Figure 3: 2010 PWR average collective dose per reactor by country (man·Sv/reactor)

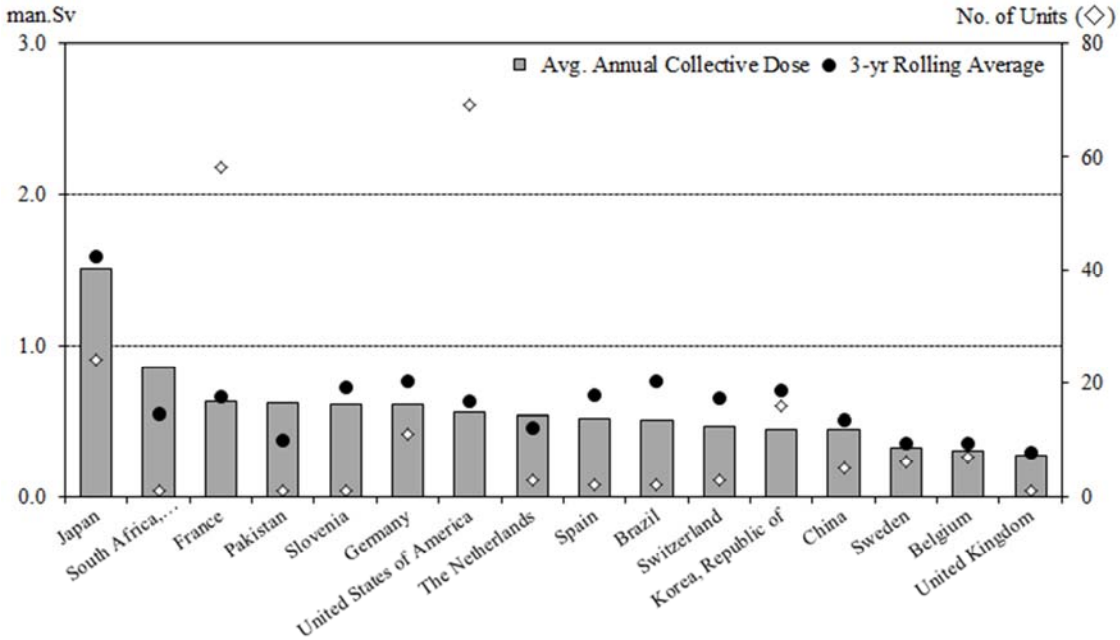


Figure 4: 2010 VVER average collective dose per reactor by country (man·Sv/reactor)

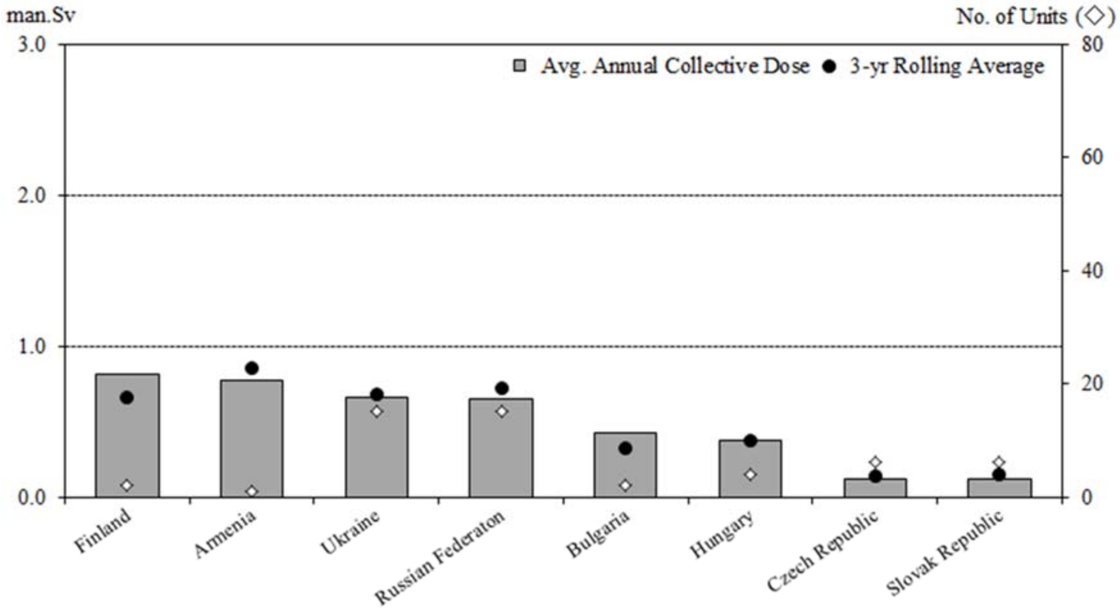


Figure 5: 2010 BWR average collective dose per reactor by country (man·Sv/reactor)

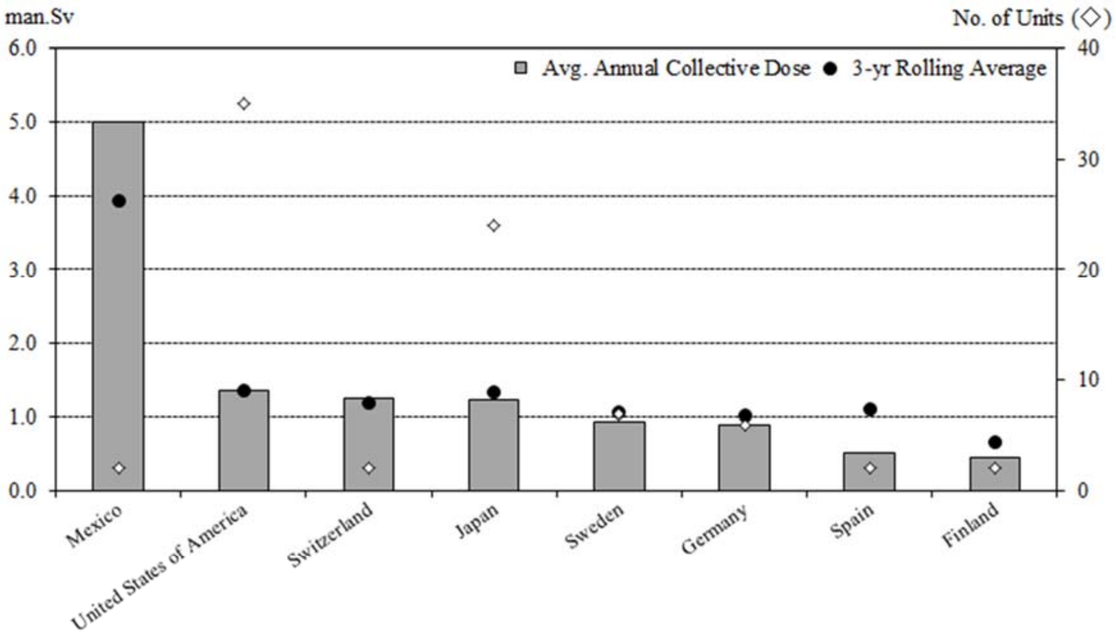


Figure 6: 2010 PHWR average collective dose per reactor by country (man·Sv/reactor)

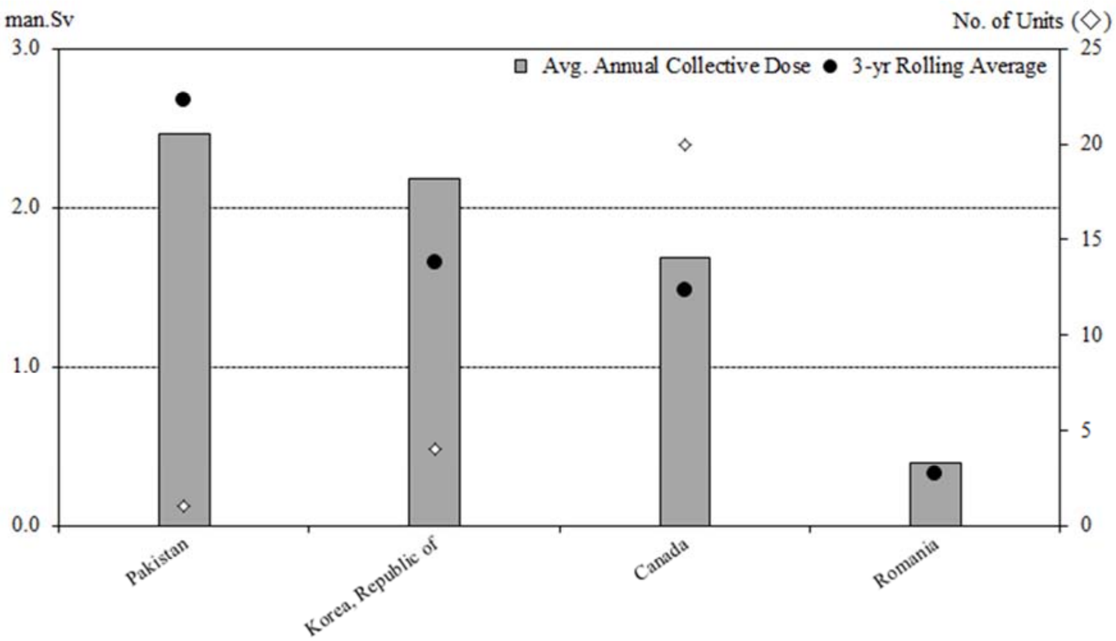
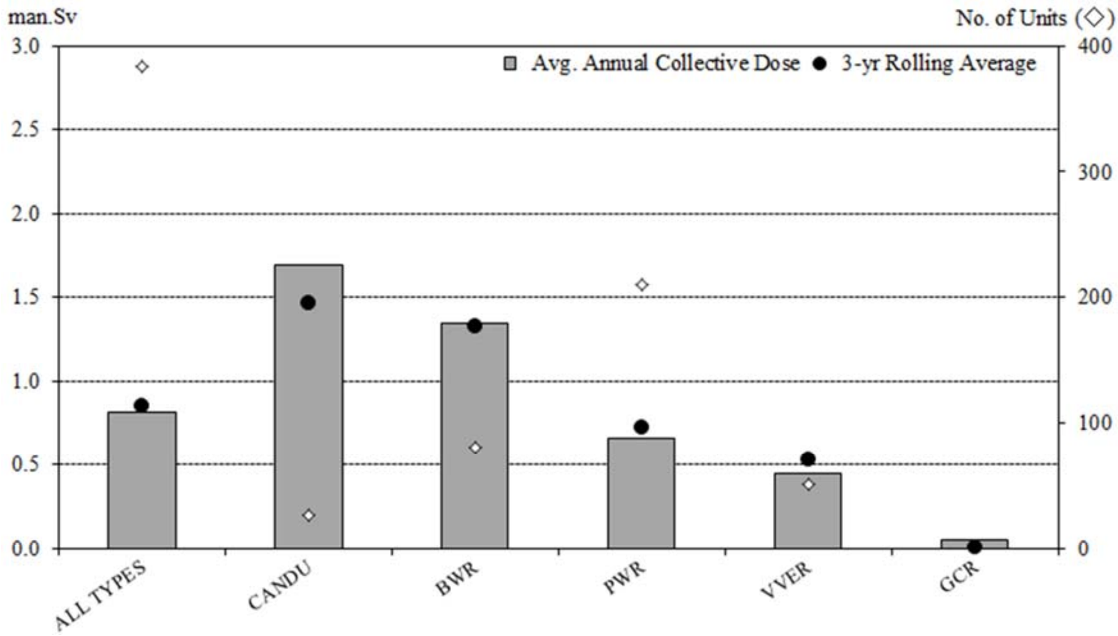


Figure 7: 2010 average collective dose per reactor by reactor type (man·Sv/reactor)



The following discussion provides a brief overview of the results and trends observed in ISOE European and Asian regions.[5] However, it is noted that due to the various power plant designs and the complex parameters influencing collective doses, these analyses and figures do not support any conclusions with regard to the quality of radiation protection performance in the countries addressed. More detailed discussion and analyses of dose trends in individual countries are provided in Chapter 5.

European region

Average annual collective dose per reactor (Table 3)

Regarding PWR reactors, the average annual collective dose per reactor significantly decreased in 2010 compared with 2009, with respective values of 0.56 man.Sv and 0.71 man.Sv. Three countries mainly contribute to this decrease: Germany, Spain, and Sweden. However, an increase in Switzerland, Slovenia, and the Netherlands is noted.

The average annual collective dose per reactor of VVERs remains the same in 2010 as in 2009, with a value of 0.25 man.Sv per reactor.

Regarding BWRs, the average collective dose has decreased compared to 2009, with a value at 0.86 man.Sv compared with that of 1.26 man.Sv in 2009.

Three-year rolling average annual collective dose (Table 4)

The evolution of the three-year rolling average annual collective dose, which provides a better representation of the general trend in dose, shows a continuity of the decrease for VVERs. There is a stability of the averages for PWRs and, after an increase in 2007-2009, a decrease of the value during 2008-2010 for BWRs.

Regarding VVERs, the Czech Republic presents the lowest three-year rolling average annual collective dose per reactor in 2008-2010 with 0.13 man.Sv per reactor, followed by the

5. For ISOE North American and IAEA regions, see data available in country reports.

Slovak Republic (0.15 man.Sv per reactor), Hungary (0.38 man.Sv per reactor) and Finland (0.65 man.Sv per reactor).

For European PWRs, the data per country show that with respect to the three-year rolling average annual collective dose for 2008-2010, six main groups can be distinguished:

- United Kingdom – below 0.3 man.Sv per reactor;
- Belgium, the Netherlands, Spain – between 0.3 and 0.4 man.Sv per reactor;
- Switzerland – around 0.45 man.Sv per reactor;
- Slovenia – around 0.55 man.Sv per reactor;
- France, Sweden – around 0.65 man.Sv per reactor;
- Germany – above 0.7 man.Sv per reactor.

The three-year rolling average annual collective dose per reactor for BWRs are quite similar in Germany, Spain, Sweden, and Switzerland, around 1 man.Sv per reactor. Finland is presenting the lowest value with 0.50 man.Sv per reactor.

Main events influencing the collective dose

The country reports (in Chapter 5) provide information from each participating countries on the main events which influenced the collective dose in 2010. For the European countries, the main points are the following:

- France: Some unforeseen events (with an impact of 0.928 man.Sv on the total dose of the fleet) and two steam generator replacements.
- Germany: Two unplanned outages of 12 months in BWRs. Full system decontamination (FSD) in Grafenrheinfeld.
- Spain: Installation of permanent shielding in some areas of Cofrentes NPP. Special treatment of fulfilment water in reactor cavity of Trillo NPP.
- Sweden: At Ringhals 1, major work on reactor main circulation valves was accomplished. At Forsmark 3, unplanned shutdown on two occasions caused by leaking fuel.
- Switzerland: 2010 was marked by an event classified by ENSI as Level 2 on the INES Scale at Leibstadt NPP.
- United Kingdom: The annual dose at Sizewell B was dominated by a forced outage of around 200 days in duration. The forced outage was carried out to repair around 15 pressuriser heaters.

Asian region

In the Asian region, the average annual collective dose per reactor was stable or lower than the previous year for all reactor types.

The Japanese fiscal year is from April to the following March. The Tohoku District - off the Pacific Ocean Earthquake occurred on 11 March 2011. Due to the nuclear accident caused by the earthquake and tsunami, the exposure data for Fukushima Dai-ichi and Fukushima Dai-ni nuclear power stations are under estimation by the utility. The average annual collective dose per reactor for Japanese BWR in FY 2010 was 1.13 man.Sv, which was the same as the previous year excluding Fukushima Dai-ichi and Fukushima Dai-ni NPS. The average collective dose for Japanese PWR, 1.51 man.Sv, decreased from 1.61 man.Sv in FY 2009, but it remains at a high exposure level. Main events influencing the exposure for PWR are preventive maintenance works including the work for pressuriser nozzle.

The average annual collective dose per reactor for PWRs in the Republic of Korea was 0.45 man.Sv, which was the lowest average collective dose for PWRs of the Republic of Korea. Regarding PHWRs in the Republic of Korea, the average collective dose in 2010 was as high (2.18 man.Sv) as the previous year (2.21 man.Sv) due to the refurbishment of Wolsung Unit 1 including the replacement of the pressure tubes and calandria tubes.

2.2 Occupational exposure trends: Definitely shutdown reactors

In addition to information from operating reactors, the ISOE database contains dose data from 75 reactors which are shutdown or in some stage of decommissioning. This section provides a summary of the dose trends for those reactors reported during the 2008-2010 period. These reactor units are generally of different type and size, at different phases of their decommissioning programmes, and supply data at various levels of detail. For these reasons, and because these figures are based on a limited number of shutdown reactors, definitive conclusions cannot be drawn. Under the ISOE Working Group on Data Analysis, work continued in 2010 aimed at improving data collection for shutdown and decommissioned reactors in order to facilitate better benchmarking.

Table 5 provides average annual collective doses per unit for definitely shutdown reactors by country and reactor type for 2008-2010, based on data recorded in the ISOE database, supplemented by the individual country reports (Chapter 5) as required. Figures 8-11 present the average collective dose per reactor for shutdown reactors for 1992-2010 by reactor type (PWR, BWR, and GCR). In all figures, the "number of units" refers to the number of units for which data has been reported for the year in question.

Table 5: Number of units and average annual dose per reactor by country and reactor type for definitely shutdown reactors, 2008-2010 (man·mSv/reactor)

		2008		2009		2010	
		No.	**Dose**	**No.**	**Dose**	**No.**	**Dose**
PWR	France	1	23.2	1	62.1	1	117.2
	Germany	5	160.0	5	128.0	2	388.4
	Italy	1	1.1	1	1.7	1	3.2
	Spain	1	134.7	1	244.0	1	53.0
	United States	10	7.1	8	1.5	8	2.0
VVER	Bulgaria	4	31.0	4	29.4	4	11.3
	Germany	5	27.0	5	20.0	n/a	n/a
	Russian Federation	2	78.0	2	84.0	2	77.6
BWR	Germany	3	179.0	3	138.0	1	427.1
	Italy	2	29.1	2	6.18	2	60.3
	Japan					2	123.8
	The Netherlands	1	0.3	1	0.6	n/a	n/a
	Sweden	2	39.1	2	27.0	2	6.2
	United States	3	13.4	4	4.8	5	21.6

Table 5: Number of units and average annual dose per reactor by country and reactor type for definitely shutdown reactors, 2008-2010 (man·mSv/reactor) (*continued*)

		2008		2009		2010	
		No.	**Dose**	**No.**	**Dose**	**No.**	**Dose**
GCR	France	6	2.8	6	8.8	6	1.3
	Germany	2	13.0	2	17.0	n/a	n/a
	Italy	1	2.9	1	0	1	1.7
	Japan	1	20.0	1	20.0	1	50.0
	United Kingdom	16	55.0	16	42.0	16	48.0
LWGR	Lithuania	1	188.4	1	144.7	2	236.2
LWCHWR	Japan	1	431.3	1	114.6	1	111.6

Figure 8: Average collective dose per shutdown reactor: PWR/VVERs (man·mSv/reactor)

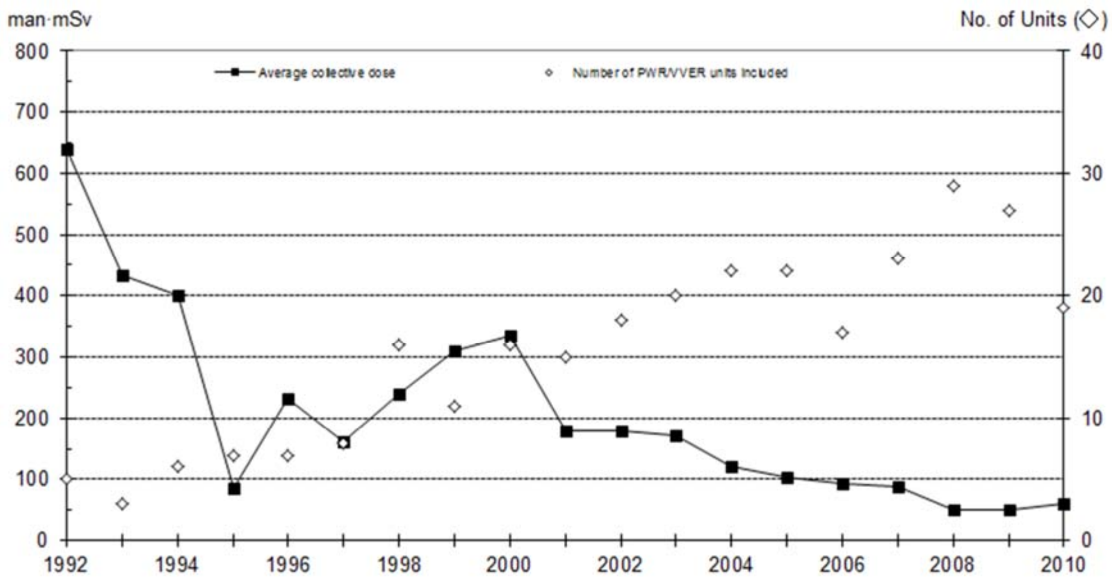


Figure 9: Average collective dose per shutdown reactor: BWRs (man·mSv/reactor)

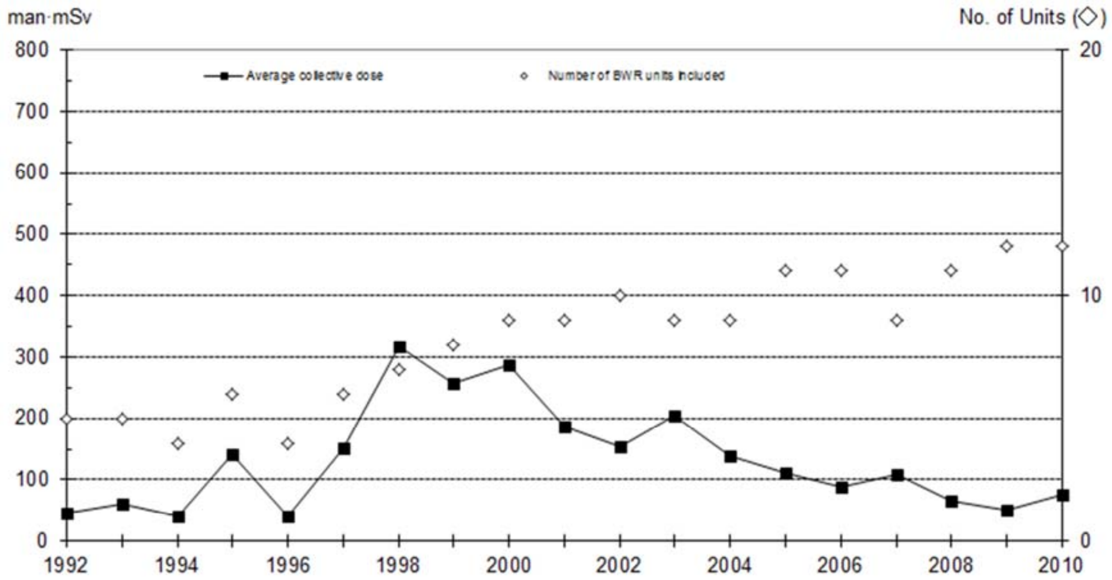


Figure 10: Average collective dose per shutdown reactor: GCRs (man·mSv/reactor)

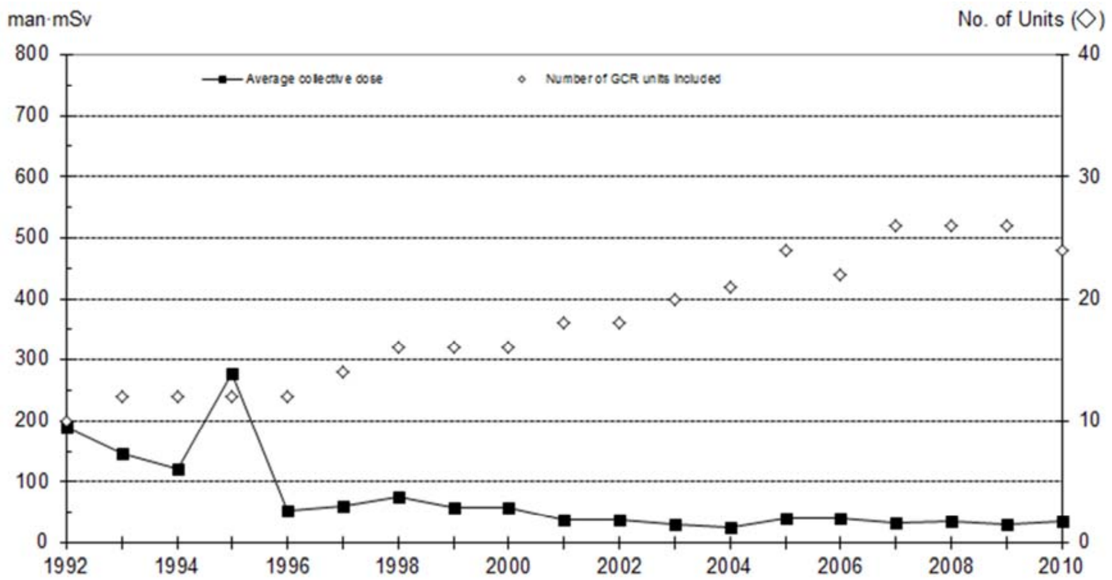
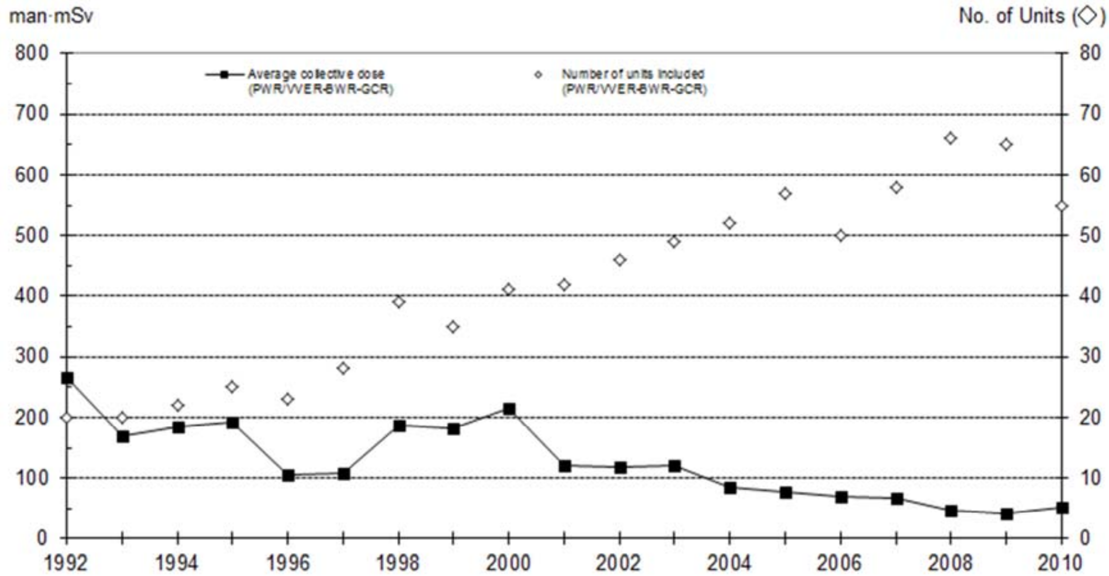


Figure 11: Average collective dose per shutdown reactor: PWR/VVER, BWR, GCR (man·mSv/reactor)



3. ISOE EXPERIENCE EXCHANGE ACTIVITIES

While ISOE is well known for its occupational exposure data and analyses, the programme's strength comes from its efforts to share such information broadly amongst its participants. The combination of ISOE symposia, ISOE Network, and technical visits provides a means for radiation protection professionals to meet, share information, and build links between ISOE regions to develop a global approach to occupational exposure management. This chapter provides information on the main information and experience exchange activities within ISOE during 2010.

3.1 ISOE ALARA Symposia

ISOE International ALARA Symposium

The ETC, in collaboration with Sizewell B NPP, organised the 2010 ISOE International Symposium, held 17-19 November 2010 at Cambridge, United Kingdom and sponsored by the OECD/NEA and the IAEA. Participants attending the symposium numbered 150, from 24 countries and 13 vendors. Distinguished papers selected by the participating technical centres for presentation at the 2012 ISOE International ALARA Symposium in Fort Lauderdale, USA included:

- "GAMPIX A New Generation of Gamma Camera for Hot Spot Localisation", F. Carrel, *et al.* (CEA, France);
- "SAP Nuclear – A New Software for Radiation Protection in Slovenské Elektrárne/ Enel Company", F. Putignano (Enel, Slovak Republic);
- "Steam Generator Replacement of the Belgian Doel 1 Unit: Follow-up and On Site Dosimetry", B. Walschaerts, *et al.* (Tractebel Engineering, Belgium).

The 2012 and 2013 ISOE International ALARA Symposia will be organised by NATC and ATC, respectively.

ISOE regional ALARA symposia

NATC, in co-operation with the Electric Power Research Institute (EPRI), organised and conducted the 2010 ISOE North American ALARA Symposium from 11-13 January 2010 in Fort Lauderdale, USA. Participation included 130 participants. Browns Ferry nuclear station was presented with the World Class ALARA Performance Award. The following awards were noted:

- "Cook Unit 2 Refuelling Outage ALARA Success: 34 Person Rem", T. Brown (Cook NPP, USA);
- "Radiation Protection Management and ALARA Lessons Learned During TMI Steam Generator/Refuel Outage", W. Harris (Exelon Nuclear, USA);
- "The Canadian Nuclear Renaissance", T. Jamieson (CNSC, Canada).

ATC, in collaboration with the KHNP and KINS (Republic of Korea), organised and conducted the 2010 ISOE Asian ALARA Symposium from 30-31 August 2010 in Gyeongju, Republic of Korea. A technical visit to Wolsong Nuclear Power Site and Wolsong Low Level

Radioactive Waste Disposal Center was held on 1 September 2010. The symposium was attended by 120 participants. The following awards were noted:

- "Operation of Remote Monitoring and Video Telephony System for Advanced RP", W-S. Yoon (KHNP, Republic of Korea);
- "Tritium Release Reduction Based on Release Trend Analysis", J. Shin (KHNP, Republic of Korea).

The proceedings and conclusions of the various symposia are available on the ISOE Network.

3.2 The ISOE Network (www.isoe-network.net)

The ISOE Network is a comprehensive information exchange website on dose reduction and ALARA resources for ISOE participants, providing rapid and integrated access to ISOE resources through a simple web browser interface. The network, containing both public and members-only resources, provides participants with access to a broad and growing range of ALARA resources, including ISOE publications, reports and symposia proceedings, web forums for real-time communications amongst participants, members' address books, and on-line access to the ISOE Occupational Exposure Database.

ISOE Occupational Exposure Database

In order to increase user access to the data within ISOE, the ISOE occupational exposure database is accessible to ISOE participants through the ISOE Network. Since 2005, the database statistical analysis module, known as MADRAS, has been available on the ISOE Network. Major categories of pre-defined analyses include:

- benchmarking at unit level;
- average annual collective dose per reactor;
- annual total collective dose;
- annual collective dose per TWh;
- contribution of outside personnel and outages to total collective dose;
- trends in the number of reactor units;
- three-year rolling average for collective dose per reactor;
- miscellaneous queries.

Outputs from these analyses are presented in graphical and tabular format, and can be printed or saved locally by the user for further use or reference. In 2010, two new modules were developed and implemented: the data completeness module that provides a global overview of the data completeness, and the data extract module to extract data from questionnaires.

RP Library

The RP Library, one of the most used website features, provides ISOE members with a comprehensive catalogue of ISOE and ALARA resources to assist radiation protection professionals in the management of occupational exposures. The RP Library includes a broad range of general and technical ISOE publications, reports, presentations, and proceedings. In 2010, the following types of documents were made available:

- benchmarking reports;
- RP experience reports;
- ALARA tools.

RP Forum

In addition to the RP Library, registered ISOE users can access the RP Forum to submit a question, comment, or other information relating to occupational radiation protection to other users of the Network. In addition to a common user group for all members, the forum contains a dedicated regulators group and a common utilities group. All questions and answers entered in the RP Forum are searchable using the website search engine, increasing the potential audience of any entered information.

During 2010, the following requests were posted on the network. For each request, a synthesis of all answers was prepared by ETC and made available on the RP Forum.

Table 6: Requests posted on the RP forum (all members)

Date	Country	Title
Aug. 2010	USA: Summer	Type of protective clothing use at NPPs
Aug. 2010	USA: Diablo Canyon	LHRA/VHRA key control tracking method
Aug. 2010	USA: Fermi 2	"SMART" swing gate use at NPPs
Sept. 2010	USA: Cook	Hot spot definition
Sept. 2010	USA: Fermi 2	Routine survey frequency of general areas
Sept. 2010	USA: Palo Verde	In-plant alpha monitoring protocols
Sept. 2010	USA: Catawba	Permanent shielding in PWR containment inquiry

Table 7: Requests posted on the RP forum (utilities only)

Date	Country	Title
Jan. 2010	Finland: Loviisa	Use of mobile phones (GSM) inside RCA
Feb. 2010	Romania: Cernavoda	EPD/TLD dosimeters
Feb. 2010	U.K.: Sizewell B	Use of a daily dose limit
Feb. 2010	France: EDF	New electronic dosimetry system?
Mar. 2010	France: EDF	RP training for managers
Apr. 2010	Slovak Republic: Bohunice	^{85}Kr and ^{76}As in radioactive releases
May 2010	Sweden: Ringhals	Background correction for individual monitoring of Hp(10) and HP(0.07)
May 2010	USA: NATC	Counting of alpha contamination smears
May 2010	USA: Kewaunee	RP cavity survey practices after drain down

Table 7: Requests posted on the RP forum (utilities only) (*continued*)

Date	Country	Title
Jul. 2010	Canada: Gentilly 2	Smoking in controlled zone
Jul. 2010	France: EDF	Dose rates data for PWRs (2002-2008)
Aug. 2010	France: EDF	Industrial radiography
Oct. 2010	Canada: Gentilly 2	Control of fixed contamination
Nov. 2010	France: EDF	Questionnaire on "monitoring, sampling and flow measurement of gaseous effluent discharges"
Nov. 2010	Sweden: Ringhals	Management involvement in ALARA issues
Nov. 2010	Sweden	Dose constraints experience and implementation
Nov. 2010	Japan: JNES	Questionnaire on JOB and TASK in an outage

3.3 ISOE benchmarking visits

To facilitate the direct exchange of radiation protection practice and experience, the ISOE programme supports voluntary site benchmarking visits amongst the participating utilities in the four technical centre regions. These visits are organised at the request of a utility with technical centre assistance and included in the programme of work for the coming year. The intent of such visits is to identify good radiation protection practices at the host plant in order to share such information directly with the visiting plant. While both the request for and hosting of such visits under ISOE are voluntary on the utilities and the technical centres, post-visit reports are made available to the ISOE members (according to their status as utility or authority member) through the ISOE Network website in order to facilitate the broader distribution of this information within ISOE. Highlights of visits conducted during 2010 are summarised below.

Benchmarking visits organised by ETC

In 2010, two benchmarking visits were organised by ETC for the French utility EDF, using ISOE contacts, but no ISOE/ETC resources. The reports are available on the ISOE website (for all ISOE members for the Trillo report and for utilities only for the Vogtle and Calvert Cliffs reports).

Trillo NPP (Spain)

The visit took place on 16-17 June 2010. The French team was composed of two representatives of EDF and two representatives of CEPN.

The main topics discussed were:

- general organisation and management of radiation protection in normal operation and during outages;
- radiation protection training of RP specialists and exposed workers;
- radiological cleanliness.

Calvert Cliff NPP and Vogtle NPP (USA)

The visit took place on 4-5 October 2010 for Calvert Cliff NPP and on 7-8 October 2010 for Vogtle NPP. The French team was composed of three representatives of EDF and two representatives of CEPN.

The main topics discussed were:

- remote monitoring systems;
- training;
- dose and contamination simulation tools.

Benchmarking visits organised by NATC

Representatives from Braidwood, Comanche Peak, and Cook NPPs participated in a benchmarking visit to Doel NPP (Belgium) in May 2010.

The main topics discussed were:

- radiation protection organisation;
- source term management;
- design features;
- training;
- outage planning and management;
- outage dose monitoring.

4. ISOE PROGRAMME MANAGEMENT ACTIVITIES DURING 2010

In 2010, the ISOE programme continued to focus on the collection and analysis of occupational exposure data and on the effective exchange of operational radiation protection information and experience, including enhanced inter-regional co-operation and co-ordination. This was facilitated through the ISOE ALARA Symposia, ISOE Network website and ISOE-organised benchmarking visits (see Chapter 3 for details). These initiatives have continued to position the ISOE programme to better address the operational needs of its end users (radiation protection professionals) in the area of occupational radiation protection and ALARA practices at nuclear power plants.

4.1 Management of the official ISOE databases

Official database release

ISOE participants provided their 2009 data using the ISOE Network data entry module on the web and the ISOE database software under Microsoft ACCESS, which was integrated into the database by ETC. The ISOE Network data entry module was made available in January 2010 and the data entered directly on the web are available as soon as questionnaires are validated.

ETC continued to manage the official ISOE database, preparing and distributing the CD-ROM/MS-ACCESS version of the database with 2008 data and distributing it in January 2010. The specific databases for each participating authority were created and distributed by ETC. The end-of-year release of the database and ISOE software on CD-ROM was provided to all ISOE participants following the annual ISOE Management Board meeting.

4.2 Management of the ISOE Network

The ISOE Network continued to serve as the central portal for ISOE-related information and resources, including the ISOE database. All new user accounts requested by ISOE national co-ordinators or individuals were created and implemented by the ETC and the NEA Secretariat notified users. At the end of 2010, about 611 utility and 104 regulatory member accounts had been created.

4.3 ISOE management and programme activities

As part of the overall operations of the ISOE programme, ongoing technical and management meetings were held throughout 2010, as listed in Table 8.

ISOE Management Board

The ISOE Management Board continued to focus on the management of the ISOE programme, reviewing the progress of the programme at its annual meeting in 2010 and approving the programme of work for 2011. The 2010 mid-year meeting of the ISOE Bureau focused on the status of the ISOE activities for 2010, the status of the renewal of the ISOE Terms and Conditions and planning for the ISOE annual session 2010.

Table 8: Technical and management meetings held throughout 2010

ISOE meetings	Date
Technical Meeting on ISOE Application on the Web	Jan. 2010
ISOE Bureau	May 2010; Nov. 2010

Working Group on Data Analysis	Sept. 2010
NEA-ETC Web Working Group	Oct. 2010
20th ISOE Management Board Meeting	Nov. 2010
Joint NEA/CRPPH-ISOE activities	
Expert Group on Occupational Exposure	Mar. 2010; Oct. 2010

ISOE Working Group on Data Analysis

The Working Group on Data Analysis (WGDA) met in September 2010, continuing its focus on the integrity, completeness, and timeliness of the ISOE database and options for improving ISOE data collection and analysis, including the implementation of new pre-defined MADRAS queries. New proposed information sheets from the Technical Centres were discussed. The WGDA held a topical session at its September 2010 meeting to present a United States pilot project to automatically extract ISOE 1 data from existing dosimetry management software of US plants.

Task Team on Decommissioning

The ISOE D questionnaire will be adapted to decommissioning with a minimised number of job/tasks and the possibility to report relevant decommissioning activities after their completion. A new proposal will be submitted at next year's WGDA meeting.

Joint NEA/CRPPH-ISOE activities: Expert Group on Occupational Exposure

The EGOE was created by the NEA's Committee on Radiation Protection and Public Health (CRPPH), with an invitation to ISOE to participate in its activities. The EGOE met twice in 2010, with significant participation by ISOE members, including all Technical Centres. The EGOE performed a study on implementation of ICRP Publication 103, the scope of which is the interpretation and analysis of how the concept of dose constraints is being implemented for occupational exposure management. A report is under preparation. A survey within the European Radioprotection Authority Network (ERPAN) has also been conducted to collect information on practical information of dose constraints from some countries.

5. PRINCIPAL EVENTS OF 2010 IN ISOE PARTICIPATING COUNTRIES

As with any summary data, the information presented in Chapter 2, "Occupational Dose Studies, Trends, and Feedback", provides only a general overview of average numerical results from the year 2010. Such information serves to identify broad trends and helps to highlight specific areas where further study might reveal relevant experiences or lessons. However, to help to enhance this numerical data, this section provides a short list of important events which took place in ISOE participating countries during 2010 and which may have influenced the occupational exposure trends. These are presented as reported by the individual countries.[6] It is noted that the national reports contained in this section may include dose data arising from a mix of operational and/or official dosimetry systems.

ARMENIA

Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man.Sv/unit]**
VVER	1	0.77
Reactors in cold shutdown or in decommissioning		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man.Sv/unit]**
VVER	1	No separate data is available

Summary of national dosimetric trends

For the year 2010, the dosimetric trends at the Armenian NPP have slightly increased for collective dose due to works in confinement in relation to modernisation of the neutron flux control system and installation of filters which prevent sump clogging. The maximum individual dose was 15.6 mSv. The dose for outside workers was 0.133 man.Sv.

Events influencing dosimetric trends

No significant events were registered for the impact on dosimetric trends.

Number and duration of outages

For the year 2010, one 43-day duration outage was performed.

6. Due to various national reporting approaches, dose units used by each country have not been standardised.

New plants on line/plants shutdown

The new plant construction is on line, and sitting considerations are currently ongoing, however the new safety improvement approaches in relation to Fukushima Dai-ichi accident will impact on plant design regulatory requirements and site evaluation consideration.

Major evolutions

The dose reduction programme including ALARA culture implementation is slowly progressing, however steps taken for improvement of the old radiation control system are almost finished.

Component or system replacements

During the outage in 2010, no components or systems were replaced.

Safety-related issues

Some safety-related issues are expected due to medium activity radioactive waste treatment and storage activities.

Unexpected events

None registered for 2010.

New/experimental dose reduction programmes

No new/experimental dose reduction programmes were applied in 2010.

Organisational evolutions

Dose planning for the reduction of individual doses of staff remains the main tool for ALARA implementation.

Issues of concern in 2011

In 2011 medium activity radioactive waste conditioning issues remain to be solved.

Technical plans for major work in 2011

A modernisation plan of the radiation control system, including airborne and liquid releases, and dose reduction programme for radioactive waste management were initiated.

Regulatory plans for major work in 2011

Inspections at Armenian NPP are planned so as to control compliance with license conditions and regulatory requirements and follow-up actions.

Review of the environmental impact assessment (EIA) and the safety assessment report (SAR) in terms of radiation protection and safety of radioactive waste management due to new unit construction is also planned.

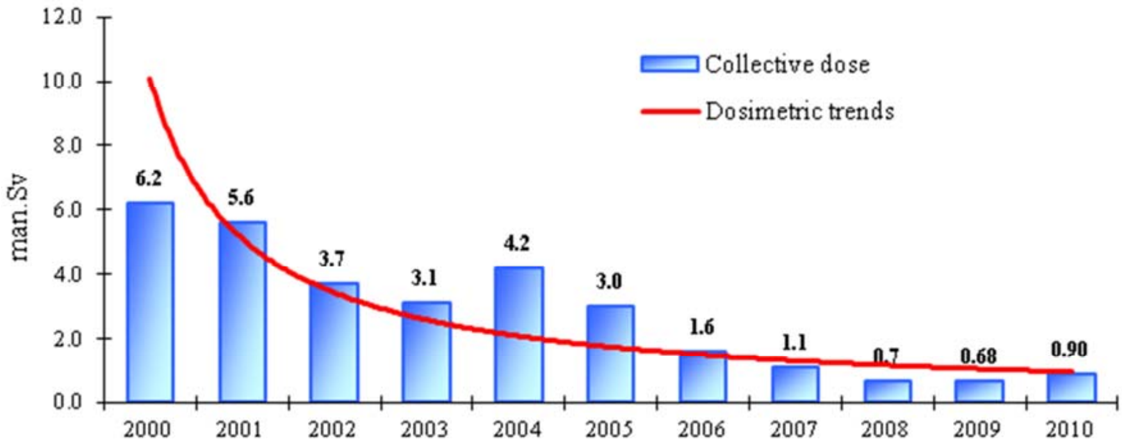
BULGARIA

Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man.Sv/unit]**
VVER-1000	2	0.426
Reactors in cold shutdown or in decommissioning		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man.Sv/unit]**
VVER-440	4	0.0113

Summary of national dosimetric trends

Collective dose (CD) at NPP Kozloduy, 2000-2010



Events influencing dosimetric trends

None.

Number and duration of outages

Unit No.	Outage duration (days)	Outage information	RWP
Unit 5	50 d	Refuelling and maintenance activities	38 370.24 man.hours
Unit 6	49 d	Refuelling and maintenance activities	38 909.55 man.hours

New plants on line/plants shutdown

None.

Major evolutions

None.

Component or system replacements

Replacement of 31 tubes from the upper reactor head.

Safety-related issues

None.

Unexpected events

Cracks on a couple of tubes from the upper reactor head.

Organisational evolutions

A new external state-owned organisation – Radwaste Treatment Enterprise of Units 1 and 2 was established.

Issues of concern in 2011

Probably some decommissioning activities on Units 1-4 will be performed by the new external state-owned organisation (Radwaste Treatment Enterprise). Reactor units as NPP units should disappear.

Technical plans for major work in 2011

Refuelling and maintenance of Units 5 and 6.

CANADA

Dose information

Operating reactors		
Reactor type	Number of reactors	Average annual collective dose per unit [man.Sv/unit]
PHWR	20	1.208

Summary of national dosimetric trends

The Canadian collective dose for 2010 for the PHWR (CANDU) fleet of reactors was 24.158 person.Sv for 20 reactors (17 operating units and 3 units in refurbishment) which represents an average of 1.208 person.Sv/reactor (120.8 person.rem/reactor).

The total collective dose for the 17 operating units was 18.66 person.Sv with an average of 1.10 person.Sv/reactor (110 person.rem/reactor) in operation.

Collective dose for the units in refurbishment in 2010 (Bruce-A, Units 1 and 2, Point Lepreau) was 5.498 person.Sv. The average collective dose was 1.832 person.Sv/reactor (183.2 person.rem/reactor) in refurbishment.

In 2008-2010, the three-year rolling average annual collective dose per reactor for operating and refurbishing Canadian CANDUs was 1.29 person.Sv/reactor (129 person.rem/ reactor), which represents a ~8% increase from the 2007-2009 three-year rolling average annual collective dose of 1.19 man.Sv/reactor (119 person.rem/reactor).

Collective dose for units in safe storage (Pickering-A, Units 2 and 3) was 0.065 person.Sv (average collective dose 0.033 person.Sv/reactor or 3.25 person.rem/reactor).

There was no radiation exposure in excess of regulatory dose limits.

Events influencing dosimetric trends

Ontario Power Generation/Darlington Nuclear Generating Station

Darlington Nuclear Generating Station (DNGS) has four operating units (1 to 4). The station total collective dose for 2010 was 3.704 person.Sv or 0.926 person.Sv/unit. The total collective internal dose was 0.220 person.Sv.

The 2010 total collective dose outage was 3.373 person.Sv, higher than in 2009, due to two planned outages (Units 2 and 4) and two forced outages (Units 3 and 4). Scaffolding set-up and removal was higher than estimated due to less experienced scaffolding crews. A corrective action plan has been developed to address the dose performance.

Darlington continues to strive for improvements in radiation protection through a strategic source term reduction plan scheduled to continue through 2013. Internal dose was reduced in 2010 due to a number of initiatives implemented by the Darlington site to reduce tritium source term. Examples include the improvement in dryer performance to reduce tritium in air concentrations, a reduction in the tritium content in moderator heavy water, and a reduction in heavy water leaks. Annual collective dose from normal operation was 0.331 person.Sv in 2010. The maximum effective dose received by a worker was 15.74 mSv.

Ontario Power Generation/Pickering Nuclear Generating Station-A

Pickering Nuclear Generating Station-A (PNGS-A) has two operating units (1 and 4) and two units in safe storage (2 and 3).

- PNGS-A operating units (1 and 4)

The total collective dose for these two units was 3.074 person.Sv or 1.537 person.Sv/ unit. The external dose was 2.707 person.Sv and internal dose was 0.367 person.Sv. The internal dose performance was better than expect in 2010 due to improved leak management, increased vapour recovery dryer reliability, use of a supplemental dehumidifier during outages to reduce ambient tritium concentrations in the reactor building, and mandatory use of plastic suits for work in the boiler room.

The 2010 outage doses of 2.688 person.Sv resulted from planned and forced outages in Units 1 and 4. The outage doses were higher than expected due to forced outages, higher than expected dose rates on the Unit 1 reactor face, and additional work scope in both Units 1 and 4 outages. Annual dose from routine operations was 0.386 person.Sv.

- PNGS-A Units (2 and 3) in safe storage

The total collective effective dose of Unites 2 and 3 was 0.065 person.Sv or 0.033 person.Sv/unit (the external dose was equal to 0.049 person.Sv and internal dose was 0.016 person.Sv).

In 2010, PickeringA transitioned Units 2 and 3 from “guaranteed shutdown state” to “safe storage”. The project ended in September 2010 and no dose was reported from safe storage since that date.

Ontario Power Generation/Pickering Nuclear Generating Station-B

Pickering-B has four operating units (5 to 8). The total collective effective dose was 3.94 person.Sv (0.985 person.Sv/unit). This dose was higher than in 2009, due to two planned outages in Units 5 and 7. Outage P1072 had a total outage dose of 0.950 person.Sv and a duration of 75 days. Outage P101 had a total outage dose of 2.288 person.Sv with a duration of 76 days. The planned vacuum building outage had a minor impact on annual dose (0.074 person.Sv).

Annual dose for normal operations was 0.698 person.Sv, whereas total collective dose (outages) was 3.238 person.Sv.

The total collective external dose was 3.352 person.Sv and the total collective internal dose was 0.584 person.Sv.

The performance for the internal dose component of 0.148 person.Sv/unit can be attributed to several airborne exposure reduction initiatives (e.g. improved drier performance, decreased tritium curie content in moderator and heat transport D_2O, and easier access to trends and current tritium levels in the units).

Hydro-Quebec/Gentilly-2 Nuclear Generating Station

Hydro-Quebec has one operating unit at Gentilly-2. The total collective effective dose for 2010 was 0.746 person.Sv. The external component was 0.625 person.Sv and the internal component was 0.121 person.Sv. Internal dose has remained essentially the same in 2010 due to efforts made in the past few years to optimise the radiation protection practices related to the wearing of respiratory protection equipment at Gentilly-2.

The total collective dose (outage) is of 0.641 person.Sv. The slight increase in outage dose in 2010 was attributed to an increase in outage work scope and duration. Annual dose from normal operation in 2010 was 0.105 person.Sv.

New Brunswick Power/Point Lepreau Generating Station

New Brunswick Power has one operating unit at Point Lepreau. The station was shut down on 28 March 2008 for a planned refurbishment.

In 2010, the station remained shut down as the refurbishment outage continued. Due to the refurbishment work, where many tasks involve high hazards, collective dose to workers is higher than experienced in previous years.

The 2010 total collective effective dose was 1.375 person.Sv with an external dose of 1.325 person.Sv and an internal dose of 0.050 person.Sv. The maximum effective dose received by a worker in 2010 was 11.9 mSv.

Point Lepreau suspended the installation of the calandria tubes for approximately 5 months in 2010 due to issues with the leak tightness of the rolled joints. It was determined that all 380 calandria tubes previously inserted inside the reactor would be removed and replaced to achieve the required calandria tube rolled joint seal integrity. Refurbishment activities to replace the calandria tubes resumed in the fall of 2010.

Doses in 2010 were significantly lower than the prior two years of refurbishment due to:

- Suspension of refurbishment activities.

- The average daily collective doses from installation activities being significantly lower than dismantling activities (due to reduced dose rates and exposure times).

Bruce Power/Bruce Nuclear Generating Station-A

Bruce Nuclear Generating Station-A (Bruce-A) has two operating units (3 and 4) and two units in refurbishment (1 and 2).

- Bruce-A operating units (3 and 4)

The total collective effective dose was 3.542 person.Sv (or 1.771 person.Sv/unit) with an internal component of 0.194 person.Sv and an external dose of 3.348 person.Sv. Internal dose was reduced in 2010 due to the use of new protective equipment (Sperion plastic suits) and optimisation of the vault vapour recovery system.

In 2010, there were two planned outages. The collective dose due to outages was measured at 3.277 person.Sv, whereas the annual dose from normal operation in 2010 was 0.265 person.Sv.

- Bruce-A Units 1 and 2 Restart Project

Units 1 and 2 are shutdown and have been in refurbishment since 2005. A significant portion of dose intensive work was carried out in 2007 and 2008.

The total collective dose for Units 1 and 2 was 4.123 person.Sv (with an external dose 4.098 person.Sv and an internal dose of 0.025 person.Sv). Note: The 2009 total internal dose is revised to 0.565 person.Sv due to worker doses involved in the alpha event at Unit 1 in November 2009. In 2010, the maximum dose to a worker at Bruce-A Restart Project was 12.9 mSv.

Bruce Power/Bruce Nuclear Generating Station-B

Bruce-B is composed of four operating units (5-8). The total collective effective dose was 3.613 person.Sv (0.903 person.Sv/unit) with an external dose of 2.995 person.Sv and an internal dose of 0.618 person.Sv. The total collective dose from 2010 outages was 3.079 person.Sv.Annual dose from normal operation in 2010 was 0.534 person.Sv.

There were two major planned outages at Bruce-B in 2010 which had a significant impact on the total collective dose for the year. There were also two forced outages that had relatively insignificant dose consequences.

The collective external dose in 2010 was the lowest in the past five years. This can be attributed to improvements in outage dose management. However, there was an increase in annual internal dose at Bruce-B due to the moderator spill event at Unit 6, which resulted in 0.290 person.Sv of internal dose. The maximum dose to a worker at Bruce-B was 25.18 mSv in 2010. This worker was involved in the moderator spill event at Unit 6.

Number and duration of outages

CANDU units do not have refuelling outages. There were 11 planned maintenance outages and 6 forced outages in Canada in 2010.

Bruce-A Units 1 and 2 have been undergoing major refurbishments since 2005. Point Lepreau has been undergoing major refurbishment since March 2008.

New plants on line/plants shutdown

Pickering-A Units 2 and 3 transitioned from “guaranteed shutdown state” to “safe storage state” in September 2010.

Major evolutions

No major evolutions.

Component or system replacements

Refurbishment projects at Bruce-A Units 1 and 2 and Point Lepreau are replacing calandria tubes and other equipments during the multi-year modernisation programme.

Safety-related issues

No safety-related issues.

Unexpected events

Moderator spills at Bruce-B.

New/experimental dose reduction programme

Benchmarking teams visited CANDU units globally to evaluate best external and internal dose reduction practices. NATC ISOE participated in some of the Canadian Owner's Group sponsored site visits in 2010.

Issues of concern in 2011

No issues of concern.

Technical plans for major work in 2011

Continue refurbishment projects at three CANDU units. Implement good practices and lessons learned from global CANDU benchmarking project in 2009-2010.

CZECH REPUBLIC

Summary of dosimetric trends

Dukovany NPP

There are four units of PWR-440 type 213 in commercial operation since 1985. The collective effective dose (CED) during the year 2010 was 0.545 man.Sv. CED was 0.053 man.Sv and 0.492 man.Sv for utility and contractors employees, respectively. The total number of exposed workers was 1 786 (574 utility employees and 1 212 contractors). The average annual collective dose per unit was 0.136 man.Sv.

The maximal individual effective dose, 7.23 mSv, was reached by a contract worker carrying out insulation works during outages.

Temelín NPP

There are two units of PWR 1000 MWe type V320, which have been in commercial operation since 2004. Collective effective dose (CED) for 2010 was 0.163 man.Sv. CED was 0.030 man.Sv and 0.133 man.Sv for utility and contractors employees, respectively. The total number of exposed workers was 1 686 (557 utility employees and 1 129 contractors). The average annual collective dose per unit was 0.082 man.Sv.

The maximal individual effective dose 2.94 mSv was received by a contract worker carrying out reactor assembly/disassembly works during outages.

Number and duration of outages

Dukovany NPP

The main contributions to the collective dose were four planned outages.

	Outage information	CED (man.Sv)
Unit 1	20 days, standard maintenance outage with refuelling	0.101
Unit 2	20 days, standard maintenance outage with refuelling	0.068
Unit 3	38 days, standard maintenance outage with refuelling	0.110
Unit 4	78 days, standard maintenance outage with refuelling Reactor power uprate up to 500 MWe	0.232

Temelín NPP

The main contributions to the values of collective effective dose were two planned outages.

	Outage information	CED (man.Sv)
Unit 1	88 days, standard maintenance outage with refuelling	0.083
Unit 2	63 days, standard maintenance outage with refuelling	0.055

Major evolutions

Dukovany NPP

Very low values of outages and total effective doses represents the results of a good primary chemistry water regime, well-organised radiation protection structure, and strict implementation of ALARA principles during the working activities related to the works with high radiation risk. All CED values are based on electronic personal dosimeters readings.

Temelín NPP

The CED decreased slightly in comparison with previous years; mainly due to reduced work load during an outage at Unit 2.

Very low values of outages and total effective doses represents the results of a good primary chemistry water regime, well-organised radiation protection structure, and strict implementation of ALARA principles during the working activities related to the works with high radiation risk. All CED values are based on electronic personal dosimeters readings.

Unexpected events

Dukovany NPP

There were no unusual or extraordinary radiation events at Dukovany NPP in 2010.

Temelín NPP

There were no unusual or extraordinary radiation events at Temelín NPP in 2010.

FINLAND

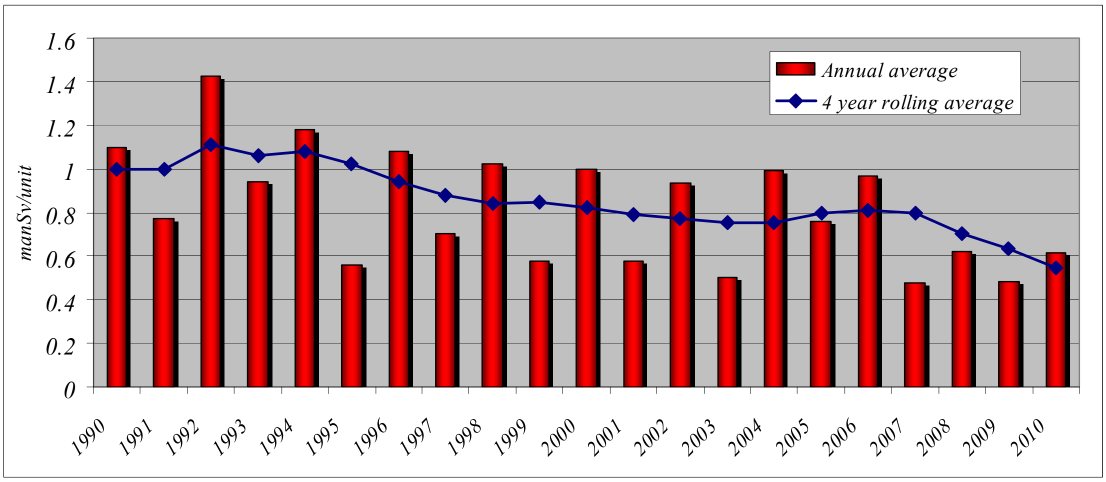
Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man.Sv/unit]**
BWR	2	0.450
VVER	2	0.784
Total: All types	4	0.617

Summary of national dosimetric trends

Annual collective dose strongly depends on length and type of annual outages. In 2010, collective dose (2.47 man.Sv) of Finnish NPPs was well below average despite the long outages completed at Loviisa 2 and Olkiluoto 1. Over the long run the four-year rolling average of collective doses shows a slightly decreasing trend since the early 1990s.

Collective dose: Annual and four-year rolling average in Finnish NPPs



Events influencing dosimetric trends

Olkiluoto NPP

The 2010 annual outage at OL1 was an extensive maintenance outage which took 26 days. In addition to refuelling the main works were replacements of low-pressure turbines, inner main steam valves, main sea water pumps, and generator cooling system. The dose (0.639 man.Sv) of OL1 maintenance outage remained low despite the extensive modernisation work. The refuelling outage at OL2 took 11 days. In addition to refuelling it included maintenance of the reactor recirculation pump. The collective dose (0.129 man.Sv) was the lowest outage dose of a plant unit at Olkiluoto utilities.

Loviisa NPP

At Unit 1 the annual outage was a short maintenance outage and at Unit 2 an eight-year maintenance outage with durations of 26 and 40 days respectively (planned 23 and 39 days). Outage collective doses (0.65 and 0.93 man.Sv) were among the lowest in plant operating history when compared to similar outage types.

A fuel leak was detected at Unit 1 during the operating period and the leaking fuel assembly was removed from the reactor during outage. Due to the long inspection outage on Unit 2 the main contributors to annual collective dose accumulation were the main component inspections and related ancillary work such as insulation, radiation protection, and scaffolding.

Unexpected events

Loviisa NPP

In March 2010 radioactive resin residue escaped from a waste tank during tank flushing to the air ventilation system of an auxiliary building. This caused slight contamination of the ducts and also a risk of spreading of radioactive particles into the environment through the ventilation channels. However, no traces of radioactivity were recorded in normal effluent control nor were radioactive particles found in the plant area during a wide measurement campaign conducted after the event. On the INES scale, the event was classified as Level 1 due to the fact that radioactivity in liquid and dry form was found in an area (air ventilation ducts) where it should not exist.

Technical plans for major work in 2011

Olkiluoto 1 outage is a refuelling outage with a scheduled duration of 7 days. At OL2 the outage is an extensive maintenance outage scheduled for 25 days. In addition to refuelling, the main works are replacements of low-pressure turbines, inner main steam valves, main sea water pumps, and the generator and its cooling system.

Olkiluoto 3 is under construction.

Both units at Loviisa will undergo short refuelling outages, with a planned duration of 16 days for Lo1 and 15 days for Lo2. Renewal of plant I&C systems continue.

Regulatory plans for major work in 2011

Work concerning updating regulatory guides for NPPs has continued during 2011. The process will take in account e.g. the experience achieved during the licensing of new NPPs. The goal is also to create a new structure for the guides and to minimise the number of guides by combining the existing ones. The majority of the new guides should be ready by the end of 2011.

STUK continues to review documents concerning OL3. The power company TVO has estimated that the operating licence application for OL3 will be submitted to the Finnish government at the end of 2011 or at the beginning of 2012.

On 6 May 2010, the Finnish government made two DIPs in favour of additional construction of nuclear power. TVO's and Fennovoima Oy's applications were both approved. The Finnish parliament ratified both granted applications on 1 July 2010. STUK launched preparation projects for new nuclear units in September 2010. One of the project tasks is to define the objectives for construction permit review according to the new YVL guides.

FRANCE

Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man.Sv/unit]**
PWR	58	0.62
Reactors in cold shutdown or in decommissioning		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man.Sv/unit]**
PWR	1	2.31×10^{-3}
CANDU	1	0.3×10^{-3}
GCR	5	0.57×10^{-3}
Fast neutron	1	0.05×10^{-3}

Annual collective dose

The 2010 average collective dose was 0.62 man.Sv/reactor for a target of 0.62 man.Sv/reactor. The average collective dose for the three-loop reactors (34 reactors) was 0.73 man.Sv/reactor; the average collective dose for the four-loop reactors (24 reactors) was 0.47 man.Sv/reactor.

In 2010, there were 20 short outages, 20 standard outages, 5 ten-yearly outages, 4 forced outages, 2 steam generator replacements, and 13 reactors with no outage. The outage collective dose represents 81% of the total annual collective dose. The collective dose from the operating period represents 19% of the total annual collective dose. The neutron total collective dose is 0.25 man.Sv (0.20 man.Sv from spent fuel transport).

Individual doses

At the end of 2010, only two persons received a dose higher than 16 mSv during 12 rolling months. Those two persons (mechanics) are among the specialties the most followed (with insulators, welders, and logisticians). No worker received a dose over 18 mSv during 12 rolling months. Of the exposed population, 79% received a cumulative dose over 12 rolling months inferior to 1 mSv, and 99% received a cumulative dose over 12 rolling months inferior to 10 mSv.

Main events influencing dosimetric trends

The main events influencing dosimetric trends are the following:

- unforeseen and additional works at Chinon (0.274 man.Sv);
- additional works (preventive SG clean-up) at Gravelines 5 (0.200 man.Sv);
- numerous unforeseen circumstances at Cattenom 4 (0.200 man.Sv);
- problems on the EP CSP activity at Paluel 1 (0.190 man.Sv);
- additional works on control rod drives at Tricastin 2 (0.064 man.Sv).

Moreover, there were two atypical outages at Bugey 3 in 2009 and 2010:

- 2009 – short outage (ASR) (25 April 2009 to 16 May 2010 for a collective dose of 624 man.mSv);
- 2010 – short outage (ASR/SGR) (17 May 2010 to 08 January 2011 for a collective dose of 937 man.mSv).

EDF three-loop reactors

In 2010, the three-loop reactor outage programme was composed of 14 short outages (ASR, one with SGR), 13 standard outages, and 2 ten-yearly outages (one with SGR). It can be noted that three reactors had no outage and that there was one forced outage at Blayais 2 (51.19 man.mSv).

The lowest collective doses for the various outage types were:

- short outage (ASR): 0.204 man.Sv for Dampierre 1;
- standard outage: 0.490 man.Sv for Dampierre 2;
- ten-yearly outage: 1.231 man.Sv for Chinon 4.

The lowest SGR collective dose was 0.547 man.Sv for Bugey 3.

It can be pointed that three outages started in 2009 and ended in 2010:

- end of short outage (ASR) for a collective dose of 24.72 man.mSv at Bugey 3;
- end of standard outage for a collective dose of 215.10 man.mSv at Bugey 5;
- end of third ten-yearly outage (VD3) for a collective dose of 426.68 man.mSv at Fessenheim 1.

EDF four-loop reactors

In 2010, the four-loop reactor outage programme was composed of 6 short outages (ASR), 7 standard outages, and 3 ten-yearly outages. It can be noted that 7 reactors had no outages and 3 reactors had forced outages: Paluel 3, Cattenom 3, and Penly 1, with a total collective dose of 0.069 man.Sv.

The lowest collective dose for the various outages types were:

- short outage (ASR): 0.153 man.Sv for Chooz 2;
- standard outage: 0.427 man.Sv for Golfech 1;
- ten-yearly outage: 1.083 man.Sv for Chooz 1.

One outage started in 2009 and ended in 2010: Flamanville 1, end of standard outage for a collective dose of 29.39 man.mSv.

RP incidents

In 2010, two RP events (ESR) reported to the French authority were classified using the INES scale:

- one event at Chinon on Unit 4 dealing with spent fuel pit works (INES 2) and one on Unit 2 dealing with SG drain plug removal (INES 1);
- one event at Blayais dealing with a foot contamination following a work at the laundry located in the RCA (INES 1).

Goals for 2011

The new collective dose goal for 2011 will be 0.73 man.Sv/reactor. For individual dose, the objective is changed to a 10% reduction within three years of the individual dose of the most exposed workers. EDF also maintains the goal of no individual dose above 18 mSv.

Future activities in 2011

Regarding collective dose, continue the ALARA programme in order to achieve the collective dose goal which is ambitious compared with the outage programme of works.

Regulatory plans for major work in 2011 (provided by French Nuclear Safety Authority, Autorité de Sûreté Nucléaire)

In 2010, ASN carried out 24 specific inspections in the area of radiation protection on sites and two inspections in EDF's head office departments. The inspections allowed ASN to observe that EDF had reacted to ASN's 2009 observations by revitalising the "as low as reasonably achievable" (ALARA) approach. While the collective dose in the NPPs had been on the rise for two years, EDF attained its collective dose objective for 2010.

Based on the inspections, ASN considers essential that EDF sustain its renewed efforts regarding the ALARA approach during future reactor outages, and ensure the long-term viability of improvements in the area of collective and individual doses. ASN also positively observed that the action plan implemented by EDF to improve radiation protection for workers during radiographic testing continued to produce positive results.

Two events with significance for radiation protection at the Chinon NPP led to reactive inspections. On 23 April 2010, during a check on cleanness at the bottom of the spent fuel pit, an operator's hand was irradiated while picking up and then handling an activated metal part. On 4 August 2010, during a cleanness check on the steam generator water box, an object generating high levels of radiation was picked up by an operator then handled by three other operators in succession before being removed from the zone. These events were classified, respectively, at Levels 1 and 2 on the INES scale. ASN carried out a site inspection after each of these events; the inspectors observed that these events were notably due to an inadequate risk analysis and to a lack of knowledge of how to act in the presence of undesirable objects detected during cleanness checks.

More generally, ASN and its technical support, the Institute of Radiation Protection and Nuclear Safety (IRSN), continued in 2010 to analyse and assess radiation monitoring systems in classified areas, as well as the implementation of radiation protection requirements on maintenance activities.

Finally, as in 2009, ASN positively assessed the advances made in the management of source term reduction. In this direction, ASN authorised EDF to inject zinc into the primary system of 16 reactors. This practice is in line with the overall approach to reduce the collective dose based on modification of the primary coolant chemistry.

For 2011, ASN will conduct an in-depth inspection of four sites of the same area (Belleville, Chinon, Dampierre, and Saint-Laurent) on the theme of radiation protection and radiological cleanness. This inspection gave the opportunity to observe discrepancies among the implementations of the radiation protection requirements on these sites. In 2010, ASN had already observed variations across the installed base of NPPs where radiation protection is concerned, and had considered that EDF had to be vigilant with regard to improvement on all sites.

More generally, ASN and IRSN remain vigilant to the setting of dose targets and the organisational and technical measures taken to achieve them, especially during reactor outages. ASN pays particularly close attention to contamination control during inspections.

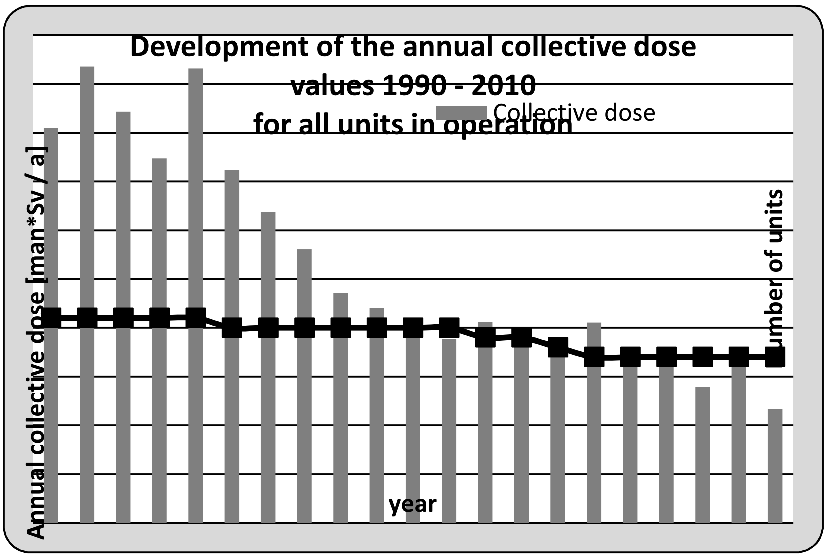
GERMANY

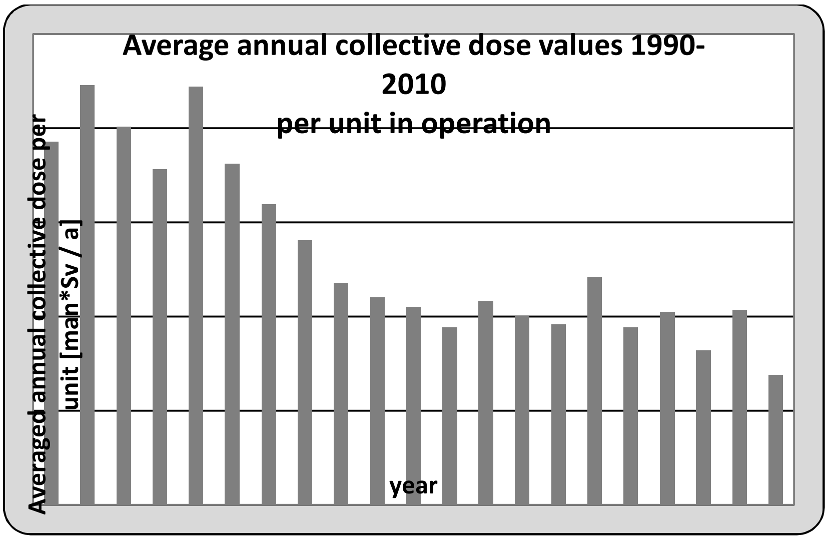
Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man.Sv/unit]**
PWR	11	0.61
BWR	6	0.83
Total: All types	17	0.69

Summary of national dosimetric trends

In 2010, Germany had 17 nuclear power plants (11 PWR, 6 BWR) in operation. The total annual collective dose was 11.69 person.Sv. The trend in the total annual collective dose is presented in the following figures (annual and average).





Number and duration of outages

The total of all planned and unplanned outages was about 1 464 days. Most of the unplanned outages were only for a few days, but for two BWRs the duration of the unplanned outage was 12 months for each of them.

Unexpected events

In 2010, 80 events were reported to the responsible German authorities of the Länder according to the German Reporting Ordinance (AtSMV). All of these events were classified as minor events with no safety significance (INES 0).

Full system decontamination

In 2010, the first nuclear power plant of the country accomplished a full system decontamination (FSD), resuming power operation after the annual outage with the FSD again. Due to this new dose reduction programme the collective dose could be dropped to 1.95 Sv instead of the expected 5.5 Sv.

Radiation protection qualifications

According to a joint initiative of VGB (nuclear service providers) and the Swiss Regulatory Body (ENSI), an educational scheme was developed for new radiation protection professionals and implemented in 2010. The first course of "Strahlenschutz-Meister (IHK)" started at the training centre of VGB (Kraftwerkschule e.V.) and the new qualifications "Strahlenschutz-Techniker (VGB)"/"Strahlenschutz-Ingenieur (VGB)" could be submitted to a blank of the VGB.

Political situation

The coalition agreement of the federal government under the chancellorship of Angela Merkel (elected September 2009) provides to delay the phase-out plan of the former democratic-green government under the chancellorship of Gerhard Schröder. In October 2010, the German Bundestag decreed with a conservative-liberal majority an 8-year delay of the schedule for the seven NNPs built before 1980 and a 14-year delay of the schedule for the 10 other NNPs.

The German federal president undersigned the 11th law of modification on the atomic law – which contains the extension of the term – in December 2010. The modifications become effective on 14 December 2010. The delay of the schedule provoked a lot of protest in the general public, organisations, and political groups.

An agreement the operating companies had to take with the delay of the schedule is the new tax on nuclear fuel. From 1 January 2011 to 31 December 2016 nuclear fuel for the commercial generation of electricity is charged with new tax, called "Kernbrennstoffsteuer".

HUNGARY

Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man.Sv/unit]**
VVER	4	0.507 (with electronic dosimeters) 0.508 (with film badges)

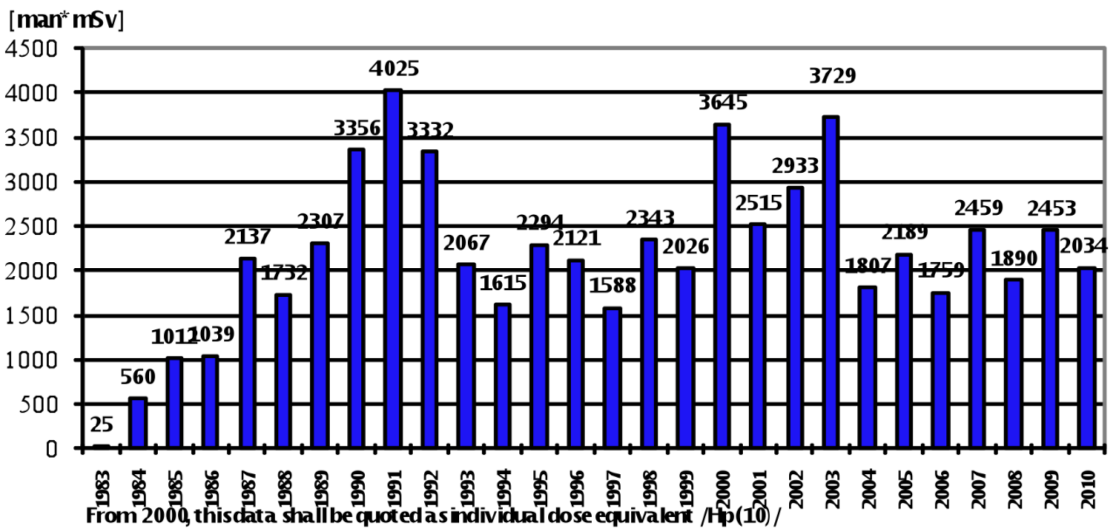
Summary of national dosimetric trends

Upon the result of operational dosimetry the collective radiation exposure was 2 027 man.mSv for 2010 at Paks NPP (1 483 man.mSv with dosimetry work permit and 544 man.mSv without dosimetry work permit). The highest individual radiation exposure was 12.1 mSv, which was well below the dose limit of 50 mSv/year, and our dose constraint of 20 mSv/year.

The collective dose decreased in comparison to the previous year. The lower collective exposures were mainly ascribed to all the outages, especially the one "so-called" long outage at Unit 4.

Development of the annual collective dose values at Paks nuclear power plant

(According to the results of film badge monitoring by the authorities)



Events influencing dosimetric trends

There was one general overhaul (long maintenance outage) in 2010. The collective dose of outage was 413 man.mSv on Unit 4.

Number and duration of outages

The duration of outages were 30 days for Unit 1, 30 days for Unit 2, 27 days for Unit 3, and 59 days for Unit 4.

Major evolutions

The four units of the Paks NPP were put into operation between 1983 and 1987. Taking into account the designed lifetime (30 years), they should be shutdown between 2013 and 2017. Considering present technical knowledge, it can be considered as a real long-term goal to extend the designed lifetime of the units by at least ten years.

JAPAN

Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man.Sv/unit]**
PWR	24	1.51
BWR	22*	1.13
Total: All types	46*	1.33

* “BWR” and “Total” include Hamaoka Units 1 and 2 that have been decommissioning since 18 November 2009 and exclude 10 BWRs of Fukushima Dai-ichi and Fukushima Dai-ni for which exposure is under estimation by the utility due to the influence of the “the Tohoku District - off the Pacific Ocean Earthquake.”

Reactors in cold shutdown or in decommissioning		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man.Sv/unit]**
GCR	1	0.05
LWCHWR	1	0.11

Summary of national dosimetric trends

The Tohoku District - off the Pacific Ocean Earthquake of magnitude 9.0 occurred on 11 March 2011, and a huge tsunami damaged the Fukushima Dai-ichi and Fukushima Dai-ni nuclear power stations. The fiscal year of Japan is from April to the following March. Exposure data of these stations in FY 2010 are under estimation by the utility. The following exposure data in FY 2009 and FY 2010 do not include the data from the 10 BWRs of these power stations. Total collective dose in FY 2010 for all PWRs and BWRs was 61.07 man.Sv, and this was lower than the FY 2009 value (63.34 man.Sv). The average annual collective doses per reactor for BWRs + PWRs, BWRs, and PWRs were 1.33 man.Sv, 1.13 man.Sv, and 1.51 man.Sv respectively. The BWR collective dose per reactor in FY 2010 was the same as the previous year. The PWR average collective dose in FY 2010 decreased from the previous year by 0.1 man.Sv. The upward tendency in recent years was stemmed, but it remains at a high exposure level.

Events influencing dosimetric trends

As mentioned above, the exposure data for Fukushima Dai-ichi and Fukushima Dai-ni are under estimation. The decrease in collective dose for PWRs was mainly due to the decrease of the improvement works. The main events influencing collective dose for BWRs were replacement work of PLR piping. The main events influencing collective dose for PWRs were preventive maintenance work for pressuriser nozzle.

Number and duration of outages

Periodical inspections were completed at 16 BWRs and 16 PWRs in FY 2010. The average duration of outage for periodical inspection was 125 days for BWRs and 92 days for PWRs. The average duration for BWRs decreased from the previous year by 64 days and PWRs increased from the previous year by 4 days.

Component or system replacements

Replacements such as PLR piping and main steam safety relief valve for BWR and residual heat removal line for PWR were carried out.

Safety-related issues

The Tohoku District - off the Pacific Ocean Earthquake and tsunami caused by the earthquake attacked the Fukushima Dai-ichi and Fukushima Dai-ni Nuclear Power Stations of Tokyo Electric Power Co. (TEPCO) on 11 March 2011. The Fukushima Dai-ichi site including six BWRs has been seriously damaged. The status of radiation doses for the workers engaged in emergency work at Fukushima Dai-ichi NPP as of 30 September is shown in the table below. The dose limit for radiation workers engaged in emergency work was regulated by the relevant laws at 100 mSv for an effective dose. With the Declaration of a Nuclear Emergency issued according to the Act on Special Measures Concerning Nuclear Emergency Preparedness, the effective dose of 100 mSv was raised to 250 mSv in the event of an unavoidable emergency.

Distribution of exposure dosage of workers engaged in emergency work at the Fukushima Dai-ichi of TEPCO (cumulative doses from March to August in 2011)

Distribution of exposure dosage (mSv)	Employee of TEPCO (person)	Others (person)	Total (person)
250 < D	6	0	6
200 < D ≤ 250	1	2	3
150 < D ≤ 200	13	2	15
100 < D ≤ 150	90	23	113
50 < D ≤ 100	262	279	541
20 < D ≤ 50	586	1 419	2 005
10 < D ≤ 20	553	1 918	2 471
D ≤ 10	1 576	9 082	10 658

Total (person)	3 087	12 725	15 812
Maximum dose (mSv)	672.27	238.42	672.27
Mean dose (mSv)	21.0	9.2	11.5

Cumulative doses include the external exposure and internal exposure.

As of 30 September 2011.

Issues of concern in 2011

Recovery from the accident of the Fukushima Dai-ichi NPS is a pressing need. For this purpose, great difficulty and a considerable occupational exposure is expected. Moreover, recovery work will continue for a long time. The Japanese regulatory system for nuclear safety will be changed reflecting the lessons learned from the nuclear accident of Fukushima Dai-ichi NPS, including the separation of the Nuclear and Industrial Safety Agency (NISA) from the Ministry of Economy, Trade, and Industry.

Technical plans for major work

Japanese utilities have the following plans as future exposure reduction measures:

- zinc injection (BWR, PWR);
- low-cobalt materials;
- ferrite coating for PLR piping after chemical decontamination (BWR);
- continuous ALARA activities (BWR, PWR).

KOREA (REPUBLIC OF)

Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit [man.Sv/unit]**
PWR	16	0.45
CANDU	4	2.18
Total: All types	20	0.79

Summary of national dosimetric trends

For the year of 2010, 20 NPPs were in operation: 16 PWR units and 4 CANDU units. The average collective dose per unit for the year 2010 was 0.79 man.Sv. As in previous years, the outages of units in 2010 contribute the major part to the collective dose, 92% of the collective dose was due to works carried out during the outages. There were in total 13 236 people involved in radiation works in 20 operating units and the total collective dose was 15.884 man.Sv.

Events influencing dosimetric trends

Because of an ongoing refurbishment of Wolsung Unit 1 from April 2009, including the replacement of the pressure tubes and calandria tubes, the collective dose in 2010 was as high (15.884 man.Sv) as the previous year (16.320 man.Sv).

Number and duration of outages

Periodic inspection was completed at 13 PWRs and 4 PHWRs. The total duration for periodical inspection was 358 days for PWRs and 428 days for PHWRs.

New plants on line/plants shutdown

Shin Kori Unit 1(PWR, 1 000 MWe) loaded its first fuel assemblies in May and began its commercial operation in December 2010.

Component or system replacements

The reactor pressure tubes of Wolsung Unit 1(PHWR), which have been operating for 28 years, are being replaced due to long operational life. This has caused sag, elongation, diametral expansion, and wall reduction of pressure tubes and calandria tubes.

Steam generators, which have been operating for 22 years, will be replaced in 2011 for Ulchin Unit 2 and in 2012 for Ulchin Unit 1.

Issues of concern in 2011

CZT technology will be employed as an effective way to support making a decision as to whether the shutdown chemistry is done well before the outage.

Technical plans for major work in 2011

A trial application of zinc injection to reduce the source term will be carried out in Ulchin Units 1 and 2.

Regulatory plans for major work in 2011

The regulatory expert organisation, Korea Institute of Nuclear Safety (KINS), has completed the development of the regulatory standards and the regulatory guides reflecting the opinions of the stakeholders for more objective and wider regulatory activities. One hundred fifteen (115) regulatory standards and 192 regulatory guides in 18 fields have been developed, deliberated, and resolved at the subcommittee level, and approved by the main committee and Ministry of Education, Science, and Technology (MEST) in mid-2011. KINS will apply these new regulatory standards and guides consistently to the national dosimetry system.

LITHUANIA

Dose information

Reactors in cold shutdown or in decommissioning		
Reactor type	Number of reactors	Average annual collective dose per unit [man.Sv/unit]

LWGR	2	0.2607
CANDU	4	2.18
Total: All types	20	0.79

Summary of national dosimetric trends

In 2010, the occupational doses at the Ignalina NPP (INPP) have maintained reducing trends: 3.41 man.Sv in 2006, 2.59 man.Sv in 2007, 3.29 man.Sv in 2008, 0.93 man.Sv in 2009, and for 2010 collective dose was 0.52 man.Sv (Unit 2 of INPP was shutdown on 31 December 2009). The collective dose for INPP personnel was 0.4849 man.Sv and for outside workers was 0.0365 man.Sv.

In 2010, 1 944 INPP workers and 1 015 outside workers were working under the influence of ionising radiation in the controlled area of the INPP.

The average effective individual dose for INPP staff was 0.25 mSv for INPP staff and 0.18 mSv for outside workers. The highest individual effective dose for INPP staff was 8.87 mSv, and 2.95 mSv for outside workers.

Events influencing the dosimetric trends

In 2010, planned INPP personnel and outside workers occupational factors were made to provide the execution of nuclear and radiation safety tasks. Planned annual collective dose for INPP personnel was 1.12 man.Sv, and 0.38 man.Sv for outside workers.

The main works during 2010 included repair works of reactor control equipment, inspection of the safety system, and executing reduction activities concerning gamma dose at work places.

Therefore the collective dose for INPP personnel was 43% of the projected dose (0.4849 man.Sv), and for outside workers was 10% of the projected dose (0.0365 man.Sv). Overall collective dose for INPP personnel and outside workers was 35% of the projected dose (0.5214 man.Sv).

The main works that contributed to the collective dose during technical service of shutdown Units 1 and 2 at the INPP are given in the table below (according to data from electronic direct reading dosimeters).

Main works	Collective dose (man.mSv)
Operators of fuel handling	196.38
Repairing the spent fuel storage pool, reactor auxiliary, fuel building	101.03
Waste and liquid waste, storage and processing system	34.38
Radiological monitoring of workplaces	30.23
Emergency cooling system	22.32
Maintenance, replacement of the systems of the reactor vessel and reactor equipment	20.75
Repairing of the main circulation circuit	17.28
Routine inspections	15.22
Repair of reactor water clean-up system	8.56
Lighting, general electrical equipment	5.85

Decontamination of premises	4.55
Shielding and temporary shielding	3.77
Pressure test of the main circulation circuit	2.07
Other works	10.09

Number and duration of outages

Following a government decision, Unit 2 of INPP was shutdown on 31 December 2009. Unit 1 of INPP was shutdown on 31 of December 2004. Units 1 and 2 were used according to technological regulations under cooled conditions with nuclear fuel in the reactor and spent fuel storage pool of Unit 2 and the spent fuel storage pool of Unit 1. INPP is still working with spent nuclear fuel.

New plants on line/plants shutdown

During 2010 the construction of the complex free release measurement facility (according to the B-10 project) was completed and handed over in operation.

On 31 of December 2009, INPP has completely stopped production of electric power. It is now an enterprise that is in the process of decommissioning.

The Detailed Plan for a new nuclear power plant (Visaginas NPP) was initiated in 2009 and was approved by the Visaginas town municipality council on 19 May 2010. Further preparatory works for construction of Visaginas NPP are ongoing.

Major evolutions

In 2010, the operation of the new cement solidification facility (CSF) for treatment of liquid radioactive waste and a temporary storage building (TSB) were continuing. During 2010, the cementation of ion exchange resins was continued. One hundred seventy-five (175) containers were filled up with waste; each container can hold eight 200-litre drums. There are 859 containers in the storage facility. During 2010 the 128.9 m^3 of pulp was recycled. In 2011 the cement solidification work will continue.

During 2010, the transportation of spent nuclear fuel from Unit 1 to the Interim Spent Fuel Storage Facility (ISFSF) has continued. Six (6) containers of CONSTOR type were transported; in total there are 118 containers in the facility. In March 2010 ISFSF was completely filled. Spent fuel unloading from the spent fuel storage pool of Units 1 and 2 will be completed only when a new Interim Spent Fuel Storage Facility is built.

In 2010, the measures foreseen in the Plan of Implementation of the Decommissioning Programme for Unit 1 at the INPP were further implemented. During 2010 the decommissioning process of Unit 2 was started.

Goals for 2011:

- Continuing the safe decommissioning of Units 1 and 2.
- Evaluation and upgrading the level of safety culture.
- Extension and support of the effectiveness of the quality improvement system.
- Highest individual dose shall be below 18 mSv.
- Collective dose shall not exceed 1.26 man.Sv (for INPP personnel will not exceed 1.01 man.Sv and for outside workers will not exceed 0.25 man.Sv).
- Continuous implementation of the ALARA principle.

Component or system replacements

In 2010, there were no component or system replacements.

Safety-related issues

During 2010, a project for a system of safety parameters for the reactors in cold shutdown was developed and provided for consideration to the State Nuclear Power Safety Inspectorate (VATESI).

Unexpected events

In 2010, there were no unexpected events.

New/experimental dose reduction programmes

In 2010, there were no new/experimental dose reduction programmes. It is possible to reduce doses by employing new principles of organisation of work, through extensive work on modernisation of plant equipment, and by using automated systems and implementing programmes introducing the ALARA principle in practice during work activities.

Organisational evolutions

From 1 January 2010 all departments were changed according to the new management structure of Ignalina NPP. The priority of further INPP work is nuclear and radiation safety, transparent and efficient work, personnel responsibility, high professional qualities, and social responsibility.

Issues of concern in 2011

Decommissioning of LWGR-type reactors and technological installations and systems were executed for the first time in the world. Therefore high attention must be paid to this kind of activity.

Technical plans for major work in 2011

In 2011, construction activity will be continued on the new Interim Spent Fuel Storage Facility (according to the B-1 project) and for the Radioactive Waste Treatment Facility (according to the B-2, 3, 4 project). The building of the Buffer Storage of the Landfill Facility for Short-lived Very Low-level Waste (according to the B-19 project) will be completed and handed over in operation. Design of the Low- and Intermediate-level Radioactive Waste Disposal Facility (according to the B-25 project) will be continued. Spent fuel unloading from Unit 2 will be completed only when new Interim Spent Fuel Storage Facility will be built, so it is required to pay proper attention to ensure nuclear and radiation safety of the reactor and spent nuclear fuel ponds.

Regulatory plans for major work in 2011

Among other responsibilities, the Radiation Protection Centre (RPC) is responsible for supervision of the fulfilment of the requirements regarding the radiation protection of workers and the general public from negative impact which may cause the ionising radiation, including ionising radiation, arising from nuclear facilities in operation and decommissioning. According to the current Law on Nuclear Energy, RPC is one of the competent authorities, which participates in the licensing process of nuclear facilities and is responsible for the expertise and review of submitted licensing documents in the field of radiation protection.

In 2011 RPC will continue radiation protection supervision and control activities in INPP and in the licensing process of INPP decommissioning activities. After reviewing licensing documents, RPC will provide requirements and suggestions on improving the radiation protection situation and, if possible (taking into account the ALARA principle), reducing occupational doses and doses for the population.

However, the changes of responsibilities and functions of RPC and VATESI regarding the radiation protection supervision and control of nuclear facilities is foreseen in the new Drafts of the Law on Nuclear Energy, the Law on Radiation Protection, and other related legislation, submitted to the Lithuanian parliament for approval in 2011. According to these drafts all functions of the radiation protection supervision and control of nuclear facilities will be assigned to VATESI. However, RPC will take part in the environment impact assessment process of the INPP decommissioning projects, evaluating the radiological impact for the population.

MEXICO

Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit [man.Sv/unit]**
BWR	2	5.00

Summary of national dosimetric trends

The nuclear reactors existing in Mexico are two BWR/GE units at the Laguna Verde Nuclear Power Station located in Laguna Verde, State of Veracruz, Mexico. The collective dose has become higher, due to two main factors: the continuing increase of the radioactive source term (^{60}Co), and two long refuelling outages (more than 100 days each) that included the conclusion of the extended power uprate (EPU) for each unit.

Events influencing dosimetric trends

Increase of radioactive source term

This factor was originated by the reactor water chemical instability induced in turn by the application of noble metals and hydrogen since 2006 to prevent the stress corrosion cracking of reactor internals. This factor is still strongly influencing dose rates at the plant and specifically in the drywell during refuelling outages. The average dose rates in the drywell, for example, have increased by a factor of 2.24 in Unit 1 and 1.78 in Unit 2. The activities in the drywell, in turn, contribute to 70-80% of the collective dose of refuelling outages.

The contribution of the increased source term has been estimated for 2010 in reference to the baseline value of 2005, of 1.16 person.Sv for Unit 1, and 0.99 person.Sv for Unit 2.

Measures have been taken to stop and eventually reverse the source term trend, as it is described in the section on “New/experimental dose reduction programmes”.

Extended power uprate (EPU) activities

The purpose of this project was to increase the power of the plant by 20%. It took two operating cycles to complete the extended power uprate project for both units, starting in

2008 and finishing in the first quarter of 2011. The collective dose due to the EPU (direct and indirect) was quite significant: 2.48 person.Sv for Unit 1, and 1.01 person.Sv for Unit 2.

Number and duration of outages

Unit 1: 14th refuelling outage (U1RFO14): 163 days, including 134 additional days for completing the extended power uprate project in Unit 1.

Unit 2: 11th refuelling outage (U2RFO11): 112 days, including 83 additional days for completing the extended power uprate project in Unit 2.

Major evolutions

Power uprate project

The objective of the LV power uprate project was the increase of the nominal power of each unit by 20%. To date, the project has been completed, and the next main activities for each unit include:

- substitution of four steam heaters;
- substitution of the two main steam reheaters (MSRs);
- substitution of the main condenser pipes (Cu-Ni) by titanium pipes;
- redesign of turbine building HVAC system;
- substitution of HP and LP turbines;
- substitution of generators;
- redesigned condensate steam ejectors;
- addition to two more steps to the condensate demineraliser system;
- addition of a condensate pump and booster condensate pump;
- reinforcement of safety relief valves (SRVs);
- redesign and upgrading the HVAC cooling system of primary containment.

New/experimental dose reduction programmes

The main problem associated with the high collective dose at Laguna Verde NPS is the continued increase of the radioactive source term (insoluble cobalt deposited in internal surfaces of piping, valves and equipment in contact with the reactor water coolant).

Control and optimisation of reactor water chemistry plays a fundamental role in the control and eventual retraction of the source term. The main strategies/actions aiming at such a purpose are:

- Change the old, stellited turbines by new, cobalt-free turbines (completed, EPU project).
- Replaced jet pumps wedges; the removed ones were stellited, the new ones are cobalt-free.
- On line noble metal chemistry (OLNC): significant reduction of BRAC points (dose rate in contact with recirculation lines) expected.
- Cobalt selective removal resins (PRC) continuous application to reactor water.
- Continue the application of zinc to the reactor water.

- Substitution of part of the condensate drains system piping to reduce the amount of Fe entering the reactor. Fe in excess is a vehicle for the carryover of cobalt.
- Reactor water clean-up system (RWCU) kept under continuous operation.
- Fuel pool cooling and clean-up system (FPCC) hydrolysing.
- Optimising continuity and availability of hydrogen injection to the reactor.
- Chemical decontamination of recirculation loops during refuelling outages: to be applied until all of the other reactor water chemistry parameters become stabilised and optimised, in order to avoid a recontamination next cycle after decontamination (estimated for year 2014).

Issues of concern in 2011

No issues of concern for 2011.

Technical plans for major work in 2011

Work on the mentioned strategies for radioactive source term reduction.

PAKISTAN

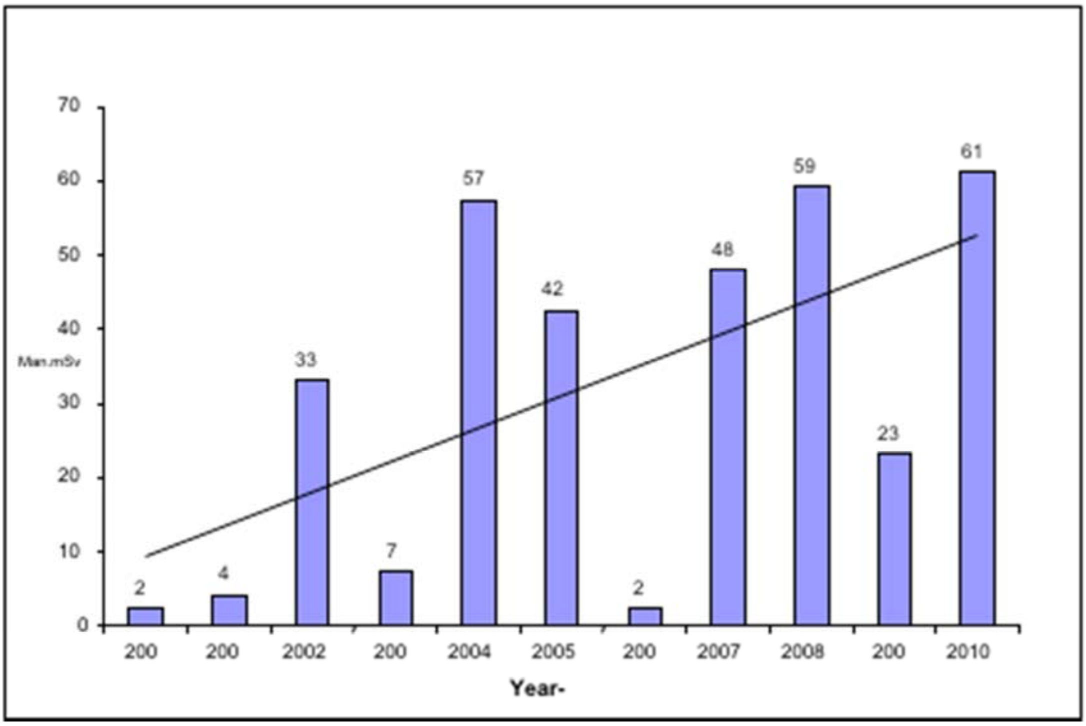
Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit [man.Sv/unit]**
PHWR (KANUPP)	1	2.467
PWR (CNPP-1)	1	0.612 (including 0.558 man.Sv of refuelling outage 6)

Summary of dosimetric trends

The total collective dose received was 612.573 man.mSv and the average dose was 0.392 mSv/person. The number of workers receiving doses ≥ 1 mSv was 163. Six workers received doses ≥ 5 mSv but less than 6 mSv. The maximum dose received by an individual was 7.503 mSv. In addition, the trend for collective doses in CNPP Unit 1 is given below.

Collective doses data of CNPP Unit-1 from 2000 to 2010 (yearly values)



Events influencing dosimetric trends

Collective dose was higher as compared to previous years' doses. The main cause was overhauling of RCP-B which was performed for the first time at C-1 since starting of its commercial operation in 2000. The job was performed during refuelling outage 6 of C-1 (11 April 2010 to 14 June 2010). Details of major hot jobs performed including overhauling of RCP-B during refuelling outage 6 are shown in the table below.

S. No.	Job	Estimated dose	Received dose*
		(man.mSv)	
1	Fuel handling operations	105	138.389
2	Valve maintenance	55	29.377
3	Scaffolding and insulation	50	87.920
4	In-service inspection (ISI) jobs	55	23.015
5	RCP-B overhauling including decontamination and inspection	50	51.368
6	SG nozzle dam fitting and removal	35	24.503
7	CIN thimble tube cleaning, flushing, and inspection	10	2.886
8	Installation of LPMS	50	28.183

* EPD doses only.

Number and duration of outages

In addition to refuelling outage 6, there were two short outages:

- 16-17 July 2010 with collective dose 0.351 man.mSv;
- 11-12 September 2010 with collective dose 0.588 man.mSv.

New plants on line/plants shutdown

None in 2010.

Organisational evolutions

A Technical Support Organisation has been established at CNPGS to provide support for various maintenance activities at Chashma Units (C-1 and C-2).

Issues of concern in 2011

Overhauling of RCP-A including dismantling, decontamination, and inspection/ overhauling during RFO-7.

The Chashma Nuclear Power Generating Station (C-2) will start its commercial operation on 12 May 2011 and will contribute 300 MWe to the national grid.

ROMANIA

Dose information

Operating reactors		
Reactor type	Number of reactors	Average annual collective dose per unit [man.Sv/unit]
CANDU	2	0.394

Summary of national dosimetric trends

Occupational exposure at Cernavoda NPP (2000-2010)

	Internal effective dose (man.mSv)	External effective dose (man.mSv)	Total effective dose (man.mSv)
2000	110.81	355.39	466.2
2001	141.42	433.44	574.86
2002	206.43	344.04	550.48
2003	298.02	520.27	818.28
2004	398.26	258.45	656.71
2005	389.3	342.29	731.59
2006	302.27	258.79	561.06
2007	83.34	187.49	270.83
2008	209.3	479.34	688.6
2009	67.6	417.7	485.3

2010	210.3	577	787.3

Events influencing dosimetric trends

Normal operation of the plant (U1 and U2)

During normal operation intervals of both units there were not radiological events that could have an impact on individual and collective doses. At the end of 2010:

- There were 19 employees with individual doses exceeding 5 mSv; none with individual dose over 10 mSv (unplanned exposure) and none with individual dose over 15 mSv.
- The maximum individual dose since the beginning of the year was 7.02 mSv.
- The contribution of internal dose due to tritium intake was 26.7%.

Planned outage

A 24-day planned outage was done at Unit 1 between 8 May-1 June 2010. Activities with major contribution to the collective dose were as follows:

- end fitting positioning assembly reconfiguration;
- steam generators' eddy current inspection;
- modification of SDS #2 instrument lines fixing solution;
- snubber inspection; piping supports inspection.

Total collective dose at the end of the planned outage was 414 man.mSv (319 man.mSv external dose and 95 man.mSv internal dose due to tritium intakes). This planned outage had a 52% contribution to the collective dose of 2010.

Planned outages dose history

Year	Unit	Interval	External collective dose received (man.mSv)	Internal collective dose (^3H intakes) received (man.mSv)	Total collective dose received (man.mSv)
2003	1	15.05-30.06	345	161	506
2004	1	28.08-30.09	153	179	332
2005	1	20.08-12.09	127	129	256
2006	1	9.09-4.10	103	107	210
2007	2	20-29.10	16	0	16
2008	1	10.05-03.07	187	111	298
2009	2	09.05-01.06	122	11	133
2010	1	08.05-01.06	319	95	414

Unplanned outages

- Unit 2 – Unit was shutdown between 1-4 March in an orderly fashion due to a relatively large D_2O leak on the primary heat transport system (12.454 man.mSv external dose).

- Unit 2 – A complete SDS #2 trip occurred on 6-8 July due to human error during maintenance on SDS #2 pressure transmitters (4 man.mSv external dose).
- Unit 1 – Unit was shutdown between 28-30 July in an orderly fashion for repairs at D_2O leaking DN scan tubing (BSI 63105) in the feeder cabinet. The cause of the deterioration was fretting between the impulse lines (14 man.mSv external dose).

Radiation protection-related issues

During 2010, modernisation of the "tritium in air monitoring" system in Unit 1 continued with installing the fifth loop, in order to improve the system efficiency, so the system now contains five local monitoring units.

Extension and improvement of area alarming gamma monitor (AAGM) system is in progress.

During the Unit 1 planned outage in 2010, the last three loops were improved so the system has now 35 operating measuring loops. In Unit 2, there are also 35 operating loops.

For the long term, a heavy water de-tritiation facility project is in progress. A pilot plant is under commissioning to test the technology to be applied to reduce tritium concentration in the CANDU reactor moderator and primary heat transport systems.

Issues of concern in 2010

The main concerns for 2010 were important works, with high radiological impact, performed during planned outage of Unit 1.

Issues of concern in 2011

The main concerns for 2011 are activities with high radiological impact, to be performed during the planned outage of Unit 2 (e.g. steam generator's ECT inspection, repair of SDS #2 instrument lines).

RUSSIAN FEDERATION

Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit [man.Sv/unit]**
PWR (VVER)	15	0.652
Reactors in cold shutdown or in decommissioning		
Reactor type	**Number of reactors**	**Average annual collective dose per unit [man.Sv/unit]**
PWR (VVER)	2	0.078

Summary of national dosimetric trends

With respect to six operating VVER-440 MWe and nine operating VVER-1000 MWe type reactors, the total (utilities employees and contractors) effective annual collective dose in

2010 was 9.781 man.Sv. This result represents a 19% or 2.289 man.Sv decrease from the year 2009 total collective dose of 12.070 man.Sv.

As usual, a considerable difference between average annual collective doses for VVER-440 and VVER-1000 reactors was registered. In 2010, the results were as follows:

- 0.863 man.Sv/reactor for VVER-440 MWe;
- 0.511 man.Sv/reactor for VVER-1000 MWe.

In 2010, there were no persons with individual doses exceeding 18 mSv at all Russian plants with VVER. The maximum recorded individual dose was 17.9 mSv. This dose was gradually received over 2010 by the worker of Kola NPP maintenance department during repair works at SGs.

Events influencing dosimetric trends

The principal factors influencing the total collective dose change at Russian VVERs are annual outages durations and the amount of repair and maintenance works. In 2010, the total length of the planned outages for all Russian VVERs-440 and VVERs-1000 was 745 days. This value is almost equal to the total length registered in 2009 (753 days). However, the considerable redistribution between the total lengths of outage durations at VVERs-440 and VVERs-1000 was observed in 2010. Total lengths of outage durations decreased from 350 days in 2009 to 299 days in 2010 at VVERs-440 and increased from 403 to 446 days at VVERs-1000. Taking into account that the main portion of the total annual collective dose is given by old reactors of the first generation VVERs-440, the main reason for the collective dose decreasing in 2010 is connected with the reduction of the total outage duration of this type of reactor.

It should also be noted that average annual collective doses per VVER-1000 reactor are relatively constant near 0.500 man.Sv/reactor (0.483, 0.496, 0.511 man.Sv/reactor in 2008-2010 respectively). Average annual collective dose per VVER-440 reactor changed over a broader range of values (1.010, 1.254, 0.863 man.Sv/reactor in 2008-2010 respectively).

Planned outages duration and collective doses

Reactor	Duration (days)	Collective dose (man.Sv)
Balakovo 1	71	0.727
Balakovo 2	No outage	–
Balakovo 3	44	0.393
Balakovo 4	56	0.596
Kalinin 1*	42	0.643
Kalinin 2	40	0.330
Kalinin 3	60	0.290
Kola 1	37	0.324
Kola 2	33	0.419
Kola 3	100	0.936
Kola 4	54	0.748
Novovoronezh 3	41	1.073
Novovoronezh 4	34	1.141
Novovoronezh 5	98	0.482
Rostov 1**	35	0.092

* An unplanned outage for reactor pressure vessel head repair took place at Kalinin 1 from 15-31 December 2010. The total collective dose of utilities employees and contractors during this outage was 0.120 man.Sv.

** In 2010, Volgodonsk 1 was renamed Rostov 1.

New plants on line

Rostov 2 with VVER-1000 MWe type reactor (project V-320) was put in commercial operation on 10 December 2010.

Major evolutions

Based on the analysis of occupational exposure at all types of reactors, the decision to set a new individual control dose level at 18 mSv per year was adopted by Concern Rosenergoatom (Russian operating utility) for all Russian nuclear power plants starting from 1 January 2011.

Issues of concern in 2011

- Revision of occupational exposure guidelines for control of external/internal doses.
- Completion of work aimed at the development of a radiation passbook for outside workers.
- Intercalibration of the measuring equipment used at NPPs for individual dosimetry control.
- Application of operating cycle length in the 18-month range at all VVER-1000 MWe type reactors (except Novovoronezh 5).
- Completion of works aimed at development of uniform guidelines for radiological posting and labelling.

SLOVAK REPUBLIC

Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit [man.Sv/unit]**
VVER	4	0.153
Reactors in cold shutdown or in decommissioning		
Reactor type	**Number of reactors**	**Average annual collective dose per unit [man.Sv/unit]**
VVER	2	0.012

Summary of national dosimetric trends

Bohunice NPP (2 units – Bohunice 3 and 4)

The total annual effective dose at Bohunice NPP in 2010 calculated from legal film dosimeters was 225.517 man.mSv (employees 126.464 man.mSv, outside workers 99.053 man.mSv). The maximum individual dose was 3.426 mSv (outside worker).

JAVYS NPP (2 units – Bohunice 1 and 2)

The total annual effective dose at JAVYS NPP in 2010 calculated from legal film dosimeters was 24.765 man.mSv (employees 10.636 man.mSv, outside workers 14.129 man.mSv). The maximum individual dose was 1.780 mSv (NPP employee).

Mochovce NPP (2 units)

The total annual effective dose at Mochovce NPP in 2010 evaluated from legal film dosimeters and E50 was 388.425 man.mSv (employees 152.522 man.mSv, outside workers 235.903 man.mSv). The maximum individual dose was 6.111 mSv (outside worker).

Events influencing dosimetric trends

Bohunice NPP

Standard operation and short outages influenced low results of dosimetry data. Power increasing on both units – up to 107% (505 MWe).

JAVYS NPP

Unit 1 has not been in the operation and has been prepared for decommissioning (without spent fuel). Unit 2 has not been in operation. During the year nuclear spent fuel from this unit was being transported to spent fuel storage.

Mochovce NPP

Both units were in standard operation. Unit 1 had a standard maintenance outage. Unit 2 had a major maintenance outage.

Number and duration of outages

Bohunice NPP

Unit 3 had 23 days of standard maintenance outage. The collective exposure was 103.449 man.mSv.

Unit 4 had 22.8 days of standard maintenance outage. The collective exposure was 74.251 man.mSv.

JAVYS NPP

Unit 1 has been out of operation since 01 January 2007, and Unit 2 has been out of operation since 01 January 2009.

Mochovce NPP

Unit 1 had 23 days of standard maintenance outage. The collective exposure was 127.465 man.mSv, as taken from electronic dosimeters.

Unit 2 had 49.4 days of major maintenance outage. The collective exposure was 210.696 man.mSv, as taken from electronic dosimeters.

New plants on line/plants shutdown

New NPP: Completion of Mochovce Units 3 and 4 in the year 2010. A rector pressure vessel was installed at Unit 3. Completion work of both units continued.

Component or system replacements

Bohunice NPP

- Introduction of SAP Nuclear, a new software for Slovenské elektrárne, subsidiary of Enel, which replaced the previous work management software, including the radiation protection areas. This is now the common software for both Bohunice and Mochovce NPP.
- Replacement of old personal contamination monitors at the entry to the hot change rooms.

JAVYS NPP

- New free release equipment preparation.

Mochovce NPP

- New radiation monitors were installed at new gate between EMO1, 2, and EMO 3, 4, for pedestrians and cars.

Safety-related issues

JAVYS NPP

Preparation of the license for decommissioning.

Issues of concern in 2011

Bohunice NPP

Further RP staff reduction.

JAVYS NPP

Achievement of the license for decommissioning.

Technical plans for major work in 2011

Bohunice NPP

Two outages, of 23 and 40 days planned duration.

Mochovce NPP

Two outages, of 22 and 23 days planned duration.

Regulatory plans for major work in 2011

Licensing process of the first phase of NPP V1 JAVYS decommissioning.

SLOVENIA

Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit [man.Sv/unit]**
PWR	1	0.851

Summary of national dosimetric trends

The collective dose trend of Krško NPP after SG replacement in 2000 shows a decrease during the last decade. The three years' collective dose average was 0.55 man.Sv for the period 2008-2010. The fuel cycle is 18 months.

Maximum individual annual dose in the year 2010 was 6.49 mSv, average dose per person was 0.76 mSv.

Events influencing dosimetric trends

The outage collective dose was 0.775 man.Sv; it was a refuelling outage with pressuriser weld overlays.

Number and duration of outages

One planned outage of 37 days.

Major evolutions and dose reduction programme

The dose reduction programme has been established by a special plant management manual. This programme is regularly reviewed at ALARA committee meetings.

Action to support the dose reduction programme in the next year will be replacement of the reactor vessel head. This will include a new, permanent gamma shield and removable neutron shields as well as additional improvements to simplify vessel open and close tasks.

Technical plans for major work in 2011

Krško NPP will evaluate the prevention and mitigation of severe accidents and will implement the improvements in accordance with the expected requirements of the regulator and the Safety Terms of Reference (STORE) approach.

Regulatory plans for major work in 2011

The Slovenian Nuclear Safety Administration (SNSA) and the Slovenian Radiation Protection Administration (SRPA) will be performing regulatory control and inspection surveillance of Krško NPP operation. SNSA will request the operator to perform the stress tests in light of the Fukushima accident as soon as they are agreed upon in the EU.

SPAIN

Summary of national dosimetric trends

Per plant, the annual collective doses and the outage collective doses are as listed in the table below.

NPP	Type	Outage coll. doses (person.Sv)	No. days	Annual coll. doses (person.Sv)	Comments
Almaraz I	PWR	–	–	0.020	No outage
Almaraz II	PWR	0.695	65	0.725	Uprating 8%
Ascó I	PWR	–	–	0.028	No outage
Ascó II	PWR	0.756	49	0.793	
Vandellos II	PWR	–	–	0.053	No outage
Trillo	PWR	0.322	31	0.338	
S.M. Garoña	BWR	0.271	11	0.584	
Cofrentes	BWR	–	–	0.490	No outage

Regarding the annual collective dose in PWRs, the PWR average for this year has been 0.32 person Sv while the three-year rolling average has been 0.44 person.Sv.

In relation to the annual collective dose in BWRs, the average total collective dose has been 0.53 person.Sv. The three-year rolling average is 1.16 person.Sv.

Year	PWR			BWR		
	Outages	Collective doses (person.Sv)	Three-year rolling average	Outages	Collective doses (person.Sv)	Three-year rolling average
2004	4	0.31	0.41	0	0.46	1.38
2005	5	0.38	0.37	2	2.32	1.65
2006	5	0.38	0.36	0	0.41	1.06
2007	5	0.51	0.42	2	4.15	2.29
2008	3	0.29	0.39	0	0.50	1.69
2009	5	0.72	0.51	2	2.31	2.32
2010	3	0.32	0.44	1	0.54	1.16

BWR summary

Cofrentes NPP has not had any forced or planned outages for maintenance tasks in 2010. During 2010, permanent shielding was installed in several areas (basically, valves and pipes) of the plant, resulting in an important drop of the dose rate in the area, over 50%. For 2011 an ambitious plan for dose reduction will be undertaken with the next phase of permanent shielding installation. Also, in 2011 a recirculation pump engine and components and tubing of TIP detectors will be replaced, with an estimated collective dose for these tasks around 0.195 person.Sv.

S.M. Garoña NPP has had three short shutdowns and one cold shutdown for maintenance tasks. All short shutdowns have included some work inside the drywell. By 2013 a decontamination of the recirculation loops is foreseen.

PWR summary

Vandellós II NPP has not had an outage during 2010. Some changes were implemented in radiation protection organisation, with the former radiation protection manager now included as adviser of plant manager as RP staff.

Almaraz II NPP has had one long outage due to an 8% power uprating. Also, there were some special works with an important radiological impact. These tasks were the following: inspection in 100% of steam generator tubes and pressuriser security valve replacement. Three tubes of steam generator No. 3 were also removed. Some improvements related to control contamination at steam generators tasks and dose reduction (low dose rate areas) were implemented during the outage.

A programme for dose reduction for Trillo NPP was proposed to the regulator in 2009 and it is running. Due to high dose rate inside several areas in the last outage in 2009, some actions were implemented. The most important of these actions was a special treatment of fulfilment water of the reactor cavity, carried on before the outage. Positive results were achieved with a collective and individual dose reduction during outage.

During the 2010 refuelling outage at Ascó II NPP, GL 2008.1 (inspections) and thimble tasks (cleaning and replacement) were performed. Also, insulation has been modified due to requirements for GL 2008.1 inspections in Ascó II; this will also be implemented in Ascó I NPP. Others improvement for 2011 will be a design change of the RCS sample system panel with a cleaning system and shielding for dose reduction. Control access to the radiation control area was also modified in both units, and human resources of the radiation protection team were repowered.

Decommissioning summary

Jose Cabrera NPP, currently in a decommissioning phase by ENRESA (the Spanish radioactive waste management agency), had a collective dose in 2010 of 0.053 person.Sv. During 2010, ENRESA obtained the Dismantling Authorisation for Jose Cabrera NPP. ENRESA also obtained the authorisation of the Radiological Protection Service for the dismantling of the pant.

Regulatory body summary

During 2010 the main activities of CSN, the Spanish regulatory body, have been:

- The assessment of the operational RP experience in the period 1999-2009 for Vandellós II and Cofrentes NPPs previous to grant the authorisation of a new 10-year exploitation permit.
- The operational radiation protection situation at Cofrentes is a matter of special concern for the CSN. A specific complementary instruction related to the implementation of a specific ALARA plan to reduce doses in the plant was required.

- An overview of the evolution of the Spanish NPPS in the international context provided by ISOE has been published for the period 2000-2008.
- The assessment of a special radiological surveillance programme of outdoor buildings in of all Spanish NPP sites.
- A new CSN Technical Instruction IS-29 on safety criteria at spent fuel and high-level radioactive waste storage facilities was issued in November 2010.

SWEDEN

Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man.Sv/unit]**
PWR	3	0.46
BWR	7	0.91
Total: All types	10	0.77
Reactors in cold shutdown or in decommissioning		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man.Sv/unit]**
BWR	2	0.006

Summary of national dosimetric trends

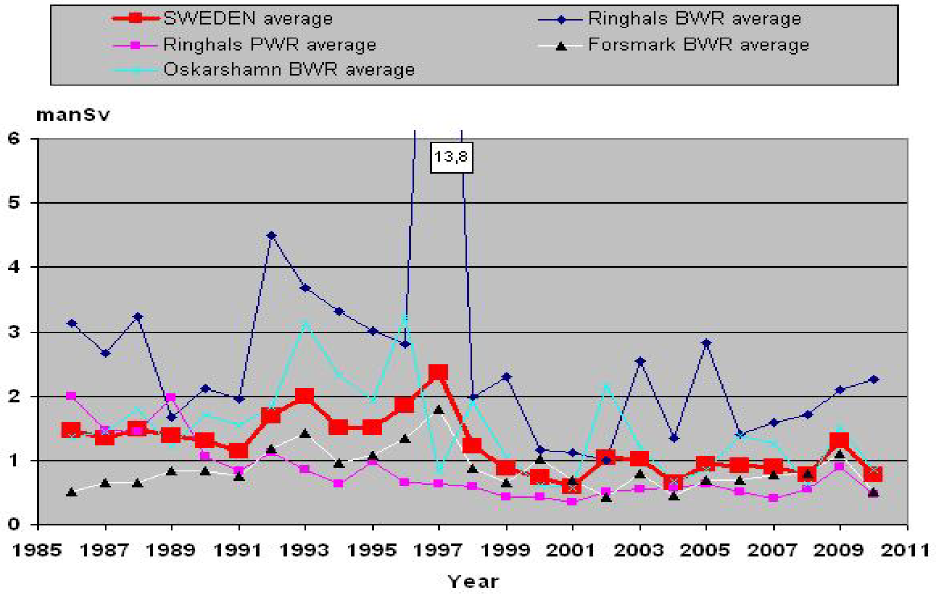
Collective and individual doses at the Swedish nuclear power plants normally show a fluctuating trend due to variations in workload. During 2010, approximately 4 500 persons at the NPPs were registered as receiving at least 0.1 mSv (TLD-dose) during at least one month (dosimeter read-out period) of the year. This resulted in a total collective dose in Sweden of 7.75 man.Sv, and a country average individual dose of 1.71 mSv. In 2010 the highest country annual individual dose was 16.9 mSv (highest plant individual dose 14.6 mSv). Note that the values presented here include the doses received at the two closed reactor units at Barsebäck NPP (40 persons with dose > 0.1 mSv, collective dose: 0.012 man.Sv, average individual dose: 0.31 mSv, and max. dose: 1.5 mSv).

Events influencing dosimetric trends

There are many projects in progress for modernisation, plant life extension, safety-related measures (regulatory demands), and power upgrades. The increase in number and extent of these projects has required an increasing amount of installation work to be done during operation and outage, which has influenced the dosimetric trends during the past years.

At Forsmark 2, the change of HP turbine and valves in 2009 caused operational problems. The valves had to be changed because it was not possible to operate on full power due to vibrations at high steam flow. The only valves available were replaced spare valves from Ringhals PWR, which contained stellite. This can result in increasing obalt concentration in the feed water and probably higher activation resulting in higher reactor water concentration of ^{60}Co.

Sweden: Average collective annual dose for plant, reactor type, and country



At Ringhals 1, major work on the reactor main circulation valves was accomplished. To assure the valves' integrity due to corrosion in the valve housing (neck) sealing, stretching devices were installed, resulting in a dose exposure of 826 man.Sv.

At Oskarshamn 1, chemical decontamination of the residual heat system and reactor clean-up system were performed to allow NDT (PT test) of a reactor drain cooler, with dose rates exceeding 100 mSv/h. The decontamination was justified by including NDT at the main circulation loops and residual heat valves, exchange of main circulation, and residual heat pumps. A good average Df 19 was achieved.

Number and duration of outages in 2010

Plant	Type of reactor	Length of outage (days)	Collective dose (man.Sv)	Comments
Forsmark 1	BWR	28	0.42	Extended 8 days
Forsmark 2	BWR	20	0.15	As scheduled
Forsmark 3	BWR	51	0.45	As scheduled
Oskarshamn 1	BWR	43	1.30	Extended 6 days due to leakage problem in reactor containment (CAT)
Oskarshamn 2	BWR	21	0.58	As scheduled
Oskarshamn 3	BWR	60	2.53	Extended 24 days due to technical problems with turbine bearing
Ringhals 1	BWR	58	1.99	Extended 20 days partly due to cable repair in the reactor water level measuring system
Ringhals 2	PWR	0	0	No outage
Ringhals 3	PWR	48	0.57	Extended 10 days partly caused by leak in RTL gasket
Ringhals 4	PWR	34	0.61	Extended 4 days caused by leak from

				SG when filling up RC

Outage collective dose is registered with EPD dose.

Component or system replacements

As a result of ongoing projects for modernisation, plant life extension, safety-related measures (regulatory demands), and power upgrades at the Swedish NPPs, there are many components and system modifications/replacements, resulting in a significant dose outcome.

Modernisation of the reactor protection system (RPS) and installation of a diversified/ redundant residual heat removal and cooling water systems (BWR), exchange of HP/LP turbines and RV internals are other examples of major work that influences dosimetric trends.

As an example, reactor internals were replaced at Oskarshamn 3. A major challenge from a radiation protection viewpoint was NDT on the moist separator, carried out at the refuelling floor, a large amount of radiation shielding was tailor-made just for this occasion.

Safety-related issues

The final OSART review at the Swedish nuclear power plants was carried out at Ringhals NPP.

Unexpected events

At Forsmark 3, unplanned shutdown on two occasions caused by leaking fuel.

Technical plans for major work in 2011

Examples for the Swedish NPPs are:

- Ringhals 4 will exchange steam generators and pressuriser.
- Forsmark 3 will perform decontamination of the residual heat system.
- Oskarshamn will perform waste handling of replaced irradiated reactor internals.

Regulatory plans for major work in 2011

In addition to basic regulatory oversight SSM will perform inspections regarding optimisation of radiation protection on a management level (organisational ALARA). During these inspections SSM will also address how the NPPs have included optimisation of radiation protection in plant changes. SSM will focus on the inclusion of occupational exposure aspects when rebuilding parts of the plant to prepare for increased safety measures or to enable power uprates. Further, SSM will inspect the handling and management of radioactive sources, in particular high activity sealed sources, at the power plants.

One of the reviews performed by SSM during 2011, where one of the focuses will be radiation protection, is the power uprate of Forsmark 2.

SWITZERLAND

Dose information

Operating reactors		
Reactor	Number	Average annual collective dose per unit and

type	of reactors	reactor type [man.Sv/unit]
PWR	3	0.534
BWR	2	1.339
Total: All types	5	0.856

Summary of national dosimetric trends

Neither collective nor average individual doses have changed significantly in recent years. The average individual dose for personnel in nuclear facilities is now 0.7 mSv. The maximum individual dose in the Leibstadt nuclear power plant was 28 mSv, caused by an unexpected event (see below). Apart from this event the maximum individual dose in all Swiss NPP was 9.2 mSv, complying with the dose constraint of 10 mSv set by the NPP themselves. Only one person showed an incorporated radioactivity leading to an effective dose of 0.1 mSv. All other 5 800 monitored persons had no measurable intake of radioactivity (evidence level < 0.1 mSv). No fixed skin contamination was registered.

Events influencing dosimetric trends

In NPP Gösgen a fuel leakage was detected during the 31st cycle (2009-2010). Due to a prolonged cleaning phase during cooling down and other radiation protection measures the radioactivity released in the primary circuit had no negative effect on the dosimetric trend.

The average dose rate at the primary cooling systems of NPP Gösgen and NPP Leibstadt on account of ^{60}Co decreased corresponding to the physical decay. The zinc injection at NPP Gösgen and the online noble chemistry at NPP Leibstadt prevented deposition and insoluble fixation of ^{60}Co.

Number and duration of outages

Each NPP had one planned outage during 2010 lasting between 22 days at Gösgen NPP and 59 days at Beznau NPP.

New plants on line

The Swiss Federal Nuclear Safety Inspectorate (ENSI) finished the expert reports about the general licensing of three new NPP near the existing sites Beznau, Gösgen, and Mühleberg.

Component or system replacements

Unexpected problems during replacement of baffle bolts and repairing canopy seals resulted in 200 person.mSv higher collective dose in Beznau 1 NPP than estimated.

Unexpected events

The year 2010 was marked by an event classified by ENSI as Level 2 on the INES scale. During maintenance work in the fuel assembly transfer system at the NPP Leibstadt, a diver recovered a pipe-like object. The object, which was highly radioactive, was the end piece from a jacketed pipe previously removed from the in-core instrumentation. Subsequent investigations showed that the diver had been exposed to a hand dose of 7.5 Sv and an effective dose of 28 mSv – both exceeding the annual dose limits specified in the Swiss Radiological Protection Ordinance.

As with the INES-2 event in 2009 in Beznau NPP, this event showed that particular attention is required when working in high and variable radiation fields. In terms of radiological protection, a range of measures must be introduced as a matter of urgency, including, for example, measures to ensure that acoustic alarms and warnings from electronic dosimeters are immediately audible even under difficult working conditions. In addition, there needs to be a systematic identification of radiation fields and this information must be made available to all concerned. Further lessons learned are: After cutting up highly activated materials the inventory of radioactivity has to be checked for lost parts. Workers in high radiation areas should only handle objects for which they are authorised.

Issues of concern in 2011

Since the catastrophic events at the Fukushima NPP in Japan on 11 March 2011, there has been a fundamental shift in the way the public regards nuclear facilities in Switzerland. Three days after Fukushima, the Swiss Federal Council suspended all applications for general licenses for the construction of new nuclear power plants. Two months later, Switzerland embarked on a political process that might lead to the phasing out of nuclear power for the purpose of electricity generation. This means a change to some of ENSI's responsibilities, as its previous assessment of new build projects is no longer relevant.

However, surveillance of the nuclear power plants currently in operation remains a key task. Monitoring existing nuclear power plants in Switzerland to ensure that they meet required safety levels is as important as it was before Fukushima. In addition, it is essential that the NPP and ENSI learn from the events in Japan.

UKRAINE

Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man.Sv/unit]**
VVER	15	0.76
Reactors in cold shutdown or in decommissioning		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man.Sv/unit]**
"ENERGOATOM" has no reactor installations in cold shutdown or under decommissioning		

Summary of national dosimetric trends

The level of collective dose of NPP personnel in 2010 amounted to 11.43 man.Sv/year, slightly below the 2009 level (11.56 man.Sv/year).

Events influencing dosimetric trends

Events affecting the radiation dose trends are as follows: number, duration, and complexity of NPP unit outages.

Number and duration of outages

Numbers of outages in 2010: 16. The average outage duration in 2010 was 76 days.

Major evolutions

Steady positive irradiation dose trends over the past ten years.

Component or system replacements

Replacement of out-of-date elements and expansion of the radiation control systems functions.

Safety-related issues

Conducting radiation safety reviews, preparation of quarterly and annual summary reports of the radiation safety status.

Unexpected events

No.

New/experimental dose reduction programmes

There are radiation safety improvement programmes for 2011-2015 in place at all NPPs operated by the company.

Technical plans for major work in 2011

There is a programme for reconstruction of the radiation control systems of Ukrainian NPPs in place at "ENERGOATOM".

UNITED KINGDOM

Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man.Sv/unit]**
PWR	1	0.271
GCR (AGR)	14	0.02
GCR (Magnox)	4	0.052
Reactors in cold shutdown or in decommissioning		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man.Sv/unit]**
GCR (Magnox)	16	0.055

Summary of national dosimetric trends

With the exception of Sizewell B all of the UK's nuclear power plants are gas-cooled. Doses were lower than the previous year at the advanced gas cooled reactors (AGRs) at Hinkley Point and Hunterston because of less in-vessel hours. The collective radiation exposure for the British Energy reactor fleet was approximately 0.54 man.Sv. The collective dose for the remaining operating Magnox-type reactors (two reactors each at Oldbury and Wylfa) was 0.206 man.Sv. Decommissioning doses remained low, averaging 0.1 man.Sv per shutdown site.

Events influencing dosimetric trends

Gas reactor doses reduced in 2010 because the AGRs at Hinkley Point and Hunterston did not perform extended vessel entries. Doses at Sizewell B were higher than planned because the plant carried out a six-month duration forced outage, to repair a number of defective pressuriser heaters.

Number and duration of outages

The gas-cooled reactors operate on a two-yearly outage frequency so each site typically has one reactor outage per annum. Refuelling of the gas-cooled reactors is carried out on-load. The highest outage doses on the gas-cooled reactors were received at Hinkley Point B and Hunterston B plants with outage doses of approximately 0.065 man.Sv. The AGR at Heysham 2 also had to carry out emergent in-vessel inspections, however these were limited in duration and only resulted in a collective radiation dose of around 0.035 man.Sv.

The annual dose at Sizewell B was dominated by a forced outage of around 200 days in duration. The forced outage was carried out to repair around 15 pressuriser heaters. The repairs required worker access to the pressuriser itself. To support the work a full-scale pressuriser mock-up was constructed to validate equipment and to train workers. During the pressuriser repairs the fuel was off-loaded from the reactor to the fuel storage pond.

Decommissioning sites: Major evolutions

All Magnox sites are owned by the Nuclear Decommissioning Authority, a government-owned management unit, with sites operated or being decommissioned under contract by a number of consortia. Of the original Magnox reactor fleet two sites remain in power operation, Oldbury and Wylfa, currently until the end of 2012. Of the permanently shutdown sites some are completely defuelled and are at various stages of decommissioning. At the end of 2010 Berkeley nuclear site became the first commercial power station in the UK to seal up its reactors in a major decommissioning milestone. The two Magnox reactor buildings were placed in a passive state, known as Safestore, and will now be monitored and maintained until the site is completely cleared in about 65 years' time. Other sites are shutdown with the reactors still fuelled and with air cooling. Defuelling of these sites continues to be rate limited by the capacity of the Sellafield reprocessing plant to receive and process fuel.

UK new nuclear build

The UK regulators are continuing to carry out generic licensing assessments of the proposed reactor designs, the Areva EPR and the Westinghouse AP1000, these are expected to conclude by the middle of 2011. There are two firm proposals to construct and commission new nuclear power plants; EDF-Energy plan to construct twin-EPRs at Hinkley Point and Sizewell; Horizon Power (an EON/RWE consortium) plan to construct new reactors at Oldbury and Wylfa. All of the proposed new reactors are on the site of existing operating plants.

UNITED STATES

Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man.Sv/unit]**
PWR	69	0.55
BWR	35	1.37
Reactors in cold shutdown or in decommissioning		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man.Sv/unit]**
PWR	7*	0.002
BWR	3*	0.036

* Includes only those shutdown reactors that report occupational dose separate from operating reactor units or other licensed activities.

Summary of national dosimetric trends

The USA PWR and BWR occupational dose averages for 2010 reflected a continued emphasis on dose reduction initiatives at the 104 operating commercial reactors. The total collective dose for the 104 reactors in 2010 was 86 313 person.mSv, a decrease of 14% from the 2009 total. The resulting average collective dose per reactor for USA LWR was 830 person.mSv/unit. The average measurable dose per individual for all LWR licensees was 0.0012 Sv (120 mR). Five individuals received between 20-30 mSv at a site in 2010. Four of those individuals were at the same US site.

US PWRs

The total collective dose for US PWRs in 2010 was 38 237 person.mSv for 69 operating PWR units. The 2010 average collective dose per reactor was 554 person.mSv/PWR unit.

The highest annual dose US PWR site was Davis Besse at 4 641 person.mSv. US PWR units are generally on 18- or 24-month refuelling cycles. The US PWR sites that achieved annual site doses of under 100 person.mSv in 2010 were:

- Summer, 21 person.mSv;
- Ginna, 32 person.mSv;
- Seabrook, 45 person.mSv;
- Waterford, 49 person.mSv;
- Watts Bar 1, 62 person.mSv;
- Fort Calhoun, 98 person.mSv.

US BWRs

The total collective dose for US BWRs in 2010 was 48 077 person.mSv for 35 operating BWR units. The 2010 average collective dose per reactor was 1.373 person.mSv/BWR unit. This is primarily due to BWR steam dryer replacements, power uprates, and water chemistry challenges at some US BWR units in 2010.

The highest annual dose US BWR site (three-unit site) was Browns Ferry 1,2,3 at 5 567 person.mSv and Brunswick 1,2 (two-unit site) at 4 074 person.mSv. Most US BWR units are on 24-month refuelling cycles. The lowest annual dose BWR in 2010 was Pilgrim at 257 person.mSv.

In calendar year 2010, the collective dose for all light water reactor (LWR) licensees was 86.31 man.Sv. The average annual collective dose per reactor for LWR licensees was 0.83 man.Sv.

Events influencing dosimetric trends

There were fewer outages in 2010 compared to 2009, which resulted in a 14% drop in the collective dose. The total outage hours in 2010 were 3 314 hours compared to 3 743 outage hours in 2009. There was an 11% drop in outage hours in 2010.

Number and duration of outages

PWRs	# of outages	# of days in outage	Avg. days/outage
Refuelling	38	2 054.7	54.1
Other	92	434.3	4.7
BWRs	**# of outages**	**# of days in outage**	**Avg. days/outage**
Refuelling	15	652.4	43.5
Other	46	172.7	3.8

New plants on line/plants shutdown

There are no changes from 2009 in the number of operating or shutdown reactors in the United States. Watts Bar 2 is being prepared to commence initial operations in the near future. Southern Company is preparing the site for construction of two new PWRs at the Vogtle site in Georgia. South Carolina Electric & Gas is constructing a new PWR on the Summer site.

Zion Units 1 and 2 located on Lake Michigan north of Chicago started decommissioning in 2010. Staff was being hired by Energy Solutions, who is responsible for the site decommissioning. Zion 1 and 2 were Exelon nuclear units which were shutdown over ten years ago.

Safety-related issues

Several significant events occurred at US sites in 2010, which prompted a letter from the President of the Institute of Nuclear Operations to all US Chief Nuclear Officers to train all nuclear plant employees on the lessons learned from each event to prevent recurrence.

Unexpected events

Twenty-two units conducted refuelling outages in the fall of 2010. Unexpected events which led to a national focus on the lessons learned included losses of shutdown cooling, unplanned key safety function risk changes, OSHA recordable injuries, extended outage duration due to discovery work scope and exceeding collective radiation exposure goals.

The median outage duration exceeded the planned median duration by 20% (planned 29 days versus actual 35.5 days). The primary cause of extended outages was emergent work due to equipment failures and equipment issues discovered during inspections.

New/experimental dose reduction programmes

US RPMs met with EDF radiation protection managers to evaluate the CZT detector measurement programme used at EDF PWR sites. An agreement was achieved to initiate measurements at selected US PWRs in the same locations, using the same measurement protocol and CZT detector system. This would allow future comparison of spectra from various PWR plants, to better characterise source term differences among PWRs and to evaluate the effectiveness of source term reduction programmes.

Organisational evolutions

Duke Power announced plans to acquire Progress Energy, which would add the following nuclear units to the Duke nuclear fleet: Crystal River, Robinson, Harris, and Brunswick 1-2.

Issues of concern in 2011

US plants are evaluating improved methods to measure dose-significant source term in plant piping. Radiation protection training of new technicians and professionals is a priority due to the retirement of ageing personnel.

US outage staffing of contract RP technicians was a difficulty in 2010; contractor organisations were not able to fill all requests for the spring and fall outages, leading to a reduction in available contract RP technicians at most refuelling outages. This will be a continuing issue into 2011.

Technical plans for major work in 2011

Provide lessons learned from US BWR and PWR ALARA outage reports to ISOE member utilities to use in pre-job ALARA briefs to prevent recurrence of the same or similar events. Expand initiative to trained nuclear utility RP personnel on internal dosimetry and alpha controls and monitoring based on Canadian and Duke alpha events presented at the January 2011 North American ISOE ALARA Symposium.

Regulatory plans for major work in 2011

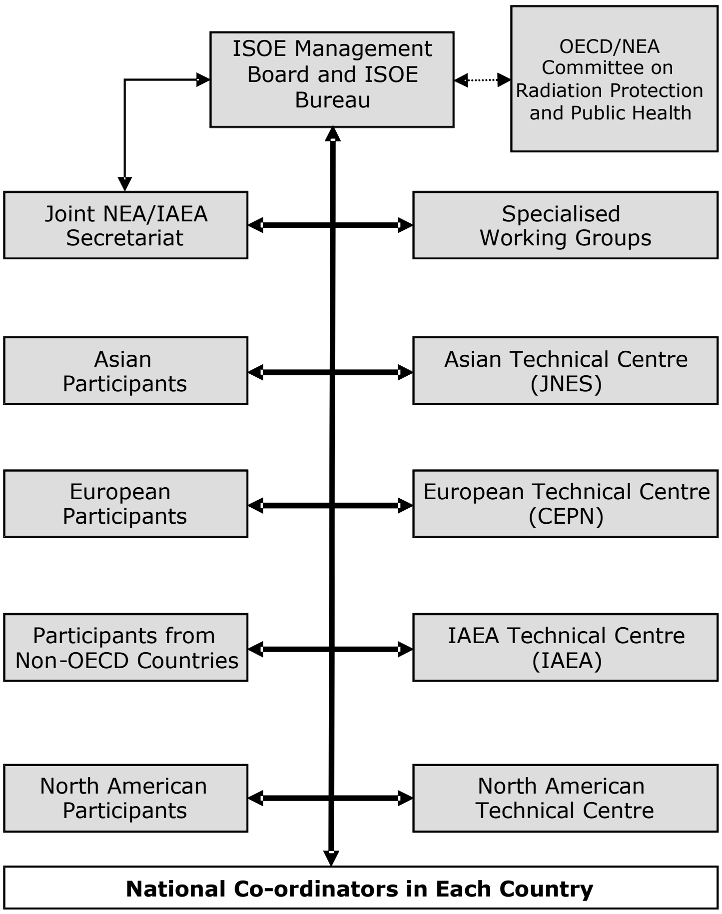
The US Nuclear Regulatory Commission (NRC) will continue its outreach to stakeholders regarding potential revisions to the agency's radiation protection standards contained in Title 10 of the Code of Federal Regulations, Part 20 (10 CFR Part 20), "Standards For Protection Against Radiation". NRC will continue its collaborations with other US federal agencies involved in setting and developing radiation protection standards and regulations within the US. These other federal agencies include the US Department of Energy (DOE), US Environmental Protection Agency (EPA), and the Occupational Safety and Health Administration (OSHA). In addition, NRC will continue its communications with domestic and international organisations involved in setting radiation protection policies, such as the National Council on Radiation Protection and Measurements (NCRP), the International Commission on Radiological Protection (ICRP), the International Atomic Energy Agency (IAEA), and the Nuclear Energy Agency (NEA).

ANNEX 1: ISOE ORGANISATIONAL STRUCTURE AND PROPOSED PROGRAMME OF WORK FOR 2011

A.1 ISOE organisational structure

ISOE operates in a decentralised manner. A Management Board composed of utility and regulatory authority representatives from all participating countries, supported by the joint NEA and IAEA Secretariat, provides overall direction. The ISOE Management Board reports to the Steering Committee of the Nuclear Energy Agency through the NEA Committee on Radiation Protection and Public Health. More information on the organisational structure can be found on the NEA website (www.oecd-nea.org).

Four ISOE Technical Centres (Europe, North America, Asia, and the IAEA) manage the programme's day-to-day technical operations, serving as contact points for the transfer of information from and to participants. A national co-ordinator in each country provides a link between the ISOE participants and the ISOE programme. A list of National Co-ordinators is given in Annex 6.



ISOE participation

The current ISOE Terms and Conditions for the period 2008-2011 came into force on 1 January 2008, for which participants under the previous Terms were invited to confirm their ongoing acceptance. Based on feedback received as of December 2010, the ISOE programme included:

- 66 participating utilities[7] in 26 countries, covering 320 operating units; 40 shutdown units);
- regulatory authorities of 24 countries (3 countries participate with 2 authorities).

Objective. During 2010, the ISOE Technical Centres and ISOE Joint Secretariat continued to pursue the formal renewal of previous participants under the current ISOE Terms and Conditions (utilities: Lithuania, Pakistan, Ukraine, USA; authorities: China, South Africa), and seek the involvement of new participants.

Objective. During 2010, a proposal developed for Management Board and utility feedback on removing participating authority restrictions on data access, for decision by the ISOE Bureau. However, it was not accepted by the Management Board.

ISOE programme activities

1) *ISOE database management*

Data collection and management

Objective: Collection of ISOE 1 and ISOE 2 data: ISOE participants will provide their 2010 ISOE 1 data through the new ISOE Network website data input modules and/or using the ISOE Software under Microsoft ACCESS. The collection of ISOE 2 data was stopped in 2010.

Objective: Collection of ISOE 3 reports: The ISOE Network website will be used to exchange and record new ISOE 3-type information (i.e. radiation protection-related information for specific operations or tasks). ISOE 3 reports will be collected through the use of the form published on the ISOE Network website.

Management of the ISOE databases

Objective: Official database – on-line update and CD-ROM release: Data submitted directly by participants through the ISOE Network will be available as soon as the data is validated. Data submitted to ETC via electronic form (ACCESS database) will be made available through the Network at regular intervals through the year. The annual CD-ROM of the whole database, including 2010 data, will be released at the end of the 2011.

Continued development of ISOEDAT on-line

Objective: Development of ISOEDAT on-line will focus on the following elements:

- ISOE 1: Incorporation of a CANDU job/task list;
- ISOE 1: Incorporation of changes based on WGDA proposals for decommissioning (end of year);
- MADRAS: Implementation of new analyses.

7. Represents the number of lead utilities; in some cases, a plant may be owned/operated by multiple enterprises.

2) ISOE management and programme activities

Objective: Maintain an efficient schedule of official meetings of the relevant ISOE groups (ISOE Management Board, Bureau and WGDA) and other *ad hoc* groups according to the Management Board direction.

ISOE Management Board and ISOE Bureau

Objective: The ISOE Management Board, supported by the ISOE Bureau, will continue to focus on the ISOE programme management by reviewing and directing the progress of the programme at its annual meeting, developing and approving the programme of work for the coming year, identifying areas for specific activities, promoting the ISOE programme, and providing direction to its sub-groups.

ISOE Working Group on Data Analysis

Objective: The Working Group on Data Analysis (WGDA)/Technical Centres will:

- continue to review the completeness and quality of ISOE data collection;
- undertake and disseminate identified technical analyses (including standard routine analyses) of use to the ISOE membership, and contribute to the development of the ISOE Annual Report;
- elaborate technical proposals and implement approved modifications to ISOEDAT to enhance data collection and analysis from nuclear power plants which are in shutdown or some stage of decommissioning;
- perform other technical analysis as directed by the Management Board, based on end-user feedback and in support of the ISOE Annual Reports;
- consider development of a survey on the use of zinc injection to reduce source terms.

Joint NEA/CRPPH-ISOE activities: Expert Group on Occupational Exposure (EGOE)

Objective: ISOE members will continue to participate in the activities of the EGOE, organised by the NEA's Committee on Radiation Protection and Public Health (CRPPH), according to the meeting schedule established by the EGOE.

ISOE publications and reports

Objective: Develop and distribute relevant ISOE publications. The following ISOE publications and reports will be produced and published in 2011. Products will be made available through the ISOE Network as appropriate:

- *ISOE Annual Reports:*
  - publish the 19th ISOE Annual Report (2009);
  - publish the 20th ISOE Annual Report (2010).
- *ISOE News*: Continue to electronically issue current ISOE information through the ISOE News, according to the ISOE Management Board decision on publication frequency (generally twice a year).
- *ISOE Symposia Proceedings*: ETC will update the ISOE Network with available symposia proceedings and presentations, as provided to the ETC by each centre.

- *Benchmark Visit Reports*: Reports of benchmarking visits organised under ISOE will be made available to the ISOE membership through the ISOE Network. Additionally, ETC will, for its benchmarking visits organised outside of ISOE resources, do its best to make the reports available to ISOE participants after obtaining the agreement of the plant visited.

3) ISOE ALARA Symposium (international and regional)

Objective: Organise to hold the following international and regional ISOE Symposium (Note: international symposia are considered a mandatory task for the technical centres; regional symposia are considered an optional task).

International symposia

- 2012 ISOE International ALARA Symposium, Fort Lauderdale, USA (8-11 Jan. 2012), organised by NATC.

Regional symposia

- 2011 ISOE North American ALARA Symposium, Fort Lauderdale, USA (9-12 Jan. 2011), organised by NATC and EPRI.
- 2011 ISOE Asian Regional Symposium, Japan (Sept.-Oct. 2011), organised by ATC.

4) ISOE Network website management and Technical Centre input

Network website management

Objective: ETC will continue to manage the website. Development and implementation of the ISOE Network website enhancements will continue to be subject to Management Board guidance.

Technical Centre input for the ISOE Network

Objective: Technical Centres will continue to make their information available for posting on the ISOE Network. The ETC will continue to post all information and products from all regions as it is made available. The ETC will continue to produce synthesis documents of requests posted on the website forum and those received by e-mail. These documents will also be posted on the website forum and attached to the request.

5) Reports and documents, information sheets, and information exchange

Objective: Effectively support information exchange activities among ISOE participants.

Technical Centre Information Sheets planned for 2011

Objective: Technical Centre Information Sheets will be prepared as listed in the following table.

Technical Centre Information Sheets planned for 2011				
Yearly analyses	**ATC**	**ETC**	**IAEA TC**	**NATC**
ATC: Japanese dosimetric results for 2010	X			

ATC: Republic of Korea dosimetric results for 2010	X			
ETC: European dosimetric results for 2010		X		
Special analyses				
Analysis of annual collective dose by reactor age category for BWRs and VVERs		X		
Alpha value around the world		X		

Information exchange activities

Objective: The Technical Centres will continue to respond to special requests from users for technical feedback, and share this information with all participants globally, according to the access privileges as a utility or authority member.

6) ISOE-organised benchmarking visits

The following site benchmarking visits will be organised under ISOE in 2011 by the technical centres in co-ordination with the ISOE WGDA and Management Board:

Benchmarking visits for 2011	
ETC	None planned under ISOE. CEPN-EDF visits will be organised using ISOE contacts, but not ISOE finances (one or two NPPs).
ATC	Japanese utilities and JNES will visit US NRC, Brunswick NPS, and Diablo Canyon NPS.
NATC	PWR ALARA association trip pending. Exelon and Cook RPMs visit to EDF plant in March 2011.

7) Other topics

Promotion of ISOE use

Objective

- A mechanism for gathering feedback from users and providing information to users will be implemented through the ISOE Network and other means as appropriate.
- Further information on ISOE will be distributed to non-OECD country participants through IAEA Technical Co-operation Projects to IAEA member states (non-OECD countries).
- Other opportunities for ISOE promotion, such as through relevant conferences and workshops, will be sought (e.g. national congress of the French Radiation Protection Society in June 2011).

Overall schedule of ISOE meetings for 2011

ISOE meetings for 2010	Jan.	May	Sept.	Nov.
Technical Centre co-ordination meeting				
ISOE Bureau/Technical Centres		X		X
Working Group on Data Analysis		X		X
20th ISOE Management Board Meeting				X
ISOE North American ALARA Symposium	X			
ISOE Asian ALARA Symposium			X	

* *Ad hoc* meetings not included.

ANNEX 2: LIST OF ISOE PUBLICATIONS

Reports

- *L'organisation du travail pour optimiser la radioprotection professionnelle dans les centrales nucléaires*, OCDE, Paris (2010).
- *Occupational Exposures at Nuclear Power Plants: Eighteenth Annual Report of the ISOE Programme, 2008*, OECD, Paris (2010).
- *Work Management to Optimise Occupational Radiological Protection at Nuclear Power Plants*, OECD, Paris (2009).
- *Occupational Exposures at Nuclear Power Plants: Seventeenth Annual Report of the ISOE Programme, 2007*, OECD, Paris (2009).
- *Occupational Exposures at Nuclear Power Plants: Sixteenth Annual Report of the ISOE Programme, 2006*, OECD, Paris (2008).
- *Occupational Exposures at Nuclear Power Plants: Fifteenth Annual Report of the ISOE Programme, 2005*, OECD, Paris (2007).
- *Occupational Exposures at Nuclear Power Plants: Fourteenth Annual Report of the ISOE Programme, 2004*, OECD, Paris (2006).
- *Occupational Exposures at Nuclear Power Plants: Thirteenth Annual Report of the ISOE Programme, 2003*, OECD, Paris (2005).
- *Optimisation in Operational Radiation Protection*, OECD, Paris (2005).
- *Occupational Exposures at Nuclear Power Plants: Twelfth Annual Report of the ISOE Programme, 2002*, OECD, Paris (2004).
- *Occupational Exposure Management at Nuclear Power Plants: Third ISOE European Workshop, Portoroz, Slovenia, 17-19 April 2002*, OECD, Paris (2003).
- *ISOE – Information Leaflet*, OECD, Paris (2003).
- *Occupational Exposures at Nuclear Power Plants: Eleventh Annual Report of the ISOE Programme, 2001*, OECD, Paris (2002).
- *ISOE – Information System on Occupational Exposure, Ten Years of Experience*, OECD, Paris (2002).
- *Occupational Exposures at Nuclear Power Plants: Tenth Annual Report of the ISOE Programme, 2000*, OECD, Paris (2001).
- *Occupational Exposures at Nuclear Power Plants: Ninth Annual Report of the ISOE Programme, 1999*, OECD, Paris (2000).
- *Occupational Exposures at Nuclear Power Plants: Eighth Annual Report of the ISOE Programme, 1998*, OECD, Paris (1999).
- *Occupational Exposures at Nuclear Power Plants: Seventh Annual Report of the ISOE Programme, 1997*, OECD, Paris (1999).

- *Work Management in the Nuclear Power Industry*, OECD, Paris (1997) (also available in Chinese, German, Russian, and Spanish).
- *ISOE – Sixth Annual Report: Occupational Exposures at Nuclear Power Plants: 1969-1996*, OECD, Paris (1998).
- *ISOE – Fifth Annual Report: Occupational Exposures at Nuclear Power Plants: 1969-1995*, OECD, Paris (1997).
- *ISOE – Fourth Annual Report: Occupational Exposures at Nuclear Power Plants: 1969-1994*, OECD, Paris (1996).
- *ISOE – Third Annual Report: Occupational Exposures at Nuclear Power Plants: 1969-1993*, OECD, Paris (1995).
- *ISOE – Nuclear Power Plant Occupational Exposures in OECD Countries: 1969-1992*, OECD, Paris (1994).
- *ISOE – Nuclear Power Plant Occupational Exposures in OECD Countries: 1969-1991*, OECD, Paris (1993).

ISOE News

2010	No. 15 (March), No. 16 (December)
2009	No. 13 (January), No. 14 (July)
2008	No. 12 (October)
2007	No. 10 (July); No. 11 (December)
2006	No. 9 (March)
2005	No. 5 (April); No. 6 (June); No. 7 (October); No. 8 (December)
2004	No. 2 (March); No. 3 (July); No. 4 (December)
2003	No. 1 (December)

ISOE Information Sheets

Asian Technical Centre

No. 34: Oct. 2009	Republic of Korea: Summary of National Dosimetric Trends
No. 33: Oct. 2009	Japanese Dosimetric Results: FY 2008 Data and Trends
No. 32: Jan. 2009	Japanese Dosimetric Results: FY 2007 Data and Trends
No. 31: Nov. 2007	Republic of Korea: Summary of National Dosimetric Trends
No. 30: Oct. 2007	Japanese Dosimetric Results: FY 2006 Data and Trends
No. 29: Nov. 2006	Japanese Dosimetric Results: FY 2005 Data and Trends
No. 28: Nov. 2005	Japanese Dosimetric Results: FY 2004 Data and Trends
No. 27: Nov. 2004	Achievements and Issues in Radiation Protection in the Republic of Korea
No. 26: Nov. 2004	Japanese Occupational Exposure During Periodic Inspection at PWRs and BWRs Ended in FY 2003
No. 25: Nov. 2004	Japanese Dosimetric Results: FY2003 Data and Trends
No. 24: Oct. 2003	Japanese Occupational Exposure of Shroud Replacements

No. 23: Oct. 2003	Japanese Occupational Exposure of Steam Generator Replacements
No. 22: Oct. 2003	Korea, Republic of; Summary of National Dosimetric Trends
No. 21: Oct. 2003	Japanese Occupational Exposure During Periodic Inspection at PWRs and BWRs Ended in FY 2002
No. 20: Oct. 2003	Japanese Dosimetric Results: FY2002 Data and Trends
No. 19: Oct. 2002	Korea, Republic of; Summary of National Dosimetric Trends
No. 18: Oct. 2002	Japanese Occupational Exposure During Periodic Inspection at PWRs and BWRs Ended in FY 2001
No. 17: Oct. 2002	Japanese Dosimetric Results: FY2001 Data and Trends
No. 16: Oct. 2001	Japanese Occupational Exposure During Periodical Inspection at PWRs and BWRs Ended in FY 2000
No. 15: Oct. 2001	Japanese Dosimetric Results: FY 2000 Data and Trends
No. 14: Sept. 2000	Japanese Occupational Exposure During Periodical Inspection at LWRs Ended in FY 1999
No. 13: Sept. 2000	Japanese Dosimetric Results: FY 1999 Data and Trends
No. 12: Oct. 1999	Japanese Occupational Exposure During Periodical Inspection at LWRs Ended in FY 1998
No. 11: Oct. 1999	Japanese Dosimetric Results: FY 1998 Data and Trends
No. 10: Nov. 1999	Experience of 1st Annual Inspection Outage in an ABWR
No. 9: Oct. 1999	Replacement of Reactor Internals and Full System Decontamination at a Japanese BWR
No. 8: Oct. 1998	Japanese Occupational Exposure During Periodical Inspection at LWRs Ended in FY 1997
No. 7: Oct. 1998	Japanese Dosimetric Results: FY 1997 Data
No. 6: Sept. 1997	Japanese Occupational Exposure During Periodical Inspection at LWRs Ended in FY 1996
No. 5: Sept. 1997	Japanese Dosimetric Results: FY 1996 Data
No. 4: July 1996	Japanese Occupational Exposure During Periodical Inspection at LWRs Ended in FY 1995
No. 3: July 1996	Japanese Dosimetric Results: FY 1995 Data
No. 2: Oct. 1995	Japanese Occupational Exposure During Periodical Inspection at LWRs Ended in FY 1994
No. 1: Oct. 1995	Japanese Dosimetric Results: FY 1994 Data

European Technical Centre

No. 52: April 2010	PWR Outage Collective Dose: Analysis Per Sister Unit Group for the 2002-2007 Period
No. 51: Dec. 2009	European Dosimetric Results for 2008
No. 50: Sept. 2009	Outage Duration and Outage Collective Dose Between 1996-2006 for VVERs
No. 49: Sept. 2009	Outage Duration and Outage Collective Dose Between 1996-2006 for BWRs

No. 48: Sept. 2009	Outage Duration and Outage Collective Dose Between 1996-2006 for PWRs
No. 47: Feb. 2009	European Dosimetric Results for 2007
No. 46: Oct. 2007	European Dosimetric Results for 2006
No. 44: July 2006	Preliminary European Dosimetric Results for 2005
No. 43: May 2006	Conclusions and Recommendations from the Essen Symposium
No. 42: Nov. 2005	Self-employed Workers in Europe
No. 41: Oct. 2005	Update of the Annual Outage Duration and Doses in European Reactors (1994-2004)
No. 40: Aug. 2005	Workers Internal Contamination Practices Survey
No. 39: July 2005	Preliminary European Dosimetric Results for 2004
No. 38: Nov. 2004	Update of the Annual Outage Duration and Doses in European Reactors (1993-2003)
No. 37: July 2004	Conclusions and Recommendations from the 4th European ISOE Workshop on Occupational Exposure Management at NPPs
No. 36: Oct. 2003	Update of the Annual Outage Duration and Doses in European Reactors (1993-2002)
No. 35: July 2003	Preliminary European Dosimetric Results for 2002
No. 34: July 2003	Man-Sievert Monetary Value Survey (2002 Update)
No. 33: Mar. 2003	Update of the Annual Outage Duration and Doses in European Reactors (1993-2001)
No. 32: Nov. 2002	Conclusions and Recommendations from the 3rd European ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants
No. 31: July 2002	Preliminary European Dosimetric Results for the Year 2001
No. 30: April 2002	Occupational Exposure and Steam Generator Replacements – Update
No. 29: April 2002	Implementation of Basic Safety Standards in the Regulations of European Countries
No. 28: Dec. 2001	Trends in Collective Doses Per Job from 1995 to 2000
No. 27: Oct. 2001	Annual Outage Duration and Doses in European Reactors
No. 26: July 2001	Preliminary European Dosimetric Results for the Year 2000
No. 25: June 2000	Conclusions and Recommendations from the 2nd EC/ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants
No. 24: June 2000	List of BWR and CANDU Sister Unit Groups
No. 23: June 2000	Preliminary European Dosimetric Results 1999
No. 22: May 2000	Analysis of the Evolution of Collective Dose Related to Insulation Jobs in Some European PWRs
No. 21: May 2000	Investigation on Access and Dosimetric Follow-up Rules in NPPs for Foreign Workers
No. 20: April 1999	Preliminary European Dosimetric Results 1998

No. 19: Oct. 1998	ISOE 3 Database – New ISOE 3 Questionnaires Received (Since Sept. 1998)
No. 18: Sept. 1998	The Use of the Man-Sievert Monetary Value in 1997
No. 17: Dec. 1998	Occupational Exposure and Steam Generator Replacements, Update
No. 16: July 1998	Preliminary European Dosimetric Results for 1997
No. 15: Sept. 1998	PWR Collective Dose Per Job 1994-1995-1996 Data
No. 14: July 1998	PWR Collective Dose Per Job 1994-1995-1996 Data
No. 12: Sept. 1997	Occupational Exposure and Reactor Vessel Annealing
No. 11: Sept. 1997	Annual Individual Doses Distributions: Data Available and Statistical Biases
No. 10: June 1997	Preliminary European Dosimetric Results for 1996
No. 9: Dec. 1996	Reactor Vessel Closure Head Replacement
No. 7: June 1996	Preliminary European Dosimetric Results for 1995
No. 6: April 1996	Overview of the First Three Full System Decontamination
No. 4: June 1995	Preliminary European Dosimetric Results for 1994
No. 3: June 1994	First European Dosimetric Results: 1993 Data
No. 2: May 1994	The Influence of Reactor Age and Installed Power on Collective Dose: 1992 Data
No. 1: April 1994	Occupational Exposure and Steam Generator Replacement

IAEA Technical Centre

No. 9: Aug. 2003	Preliminary Dosimetric Results for 2002
No.8: Nov. 2002	Conclusions and Recommendations from the 3rd European ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants
No. 7: Oct. 2002	Information on Exposure Data Collected for the Year 2001
No. 6: June 2001	Preliminary Dosimetric Results for 2000
No. 5: Sept. 2000	Preliminary Dosimetric Results for 1999
No. 4: April 1999	IAEA Workshop on Implementation and Management of the ALARA Principle in Nuclear Power Plant Operations, Vienna, 22-23 April 1998
No. 3: April 1999	IAEA Technical Co-operation Projects on Improving Occupational Radiation Protection in Nuclear Power Plants
No. 2: April 1999	IAEA Publications on Occupational Radiation Protection
No. 1: Oct. 1995	ISOE Expert Meeting

North American Technical Centre

2010-14: June 2010	NATC Analysis of Teledosimetry Data from Multiple PWR Unit Outage CRUD Bursts

2003-8: Aug. 2003	US PWR – Reactor Head Replacement Dose Benchmarking Study
2003-5: July 2003	North American BWR – 2002 Occupational Dose Benchmarking Charts
2003-4: July 2003	US PWR – 2002 Occupational Dose Benchmarking Chart
2003-2: July 2003	Three-year Rolling Average Annual Dose Comparisons – US BWR 2000-2002 Occupational Dose Benchmarking Charts
2003-1: July 2003	Three-year Rolling Average Annual Dose Comparisons – US PWR 2000-2002 Occupational Dose Benchmarking Charts
2002-5: July 2002	US BWR – 2001 Occupational Dose Benchmarking Chart
2002-4: July 2002	US PWR – 2001Occupational Dose Benchmarking Chart
2002-2: July 2002	Three-year Rolling Average Annual Dose Comparisons – US BWR 1999-2001 Occupational Dose Benchmarking Charts
2002-1: Nov. 2002	Three-year Rolling Average Annual Dose Comparisons – US PWR 1999-2001 Occupational Dose Benchmarking Charts
2001-7: Nov. 2001	US PWR Five-year Dose Reduction Plan: Donald C. Cook Nuclear Power Plant
2001-5: Dec. 2001	US BWR – 2000 Occupational Dose Benchmarking Chart
2001-4: Dec. 2001	US PWR – 2000 Occupational Dose Benchmarking Chart
2001-3: Nov. 2001	Three-year Rolling Average Annual Dose Comparisons – Canada Reactors (CANDU) 1998-2000 Occupational Dose Benchmarking Charts
2001-2: July 2001	Three-year Rolling Average Annual Dose Comparisons – US BWR 1998-2000 Occupational Dose Benchmarking Charts
2001-1: July 2001	Three-year Rolling Average Annual Dose Comparisons – US PWR 1998-2000 Occupational Dose Benchmarking Charts

ISOE international and regional symposia

Asian Technical Centre

Aug. 2010 (Gyeongju, Rep. of Korea)	2010 ISOE Asian ALARA Symposium
Sept. 2009 (Aomori, Japan)	2009 ISOE Asian ALARA Symposium
Nov. 2008 (Tsuruga, Japan)	2008 ISOE International ALARA Symposium
Sept. 2007 (Seoul, Rep. of Korea)	2007 ISOE Asian Regional ALARA Symposium
Oct. 2006 (Yuzawa, Japan)	2006 ISOE Asian Regional ALARA Symposium
Nov. 2005 (Hamaoka, Japan)	First Asian ALARA Symposium

European Technical Centre

Nov. 2010 (Cambridge, UK)	2010 ISOE International ALARA Symposium
June 2008 (Turku, Finland)	2008 ISOE European Regional ALARA Symposium
March 2006 (Essen, Germany)	2006 ISOE International ALARA Symposium

March 2004 (Lyon, France)	Fourth ISOE European Workshop on Occupational Exposure Management at Nuclear Power Plants
April 2002 (Portoroz, Slovenia)	Third ISOE European Workshop on Occupational Exposure Management at Nuclear Power Plants
April 2000 (Tarragona, Spain)	Second EC/ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants
Sept. 1998 (Malmö, Sweden)	First EC/ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants

IAEA Technical Centre

Oct. 2009 (Vienna, Austria)	2009 ISOE International ALARA Symposium

North American Technical Centre

Jan. 2010 (Ft. Lauderdale, FL, USA)	2010 ISOE North American ALARA Symposium
Jan. 2009 (Ft. Lauderdale, FL, USA)	2009 ISOE North American ALARA Symposium
Jan. 2008 (Ft. Lauderdale, FL, USA)	2008 ISOE North American ALARA Symposium
Jan. 2007 (Ft. Lauderdale, FL, USA)	2007 ISOE International ALARA Symposium
Jan. 2006 (Ft. Lauderdale, FL, USA)	2006 ISOE North American ALARA Symposium
Jan. 2005 (Ft. Lauderdale, FL, USA)	2005 ISOE International ALARA Symposium
Jan. 2004 (Ft. Lauderdale, FL, USA)	2004 North American ALARA Symposium
Jan. 2003 (Orlando, FL, USA)	2003 International ALARA Symposium
Feb. 2002 (Orlando, FL, USA)	North American National ALARA Symposium
Feb. 2001 (Orlando, FL, USA)	2001 International ALARA Symposium
Jan. 2000 (Orlando, FL, USA)	North American National ALARA Symposium
Jan. 1999 (Orlando, FL, USA)	Second International ALARA Symposium
March 1997 (Orlando, FL, USA)	First International ALARA Symposium

ANNEX 3: STATUS OF ISOE PARTICIPATION UNDER THE RENEWED ISOE TERMS AND CONDITIONS (2008-2011)[8]

Officially participating utilities: Operating reactors

Country	Utility[9]	Plant name	
Armenia	Armenian (Medzamor) NPP	Medzamor 2	
Belgium	Electrabel	Doel 1, 2, 3, 4	Tihange 1, 2, 3
Brazil	Eletronuclear A/S	Angra 1, 2	
Bulgaria	Nuclear Power Plant Kozloduy	Kozloduy 5, 6	
Canada	Bruce Power Hydro Quebec New Brunswick Power Ontario Power Generation	Bruce A1, A2, A3, A4 Gentilly 2 Pt. Lepreau Darlington 1, 2, 3, 4	Bruce B5, B6, B7, B8 Pickering A1, A2, A3, A4 Pickering B5, B6, B7, B8
China	Guangdong Nuclear Power Joint Venture Co., Ltd Ling Ao Nuclear Power Co. Ltd Qinshan Nuclear Power Co., Ltd.	Daya Bay 1, 2 Ling Ao 1, 2 Qinshan 1	
Czech Republic	CEZ	Dukovany 1, 2, 3, 4 Temelin 1, 2	
Finland	Fortum Power and Heat Oy Teollisuuden Voima Oyj	Loviisa 1, 2 Olkiluoto 1, 2	
France	Électricité de France (EDF)	Belleville 1, 2 Blayais 1, 2, 3, 4 Bugey 2, 3, 4, 5 Cattenom 1, 2, 3, 4 Chinon B1, B2, B3, B4 Chooz B1, B2 Civaux 1, 2 Cruas 1, 2, 3, 4 Dampierre 1, 2, 3, 4 Fessenheim 1, 2	Flamanville 1, 2 Golfech 1, 2 Gravelines 1, 2, 3, 4, 5, 6 Nogent 1, 2 Paluel 1, 2, 3, 4 Penly 1, 2 Saint-Alban 1, 2 Saint Laurent B1, B2 Tricastin 1, 2, 3, 4

Country	Utility	Plant name	
Germany	E.ON Kernkraft GmbH EnBW Kernkraft AG	Brokdorf Grafenrheinfeld Grohnde Philippsburg 1, 2	Isar 1, 2 Unterweser Gemeinschaftskraftwerk-

8. This annex provides the status of ISOE official participation as of December 2010.
9. Where multiple owners and/or operators are involved, only leading undertakings are listed.

Country	Utility	Plant name	
			Neckar 1, 2
	RWE Power AG	Biblis A, B Emsland	Gundremmingen B, C
	Vattenfall Europe Nuclear Energy GmbH	Brunsbüttel	Krümmel
Hungary	Magyar Villamos Muvek Zrt	Paks 1, 2, 3, 4	
Japan	Chubu Electric Power Co.	Hamaoka 3, 4, 5	
	Chugoku Electric Power Co.	Shimane 1, 2	
	Hokkaido Electric Power Co.	Tomari 1, 2, 3	
	Hokuriku Electric Power Co.	Shika 1,2	
	Japan Atomic Power Co.	Tokai 2	Tsuruga 1, 2
	Kansai Electric Power Co.	Mihama 1, 2, 3 Ohi 1, 2, 3, 4	Takahama 1, 2, 3, 4
	Kyushu Electric Power Co.	Genkai 1, 2, 3, 4	Sendai 1, 2
	Shikoku Electric Power Co.	Ikata 1, 2, 3	
	Tohoku Electric Power Co.	Onagawa 1, 2, 3	Higashidori 1
	Tokyo Electric Power Co.	Fukushima Dai-ichi 1, 2, 3, 4, 5, 6 Fukushima Dai-ni 1, 2, 3, 4	Kashiwazaki Kariwa 1, 2, 3, 4, 5, 6, 7
Korea, Republic of	Korean Hydro and Nuclear Power	Kori 1, 2, 3, 4 Ulchin 1, 2, 3, 4, 5, 6	Wolsong 1, 2, 3, 4 Yonggwang 1, 2, 3, 4, 5, 6
Mexico	Comisiòn Federal de Electricidad	Laguna Verde 1, 2	
Romania	Societatea Nationala Nuclearelectrica	Cernavoda 1, 2	
Russian Federation	Energoatom Concern OJSC	Balakovo 1, 2, 3, 4 Kalinin 1, 2, 3 Kola 1, 2, 3, 4	Novovoronezh 3, 4, 5 Rostov 1
Slovak Republic	Slovenské Electrárne	Bohunice 3, 4	Mochovce 1, 2
Slovenia	Nuklearna Elektrarna Krško	Krško 1	
South Africa	ESKOM	Koeberg 1, 2	
Spain	UNESA	Almaraz 1, 2 Asco 1, 2 Cofrentes	Santa Maria de Garona Trillo Vandellos 2
Sweden	Forsmarks Kraftgrupp AB (FKA)	Forsmark 1, 2, 3	
	OKG Aktiebolag (OKG)	Oskarshamn 1, 2, 3	
	Ringhals AB (RAB)	Ringhals 1, 2, 3, 4	

Country	Utility	Plant name
Switzerland	Forces Motrices Bernoises (FMB)	Mühleberg
	Kernkraftwerk Gösgen-Däniken (KGD)	Gösgen
	Kernkraftwerk Leibstadt AG (KKL)	Leibstadt
	Axpo AG	Beznau 1, 2

Country	Utility	Plant name	
The Netherlands	N.V. EPZ	Borssele	
Ukraine	Ministry of Fuel and Energy of Ukraine	Khmelnitski 1, 2 Rovno 1, 2, 3, 4	South Ukraine 1, 2, 3 Zaporozhe 1, 2, 3, 4, 5, 6
United Kingdom	British Energy Generation Ltd.	Sizewell B	
United States	American Electric Power Co.	D.C. Cook 1, 2	
	Constellation Energy Group	Calvert Cliffs 1, 2 Ginna	Nine Mile Point 1, 2
	Exelon Corporation	Braidwood 1, 2 Byron 1, 2 Clinton 1 Dresden 2, 3 LaSalle County 1, 2	Limerick 1, 2 Oyster Creek 1 Peach Bottom 2, 3 Quad Cities 1, 2 TMI 1
	First Energy Corporation	Beaver Valley 1, 2 Davis Besse 1	Perry 1
	Florida Power and Light	Duane Arnold 1 Point Beach 1, 2 Seabrook	St. Lucie 1, 2 Turkey Point 3, 4
	PPL Susquehanna, LLC	Susquehanna 1, 2	
	South Carolina Electric Co.	Virgil C. Summer 1	
	Southern Nuclear Operating Co.	Vogtle 1, 2	
	Tennessee Valley Authority (TVA)	Browns Ferry 1, 2, 3 Sequoyah 1, 2	Watts Bar 1
	XCel Energy	Monticello	

Officially participating utilities: Definitively shutdown reactors

Country	Utility	Plant name	
Bulgaria	Nuclear Power Plant Kozloduy	Kozloduy 1, 2, 3, 4	
Canada	Hydro Quebec	Gentilly 1	
	Ontario Power Generation	NPD	
France	Électricité de France (EDF)	Bugey 1 Chinon A1, A2, A3	Chooz A St. Laurent A1, A2
Germany	E.ON Kernfraft GmbH	Würgassen	Stade
	EnBW Kernkraft AG	Obrigheim	
	Energiewerke Nord GmbH	AVR Jülich	
	RWE Power AG	Mülheim-Kärlich	
Italy	SOGIN	Caorso Garigliano	Latina Trino
Japan	Chubu Electric Power Co.	Hamaoka 1, 2	
	Japan Atomic Energy Agency	Fugen (LWCHWR)	
	Japan Atomic Power Co.	Tokai 1	

Country	Utility	Plant name
Lithuania	Ignalina Nuclear Power Plant	Ignalina 1, 2
Russian Federation	Energoatom Concern OJSC	Novovoronezh 1, 2
Slovak Republic	JAVYS	JAVYS 1, 2
Spain	UNESA	Jose Cabrera Vandellos 1
Sweden	Barsebäck Kraft AB (BKAB)	Barsebäck 1, 2
The Netherlands	BV GKN	Dodewaard
Ukraine	Ministry of Ukraine of Emergencies and Affairs of Population Protection from the Consequences of Chernobyl Catastrophe	Chernobyl 1, 2, 3
United States	Exelon Corporation	Dresden 1 Zion 1, 2 Peach Bottom 1

Participating regulatory authorities

Country	Authority
Armenia	Armenian Nuclear Regulatory Authority (ANRA)
Belgium	Federal Agency for Nuclear Control
Brazil	Comissão Nacional de Energia Nuclear
Bulgaria	Bulgarian Nuclear Regulatory Agency
Canada	Canadian Nuclear Safety Commission (CNSC)
China	Nuclear and Radiation Safety Centre (NSC)
Czech Republic	State Office for Nuclear Safety
Finland	Säteilyturvakeskus (STUK)
France	Autorité de Sûreté Nucléaire (ASN) Direction Générale du Travail (DGT) du Ministère de l'emploi, de la cohésion sociale et du logement, represented by l'Institut de Radioprotection et de Sûreté Nucléaire (IRSN)
Germany	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, represented by GRS
Japan	Ministry of Economy, Trade and Industry (METI)
Korea, Republic of	Ministry of Education, Science and Technology (MEST) Korea Institute of Nuclear Safety (KINS)
Lithuania	Radiation Protection Centre
Mexico	Commision Nacional de Seguridad Nuclear y Salvaguardias
The Netherlands	Ministerie van Sociale Zaken en Werkgelegenheld
Pakistan	Pakistan Nuclear Regulatory Authority
Romania	National Commission for Nuclear Activities Control (CNCAN)
Slovak Republic	Public Health Authority of the Slovak Republic
Slovenia	Slovenian Nuclear Safety Administration (SNSA)

	Slovenian Radiation Protection Administration (SRPA)
Spain	Consejo de Seguridad Nuclear
Sweden	Swedish Radiation Safety Authority
Switzerland	Swiss Federal Nuclear Safety Inspectorate (ENSI)
Ukraine	State Nuclear Regulatory Committee of Ukraine
United States	US Nuclear Regulatory Commission (US NRC)

Country – Technical Centre affiliations

Country	Technical Centre*	Country	Technical Centre*
Armenia	IAEATC	Mexico	NATC
Belgium	ETC	The Netherlands	ETC
Brazil	IAEATC	Pakistan	IAEATC
Bulgaria	IAEATC	Romania	IAEATC
Canada	NATC	Russian Federation	IAEATC
China	IAEATC	Slovak Republic	ETC
Czech Republic	ETC	Slovenia	IAEATC
Finland	ETC	South Africa, Republic of	IAEATC
France	ETC	Spain	ETC
Germany	ETC	Sweden	ETC
Hungary	ETC	Switzerland	ETC
Italy	ETC	Ukraine	IAEATC
Japan	ATC	United Kingdom	ETC
Korea, Republic of	ATC	United States	NATC
Lithuania	IAEATC		

* ATC: Asian Technical Centre, IAEATC: IAEA Technical Centre, ETC: European Technical Centre, NATC: North American Technical Centre

ISOE Network and Technical Centre information

ISOE Network web portal	
ISOE Network	www.isoe-network.net
ISOE Technical Centres	
European Region (ETC)	Centre d'étude sur l'évaluation de la protection dans le domaine nucléaire (CEPN), Fontenay-aux-Roses, France
	www.isoe-network.net
Asian Region (ATC)	Japan Nuclear Energy Safety Organisation (JNES), Tokyo, Japan
	www.jnes.go.jp/isoe/english/index.html
IAEA Region (IAEATC)	International Atomic Energy Agency (IAEA), Vienna, Austria Agence Internationale de l'Energie Atomique (AIEA), Vienne, Autriche
	www-ns.iaea.org/tech-areas/rw-ppss/isoe-iaea-tech-centre.asp
North American Region (NATC)	University of Illinois, Urbana-Champaign, Illinois, USA
	http://hps.ne.uiuc.edu/natcisoe/
Joint Secretariat	

OECD/NEA (Paris)	www.oecd-nea.org/jointproj/isoe.html
IAEA (Vienna)	www-ns.iaea.org/tech-areas/rw-ppss/isoe-iaea-tech-centre.asp

International co-operation

- European Commission (EC)
- United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)

ANNEX 4: ISOE BUREAU, SECRETARIAT, AND TECHNICAL CENTRES

Bureau of the ISOE Management Board

	2007-2008	2009-2010	2011-2012
Chairperson (Utilities)	MIZUMACHI, Wataru Japan Nuclear Energy Safety Organisation JAPAN	SIMIONOV, Vasile Cernavoda NPP ROMANIA	ABELA, Gonzague EDF FRANCE
Chairperson Elect (Utilities)	SIMIONOV, Vasile Cernavoda NPP ROMANIA	ABELA, Gonzague EDF FRANCE	HARRIS, Willie Exelon UNITED STATES
Vice-Chairperson (Authorities)	RIIHILUOMA, Veli Finnish Centre for Radiation and Nuclear Safety (STUK) FINLAND	HOLAHAN, Vincent US Nuclear Regulatory Commission UNITED STATES	DJEFFAL, Salah Canadian Nuclear Safety Commission CANADA BROCK, Terry US Nuclear Regulatory Commission UNITED STATES
Past Chairperson (Utilities)	GAGNON, Jean-Yves Centrale Nucleaire Gentilly-2 CANADA	MIZUMACHI, Wataru Japan Nuclear Energy Safety Organisation JAPAN	SIMIONOV, Vasile Cernavoda NPP ROMANIA

ISOE Joint Secretariat

OECD Nuclear Energy Agency (OECD/NEA)	
OKYAR, Halil Burçin OECD Nuclear Energy Agency Radiation Protection and Radioactive Waste Management 12, boulevard des Îles 92130 Issy-les-Moulineaux, France	Tel: +33 1 45 24 10 45 Eml: halilburcin.okyar@oecd.org
International Atomic Energy Agency (IAEA)	
MA, Jizeng IAEA Technical Centre Radiation Safety and Monitoring Section International Atomic Energy Agency P.O. Box 100, 1400 Vienna, Austria	Contact point: PUCHER, Inge Tel: +43 1 2600 22717 Eml: I.pucher@iaea.org
CZARWINSKI, Renate Head, Radiation Safety and Monitoring Section Division of Radiation, Transport and Waste Safety International Atomic Energy Agency P.O. Box 100, 1400 Vienna, Austria	

ISOE Technical Centres

Asian Technical Centre (ATC)	
HAYASHIDA, Yoshihisa Principal Officer Asian Technical Centre Japan Nuclear Energy Safety Organisation (JNES) TOKYU REIT Toranomon Bldg. 7th Floor 3-17-1 Toranomon, Minato-ku Tokyo 105-0001, Japan	Tel: +81 3 4511 1801 Eml: hayashida-yoshihisa@jnes.go.jp
European Technical Centre (ETC)	
SCHIEBER, Caroline European Technical Centre CEPN 28, rue de la Redoute 92260 Fontenay-aux-Roses, France	Tel: +33 1 55 52 19 39 Eml: schieber@cepn.asso.fr
IAEA Technical Centre (IAEATC)	
MA, Jizeng IAEA Technical Centre Radiation Safety and Monitoring Section International Atomic Energy Agency P.O. Box 100, 1400 Vienna, Austria	Contact point: PUCHER, Inge Tel: +43 1 2600 22717 Eml: I.pucher@iaea.org
North American Technical Centre (NATC)	
MILLER, David W. NATC Regional Co-ordinator North American ALARA Center Radiation Protection Department Cook Nuclear Plant One Cook Place Bridgman, Michigan 49106, USA	Tel: +1 269 465 5901 x 2305 Eml: dwmiller2@aep.com

ISOE Newsletter Editor

BREZNIK, Borut Radiation Protection Superintendent Nuclear Power Plant Krško Vrbina 12 SI-8270 Krško Slovenia	Tel: +386 7 4802 287 Eml: borut.breznik@nek.si

ANNEX 5: ISOE WORKING GROUPS (2010)

Working Group on Data Analysis (WGDA)

Chair: HENNIGOR, Staffan (Sweden); Vice-Chair: STRUB, Erik (Germany)	
CANADA	
DJEFFAL, Salah McQUEEN Maureen	Canadian Nuclear Safety Commission Bruce Power
CZECH REPUBLIC	
FARNIKOVA, Monika	Temelin NPP
FRANCE	
BADAJOZ, Caroline D'ASCENZO, Lucie SCHIEBER, Caroline COUASNON, Olivier ROCHER, Alain	CEPN (ETC) CEPN (ETC) CEPN (ETC) ASN EDF
GERMANY	
KAULARD, Jorg STRUB, Erik JENTJENS, Lena BASCHNAGEL, Michael	Gesellschaft für Anlagen-und Reaktorsicherheit mbH Gesellschaft für Anlagen-und Reaktorsicherheit mbH VGB-PowerTech Biblis NPP
JAPAN	
HAYASHIDA, Yoshihisa MIZUMACHI, Wataru SUZUKI, Akiko	Japan Nuclear Energy Safety Organization (ATC) Japan Nuclear Energy Safety Organization (ATC) Japan Nuclear Energy Safety Organization (ATC)
KOREA (REPUBLIC OF)	
CHOI, Won-Chul JUNG, Kyu-Hwan ROH, Hyun-Suk	Korea Institute of Nuclear Safety (KINS) Korea Institute of Nuclear Safety (KINS) Korea Institute of Nuclear Safety (KINS)
MEXICO	
ZORRILLA, Sergio H.	Central Laguna Verde
ROMANIA	
SIMIONOV, Vasile	Cernavoda NPP
RUSSIAN FEDERATION	
GLASUNOV, Vadim	Russian Research Institute for Nuclear Power Plant Operation (VNIIAES)
SLOVENIA	
BREZNIK, Borut	Krsko NPP

Working Group on Data Analysis (WGDA) (*continued*)

SPAIN	
Miguel Angel de la Rubia Rodiz	CSN
SWEDEN	
HENNIGOR, Staffan SOLSTRAND, Christer SVEDBERG, Torgny	Forsmarks Kraftgrupp AB OKG AB Ringhals AB
UNITED STATES OF AMERICA	
HAGEMEYER, Derek LEWIS, Doris MILLER, David W. HARRIS, Willie	Oak Ridge Associated Universities (ORAU) US Nuclear Regulatory Commission D.C. Cook Plant (NATC) Exelon

WGDA Task Team on Decommissioning

Chair: KAULARD, Jorg (Germany)	
ARMENIA	
AVETISYAN, Aida	Armenian Nuclear Regulatory Authority (ANRA)
FRANCE	
CROUAIL, Pascal	CEPN (ETC)
GERMANY	
JURETZKA, Peter KAULARD, Jorg	Stade NPP Gesellschaft für Anlagen-und Reaktorsicherheit mbH
JAPAN	
HAYASHIDA, Yoshihisa MIZUMACHI, Wataru	Japan Nuclear Energy Safety Organization (ATC) Japan Nuclear Energy Safety Organization (ATC)
MEXICO	
ZORRILLA, Sergio H.	Central Laguna Verde
ROMANIA	
SIMIONOV, Vasile	Cernavoda NPP
SPAIN	
ORTIZ RAMIS, Maria Teresa	ENRESA
SWEDEN	
LINDVALL, Carl Göran LORENTZ, Hakan	Barsebäck Kraft AB Barsebäck Kraft AB
UNITED STATES OF AMERICA	
MILLER, David W.	D.C. Cook Plant (NATC)

ANNEX 6: ISOE MANAGEMENT BOARD AND NATIONAL CO-ORDINATORS (2010-2011)[10]

ARMENIA	
PYUSKYULYAN Konstantin	Armenian Nuclear Power Plant Company
AVETISYAN, Aida	Armenian Nuclear Regulatory Authority
BELGIUM	
NGUYEN Thanh Trung	Electrabel (Tihange NPP)
SCHRAYEN, Virginie	Federal Agency for Nuclear Control (FANC)
BRAZIL	
do AMARAL, Marcos Antônio	Angra NPP
BULGARIA	
NIKOLOV, Atanas	Kozloduy NPP
KATZARSKA, Lidia	Bulgarian Nuclear Regulatory Agency
CANADA	
MILLER David E.	Bruce Power
McQUEEN, Maureen	Bruce Power
DJEFFAL, Salah	Canadian Nuclear Safety Commission
GAGNON, Jean-Yves	Centrale Nucléaire Gentilly-2
VILLEMAIRE, Mike	Pickering NPP
ALLEN, Scott	Bruce Power
CHINA	
YANG Duanjie	Nuclear and Radiation Safety Center (NSC)
LI, Ruirong	Daya Bay NPS
ZHANG, Jintao	China National Nuclear Corporation
CZECH REPUBLIC	
KOC, Josef	Temelin NPP
FARNIKOVA, Monika	Temelin NPP
URBANCIK, Libor	State Office for Nuclear Safety (SUJB)
KULICH, Vladimir	Dukovany NPP
FINLAND	
KONTIO, Timo	Fortum, Loviisa NPP
RIIHILUOMA, Veli	Centre for Radiation and Nuclear Safety (STUK)
KUKKONEN, Kari	TVO, Olkiluoto NPP
VILKAMO, Olli	Centre for Radiation and Nuclear Safety (STUK)

FRANCE	
ABELA, Gonzague	EDF
CORDIER, Gerard	EDF
COUASNON, Olivier	ASN
CHEVALIER, Sophie	ASN
GUZMAN LOPEZ-OCON, Olvido	ASN

10. ISOE National Co-ordinators identified in **bold**.

GERMANY	
JENTJENS, Lena BASCHNAGEL, Michael FRASCH, Gerhard KAULARD, Jörg STRUB, Erik	VGB PowerTech e.V. RWE Power AG, Kraftwerk Biblis Bundesamt für Strahlenschutz Gesellschaft für Anlagen-und Reaktorsicherheit mbH (GRS) Gesellschaft füer Anlagen-und Reaktorsicherheit mbH (GRS)
HUNGARY	
BUJTAS, Tibor	PAKS NPP
ITALY	
MANCINI, Francesco	SOGIN Spa
JAPAN	
HAYASHIDA, Yoshihisa **KOBAYASHI, Masahide** MIZUMACHI, Wataru SUZUKI, Akira TSUJI, Masatoshi YONEMARU, Kenichi KANEOKA, Tadashi	Japan Nuclear Energy Safety Organization (ATC) Japan Nuclear Energy Safety Organization (ATC) Japan Nuclear Energy Safety Organization (ATC) Tokyo Electric Power Company Nuclear and Industrial Safety Agency (NISA) Kyushu Electric Power Company The Chugoku Electric Power Co., Inc.
KOREA (REPUBLIC OF)	
KIM Byeong-Soo CHOI, Won-Chul AN, Yong Min LEE, Hee-hwan NA, Seong Ho	Korea Institute of Nuclear Safety (KINS) Korea Institute of Nuclear Safety (KINS) Korea Hydro and Nuclear Power. Co. Ltd Korea Hydro and Nuclear Power. Co. Ltd Korea Institute of Nuclear Safety (KINS)
LITHUANIA	
TUMOSIENE Kristina PLETNIOV, Victor BALCYTIS, Gintautas	State Nuclear Power Safety Inspectorate (VATESI) Ignalina NPP Radiation Protection Centre
MEXICO	
ARMENTA Socorro MEDRANO, Marco	Central Laguna Verde National Nuclear Research Institute
THE NETHERLANDS	
MEIJER, Hans BREAS, Gerard	Borssele NPP Ministry For Environment
PAKISTAN	
NASIM, Bushra **MUBBASHER, Makshoof**	Pakistan Nuclear Regulatory Authority Chashma NPP (Unit1)
ROMANIA	
SIMIONOV, Vasile RODNA, Alexandru VELICU, Oana	Cernavoda NPP National Commission for Nuclear Activities Control National Commission for Nuclear Activities Control
RUSSIAN FEDERATION	
BEZRUKOV, Boris GLASUNOV, Vadim	Energoatom Concern OJSC Russian Research Institute for Nuclear Power Plant Operation (VNIIAES)
SLOVAK REPUBLIC	
DOBIS, Lubomir VIKTORY, Dusan	Bohunice NPP Public Health Institute of the Slovak Republic
SLOVENIA	

BREZNIK, Borut JANZEKOVIC, Helena JUG, Nina CERNILOGAR RADEZ, Milena	Krsko NPP Slovenian Nuclear Safety Administration Slovenian Radiation Protection Administration Slovenian Nuclear Safety Administration
SOUTH AFRICA (REPUBLIC OF)	
MAREE, Marc	Koeberg NPS
SPAIN	
HERRERA Borja Rosell LABARTA, Teresa ROSALES CALVO, Maria Luisa DE LA RUBIA, Miguel Angel	Almaraz NPP Consejo de Seguridad Nuclear Consejo de Seguridad Nuclear Consejo de Seguridad Nuclear
SWEDEN	
SVEDBERG, Torgny FRITIOFF, Karin LINDVALL, Carl Göran SOLSTRAND, Christer HENNIGOR, Staffan	Ringhals NPP Swedish Radiation Safety Authority Barsebäck NPP Oskarsham NPP Forsmark NPP
SWITZERLAND	
TAYLOR Thomas JAHN, Swen-Gunnar	Muhleberg NPP ENSI
UKRAINE	
BEREZHNAYA Tatiana RYAZANTSEV, Viktor	ENERGOATOM SNRCU
UNITED KINGDOM	
RENN, Guy ZODIATES, Anastasios	Sizewell B Power Station British Energy
UNITED STATES OF AMERICA	
MILLER, David GREEN, Bill LEWIS, Doris BROCK, Terry HARRIS, Willie DALY, Patrick JONES, Patricia OHR, Kenneth HUNSICKER, John	D.C. Cook Plant (NATC) Clinton Power Station US Nuclear Regulatory Commission US Nuclear Regulatory Commission Exelon – Corporate Exelon – Braidwood Constellation Energy – Calvert Cliffs Exelon – Quad Cities Station South Carolina Electric – V.C. Summer