Occupational Exposures at Nuclear Power Plants

Twenty-first Annual Report of the ISOE Programme, 2011

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Radiological Protection

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NUCLEAR ENERGY AGENCY

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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 worldwide, 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 worldwide 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 Twenty-First Annual Report of the ISOE Programme (2011) presents the status of the ISOE programme for the year of 2011.

"... 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).

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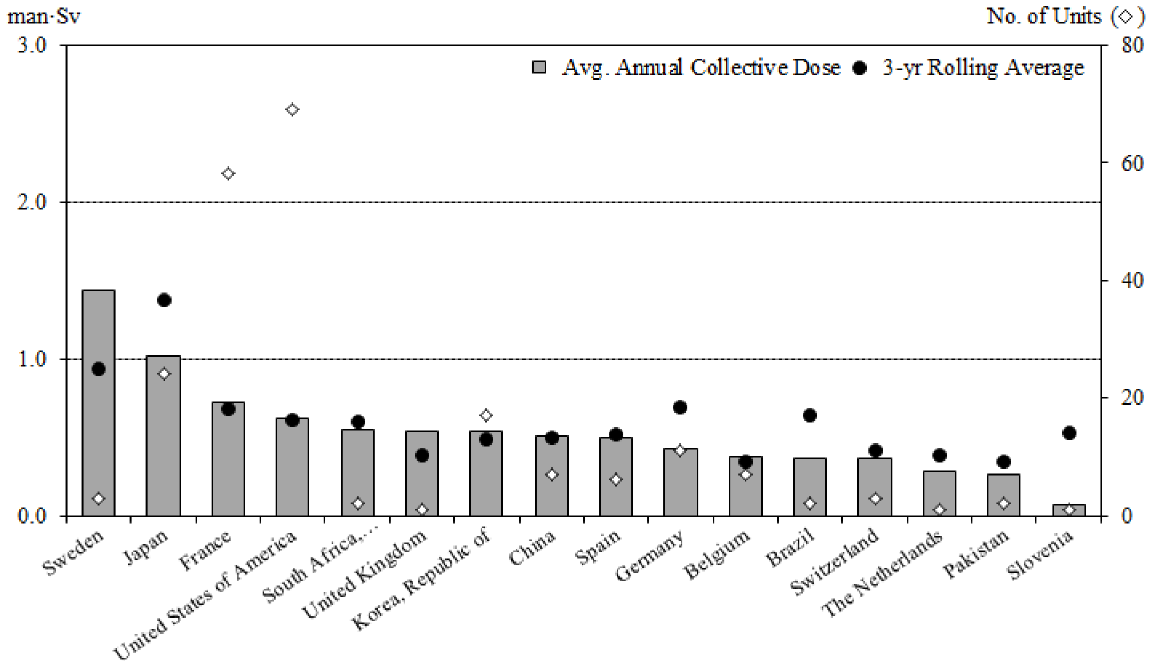

man·Sv
No. of Units (◇)
Avg. Annual Collective Dose
3-yr Rolling Average
3.0
2.0
1.0
0.0
80
60
40
20
0
Sweden
Japan
France
United States of America
South Africa,…
United Kingdom
Korea, Republic of
China
Spain
Germany
Belgium
Brazil
Switzerland
The Netherlands
Pakistan
Slovenia

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 worldwide 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 21st Annual Report of the ISOE Programme (2011) presents the status of the ISOE programme for the calendar year 2011.

ISOE is jointly sponsored by the OECD/NEA and IAEA, and its membership is open to nuclear electricity utilities and radiation protection regulatory authorities worldwide 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 2011, the ISOE programme included 67 Participating Utilities in 29 countries (317 operating units; 48 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 393 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 2011 average annual collective doses per reactor and 3-year rolling averages per reactor (2009-2011) were:

	2011 average annual collective dose (man·Sv/reactor)	**3-year rolling average for 2009-2011 (man·Sv/reactor)**
Pressurised water reactors (PWR)	0.65	0.69
Pressurised water reactors (VVER)	0.51	0.54
Boiling water reactors (BWR)	1.18	1.30
Pressurised heavy water reactors (PHWR/CANDU)	1.18	1.44
All reactors, including gas cooled (GCR) and light water graphite reactors (LWGR)	0.76	0.82

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 2011 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 Section 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 2011, 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 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 technical centres continued to host regional symposia, which in 2011 included the ISOE North American Regional ALARA Symposium in Fort Lauderdale, USA, organised by the North American Technical Centre in co-operation with EPRI. This symposium provides 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 Section 5 of this report. Details of ISOE participation and the programme of work for 2012 are provided in the 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 worldwide 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; and
- 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 2011, the ISOE programme included: 67 Participating Utilities[1] in 29 countries, covering 315 operating units & 48 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 2011. 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 477 reactor units in 30 countries (393 operating; 84 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 2011)**

Note: The list of the Official ISOE Participants at the time of the publication of this report is provided in Annex 3.

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	7	–	–	–	–	–	7
Czech Republic	-	6	–	–	–	–	6
Finland	-	2	2	–	–	–	4
France	58	–	–	–	–	–	58
Germany	11	–	6	–	–	–	17
Hungary	–	4	–	–	–	–	4
Japan	24	–	26	–	–	–	50
Korea, Republic of	17	–	–	4	–	–	21
Mexico	–	–	2	–	–	–	2
The Netherlands	1	–	–	–	–	–	1
Romania	–	–	–	2	–	–	2
Russian Federation	–	16	–	–	–	–	16
Slovak Republic	–	4	–	–	–	–	4
Slovenia	1	–	–	–	–	–	1
South Africa, Rep. of	2	–	–	–	–	–	2
Spain	6	–	2	–	–	–	8
Sweden	3	–	7	–	–	–	10
Switzerland	3	–	2	–	–	–	5
Ukraine	–	15	–	–	–	–	15
United Kingdom	1	–	–	–	–	–	1
United States	27	–	22	–	–	–	49
Total	**170**	**50**	**69**	**28**	**–**	–	**317**

Operating reactors: Not participating in ISOE, but included in the ISOE database

Country	PWR/VVER	BWR	PHWR	GCR	LWGR	Total
Pakistan	2	–	1	–	–	3
United Kingdom	–	–	–	18	–	18
United States	42	13	–	–	–	55
Total	**44**	**13**	**1**	**18**	–	**76**

Total number of operating reactors included in the ISOE database

	PWR/VVER	BWR	PHWR	GCR	LWGR	Total
Total	**264**	**82**	**29**	**18**	–	**393**

Table 1. **The Official ISOE Participants and the ISOE Database (as of December 2011) (Cont'd)**

Definitively shutdown reactors: ISOE Participants							
Country	**PWR/ VVER**	**BWR**	**PHWR**	**GCR**	**LWGR**	**Other**	**Total**
Bulgaria	4	–	–	–	–	–	4
Canada	–	–	2	–	–	–	2
France	1	–	–	6	–	–	7
Germany	3	1	–	1	–	–	5
Italy	1	2	–	1	–	–	4
Japan	–	6	–	1	–	1	8
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**	**13**	**2**	**11**	**5**	**1**	**48**
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**	**18**	**2**	**34**	**5**	**1**	**84**

Total number of reactors included in the ISOE database							
	PWR/ VVER	**BWR**	**PHWR**	**GCR**	**LWGR**	**Other**	**Total**
Total	**288**	**100**	**31**	**52**	**5**	**1**	**477**

Number of **Participating Countries**	**29**
Number of **Participating Utilities**[2]	**67**
Number of **Participating Authorities**[3]	**27**

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

3. 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 worldwide 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, shut down 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 3-year rolling average collective dose per reactor, by reactor type, for 1992-2011. In general, the average collective dose per operating reactor unit has consistently decreased over the time period covered in the ISOE database, with the 2011 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 in the 1996-1998 time period.

With respect to 2011, 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 3-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 2011, supplemented by the individual country reports (Section 5) as required. Figures 3 to 7 provide a detailed breakdown of the 2011 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, 1992-2011 (man·Sv/reactor)**

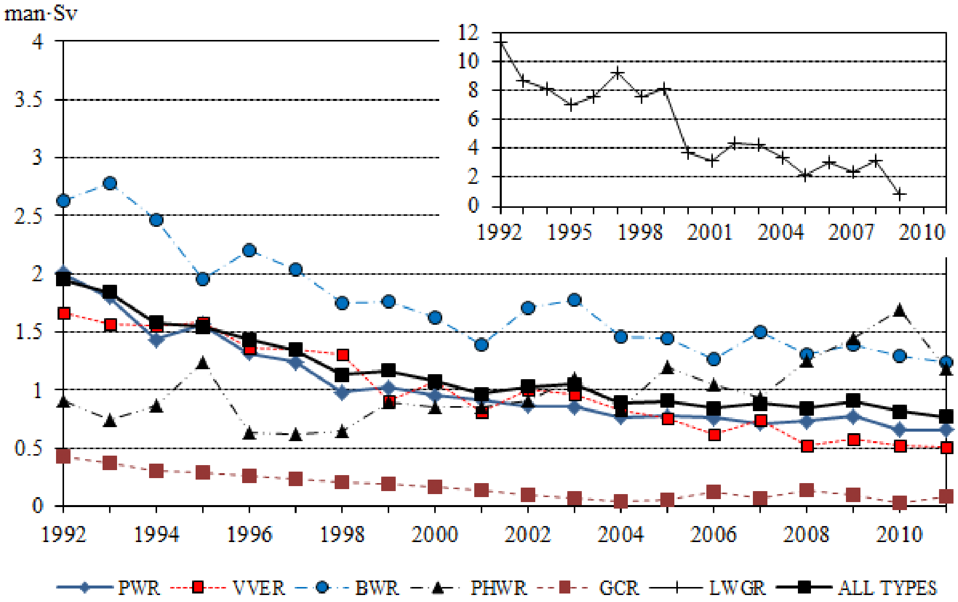


Figure 2. **3-year rolling average per reactor for all operating reactors included in ISOE by reactor type, 1992-2011 (man·Sv/reactor)**

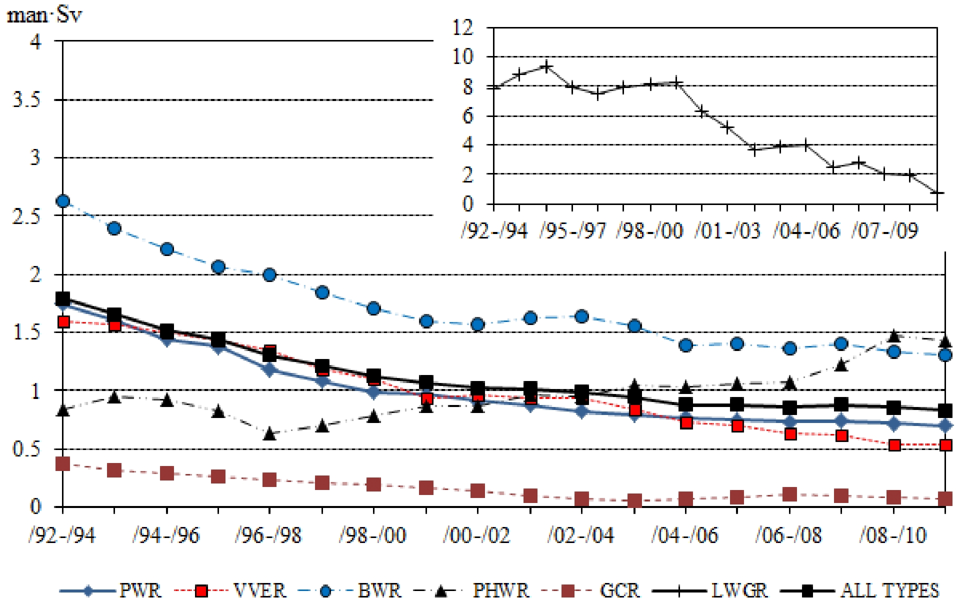


Table 2. **Summary of average collective doses for operating reactors, 2011**

	2011 average annual collective dose (man·Sv/reactor)	3-year rolling average for 2008-2011 (man·Sv/reactor)
Pressurised water reactors (PWR)	0.65	0.69
Pressurised water reactors (VVER)	0.51	0.54
Boiling water reactors (BWR)	1.18	1.30
Pressurised heavy water reactors (PHWR/CANDU)	1.18	1.44
All reactors, including gas cooled (GCR) and light water graphite reactors (LWGR)	0.76	0.82

Table 3. **Average annual collective dose per reactor, by country and reactor type, 2009-2011 (man·Sv/reactor)**

	PWR			VVER			BWR		
	2009	2010	2011	2009	2010	2011	2009	2010	2011
Armenia				0.55	0.77	1.25			
Belgium	0.36	0.30	0.37						
Brazil	1.04	0.50	0.37						
Bulgaria				0.28	0.43	0.27			
Canada									
China	0.54	0.44	0.51						
Czech Republic				0.15	0.12	0.12			
Finland				0.38	0.81	0.36	0.59	0.45	0.48
France	0.70	0.62	0.72						
Germany	1.05	0.61	0.43				1.01	0.88	0.58
Hungary				0.44	0.37	0.59			
Japan	1.61	1.51	0.96				1.32	1.23	1.05
Korea, Republic of	0.47	0.45	0.54						
Mexico							2.08	5.01	0.83
The Netherlands	0.24	0.62	0.28						
Pakistan	0.23	0.61	0.26						
Romania									
Russian Federation				0.80	0.65	0.66			
Slovak Republic				0.21	0.17	0.14			
Slovenia	0.65	0.85	0.07						
South Africa, Rep. of	0.74	0.52	0.55						
Spain	0.72	0.33	0.50				2.31	0.52	2.05
Sweden	0.92	0.46	1.43				1.41	0.93	1.07
Switzerland	0.36	0.53	0.36				1.14	1.25	1.07
Ukraine				0.72	0.66	0.59			
United Kingdom	0.34	0.27	0.54						
United States	0.66	0.55	0.61				1.49	1.35	1.42
Average	**0.77**	**0.66**	**0.65**	**0.57**	**0.53**	**0.51**	**1.39**	**1.29**	**1.18**

Note: Data provided directly from country report, rather than calculated from the ISOE database: UK (2009, 2010, 2011: GCR).
BWR dose in 2009 includes Hamaoka 1 and 2 which have been decommissioning since Nov. 18, 2009.
BWR dose in 2010 and in 2011 for Japan does not include Fukushima Daiichi Units 1-6.

Table 3. **Average annual collective dose per reactor, by country and reactor type, 2009-2011 (man·Sv/reactor) (Cont'd)**

	PHWR			**GCR**			**LWGR**		
	2009	**2010**	**2011**	**2009**	**2010**	**2011**	**2009**	**2010**	**2011**
Canada	1.39	1.69	1.27						
Korea, Republic of	2.21	2.18	0.52						
Lithuania							0.79		
Pakistan	1.86	2.47	4.01						
Romania	0.24	0.39	0.20						
United Kingdom				0.09	0.03	0.08			
Average	**1.45**	**1.70**	**1.18**	**0.09**	**0.03**	**0.08**	**0.79**		

	2009	**2010**	**2011**
Global Average	**0.90**	**0.82**	**0.75**

	Europe			**Asia**			**North America**			**IAEA**		
	2009	**2010**	**2011**	**2009**	**2010**	**2011**	**2009**	**2010**	**2011**	**2009**	**2010**	**2011**
PWR	0.70	0.56	0.65	1.15	1.08	0.79	0.66	0.55	0.61	0.65	0.52	0.43
VVER	0.27	0.28	0.27							0.72	0.64	0.62
BWR	1.26	0.86	0.96	1.32	1.23	1.05	1.52	1.55	1.39			
PHWR				2.21	2.18	0.52	1.39	1.69	1.27	0.78	1.08	1.47
GCR	0.09	0.03	0.08									
LWGR										0.79		

Note: All Lithuanian reactors were shutdown in 2010

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

Table 4. **3-year rolling average annual collective dose per reactor, by country and reactor type, 2007-2009 to 2009-2011 (man·Sv/reactor)**

	PWR			VVER			BWR		
	/07-/09	**/08-/10**	**/09-/11**	**/07-/09**	**/08-/10**	**/09-/11**	**/07-/09**	**/08-/10**	**/09-/11**
Armenia				0.86	0.86	0.86			
Belgium	0.34	0.35	0.34						
Brazil	0.94	0.76	0.64						
Bulgaria				0.32	0.32	0.33			
Canada									
China	0.58	0.51	0.50						
Czech Republic				0.15	0.13	0.13			
Finland				0.50	0.65	0.51	0.55	0.50	0.51
France	0.66	0.66	0.68						
Germany	0.90	0.76	0.69				1.06	1.03	0.82
Hungary				0.41	0.38	0.47			
Japan	1.53	1.59	1.38				1.40	1.33	1.21
Korea, Republic of	0.52	0.47	0.48						
Mexico							3.17	3.93	2.64
The Netherlands	0.25	0.38	0.38						
Pakistan	0.44	0.48	0.34						
Romania									
Russian Federation				0.80	0.71	0.70			
Slovak Republic				0.22	0.18	0.17			
Slovenia	0.56	0.55	0.52						
South Africa, Rep. of	0.74	0.67	0.60						
Spain	0.50	0.45	0.52				2.32	1.11	1.63
Sweden	0.63	0.65	0.94				1.12	1.06	1.14
Switzerland	0.40	0.45	0.42				1.13	1.18	1.16
Ukraine				0.85	0.68	0.66			
United Kingdom	0.22	0.29	0.38						
United States	0.66	0.63	0.61				1.42	1.36	1.42
Average	0.74	0.72	0.69	0.62	0.54	0.54	1.40	1.33	1.30

	PHWR			GCR			LWGR		
	/07-/09	**/08-/10**	**/09-/11**	**/07-/09**	**/08-/10**	**/09-/11**	**/07-/09**	**/08-/10**	**/09-/11**
Canada	1.23	1.49	1.44						
Korea, Republic of	1.20	1.66	1.63						
Lithuania							2.09	1.94	0.79
Pakistan	2.63	2.68	2.78						
Romania	0.29	0.33	0.33						
United Kingdom				0.10	0.09	0.07			
Average	1.22	1.47	1.44	0.10	0.09	0.07	2.09	1.94	0.79

	/07-/09	**/08-/10**	**/09-/11**
Global Average	**0.88**	**0.85**	**0.82**

	Europe			Asia			North America			IAEA		
	/07-/09	**/08-/10**	**/09-/11**	**/07-/09**	**/08-/10**	**/09-/11**	**/07-/09**	**/08-/10**	**/09-/11**	**/07-/09**	**/08-/10**	**/09-/11**
PWR	0.64	0.62	0.64	1.11	1.13	1.01	0.66	0.63	0.61	0.66	0.58	0.52
VVER	0.28	0.27	0.27							0.79	0.68	0.66
BWR	1.17	1.01	1.03	1.40	1.33	1.24	1.51	1.49	1.48			
PHWR				1.20	1.66	1.63	1.23	1.49	1.44	1.17	1.11	1.11
GCR	0.10	0.09	0.07									
LWGR										2.09	1.94	0.79

Note: calculated from the ISOE database, supplemented by data provided directly by country (See Notes, Table 3).

The following discussion provides a brief overview of the results and trends observed in ISOE European and Asian regions[1]. 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 Section 5.

European Region

Average annual collective dose per reactor (Table 3)

Regarding PWR reactors, the average annual collective dose per reactor increased slightly in 2011 compared to 2010, with respective values of 0.65 man·Sv and 0.56 man·Sv. An increase in Belgium, France, Spain, Sweden and United Kingdom as well as a decrease in Germany, Switzerland and The Netherlands can be noticed. The combination of these changes results in a global increase.

The average annual collective dose per reactor of VVERs remains the same in 2011 compared to 2010, with respective values of 0.27 man·Sv per reactor and 0.28 man·Sv per reactor.

Regarding BWRs, the average collective dose has increase compared to 2010, with a value of 0.96 man·Sv in 2011 compared to 0.86 man·Sv in 2010.

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

The evolution of the 3-year rolling average annual collective dose, which provides a better representation of the general trend in dose, shows a stability of the averages for PWRs and VVERs and, a constant value in 2009-2011 for BWRs compared to 2008-2010 value.

Regarding VVERs, the Czech Republic presents the lowest 3-year rolling average annual collective dose per reactor in 2009-2011 with 0.13 man·Sv per reactor, followed by the Slovak Republic (0.17 man·Sv per reactor), Hungary (0.47 man·Sv per reactor) and Finland (0.51 man·Sv per reactor).

For European PWRs, the data per country show that with respect to the 3-year rolling average annual collective dose for 2009 - 2011, five main groups can be distinguished:

- Belgium: around 0.3 man·Sv per reactor,
- Switzerland, The Netherlands, United Kingdom: around 0.4 man·Sv per reactor,
- Spain: around 0.5 man·Sv per reactor,
- France, Germany: around 0.7 man·Sv per reactor,
- Sweden: above 0.7 man·Sv per reactor.

Concerning the 3-year rolling average annual collective dose per reactor for BWRs in Europe, Finland is presenting the lowest value with 0.51 man·Sv per reactor, followed by Germany with 0.82 man·Sv per reactor, Sweden and Switzerland around 1.15 man·Sv per reactor and finally Spain with 1.63 man·Sv per reactor.

[1] For ISOE North-American and IAEA regions, see data available in country reports.

<u>Main events influencing the collective dose</u>

The country reports (in chapter 5) provide information from each participating countries on the main events which influenced the collective dose in 2011. For the European countries, the main points are the following:

- Czech Republic: foreign material exclusion event during Temelin 2 reactor internals dismantling. Dose increased by 40 mSv.
- France: additional works during forced outage at Tricastin 1 and penetrant testing of all fuel assemblies at Nogent 2.
- Spain: power upgrade at Almaraz 1 and 2 to 110% of the original. At Cofrentes, there was a source-term increase in recirculation systems and reactor clean-up system placed in the drywell and a dose rate increase in refuelling floor during vessel closing.
- Sweden: at Ringhals 2, Cleaning activities after a fire in containment during CAT (Containment Air Test, ILRT = Integrated Leak Rate Test). Total dose for cleaning was 1663 man.mSv. At Oskarshamn 3: internals, that were replaced in 2009, were cut into smaller peaces and put into waste packages for final storage with a total collective dose of 296 man.mSv

Asian Region

In Asian region, the average annual collective dose per reactor was lower than the previous year for all reactor type except PWR in Republic of Korea.

The exposure data in FY 2011 for Fukushima Dai-ichi (6 BWRs) and Fukushima Dai-ni (4 BWRs) nuclear power stations are not included in the ISOE database at present due to the influence of nuclear accident caused by the earthquake and tsunami from The Tohoku District - off the Pacific Ocean Earthquake occurred on March 11, 2011. The average annual collective dose per reactor for Japanese BWR in FY 2011 was 1.05 man·Sv, which was lower than the previous year (1.13 man·Sv) excluding Fukushima Dai-ichi and Fukushima Dai-ni NPS. In the past several years, exposure of BWR in Japan is continuing reduction.

The average collective dose for Japanese PWR, 0.96 man·Sv, decreased greatly from 1.51 man·Sv in FY 2010 and changed to the downward tendency from the upward tendency by the FY 2009. Main event influencing the exposure for PWR is the work for seismic margin improvement of high temperature piping support.

The average annual collective dose per reactor for PWRs in Republic of Korea was 0.54 man·Sv, which was higher by 0.09 man·Sv than the previous year, but it remains in low exposure level.

Regarding PHWRs in Republic of Korea, the average annual collective dose in 2011 decreased from 2.18 man·Sv greatly to 0.52 man·Sv compared with the previous year and returned to the level by 2008. Exposure in 2009 and 2010 were large due to the refurbishment of Wolsung Unit 1 including the replacement of the pressure tubes and calandria tubes.

IAEA Region

Average annual collective dose per reactor (Table 3)

Regarding PWR reactors, the average annual collective dose per reactor decreased slightly within the period of 2009 to 2011, with respective values of 0.65 man·Sv in 2009, 0.52 man·Sv in 2010 and 0.43 man·Sv in 2011.

The average annual collective dose per reactor of VVERs remains the same in 2011 compared to 2010, with respective values of 0.64 man·Sv per reactor and 0.62 man·Sv per reactor.

Regarding PHWRs, the average collective dose has increased compared to 2010, with a value of 1.47 man·Sv in 2011 compared to 1.08 man·Sv in 2010.

As for LWGR reactors, after the shutdown of this type of reactors in Lithuanian, there is no data for the operation of such reactors in 2011.

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

For PWRs, the 3-year rolling average annual collective dose in 2009-2011 is 0.52 man·Sv lower than the value of 0.58 man·Sv in 2008-2010.

Regarding VVER, the value remains almost the same in 2009-2011 and 2008-2010: 0.68 man·Sv and 0.66 man·Sv. As for PHWR, there is no change for the values for the two periods. After the shutdown of LWGR in Lithuania in 2010, the value for 2009-2011 (0.79 man·Sv) became lower than the valve for 2008-2010 (1.94 man·Sv).

Regarding PWRs in non-OECD countries, Pakistan presents the lowest 3-year rolling average annual collective dose per reactor in 2009-2011 with 0.34 man·Sv per reactor, followed by the China (0.50 man·Sv per reactor), Slovenia (0.52 man·Sv per reactor) and the Republic of South Africa (0.60 man·Sv per reactor).

Bulgaria presents the lowest 3-year rolling average annual collective dose per reactor in 2009-2011 with 0.33 man·Sv per reactor in non-OECD countries.

Concerning the 3-year rolling average annual collective dose per reactor for BWRs in Europe, Finland is presenting the lowest value with 0.51 man·Sv per reactor, followed by Germany with 0.82 man·Sv per reactor, Sweden and Switzerland around 1.15 man·Sv per reactor and finally Spain with 1.63 man·Sv per reactor.

For PWRs, from Table 3 and Table 4, it can be seen that countries in IAEA Technical Centre have a performance similar that of the other ISOE regions. For PHWR, the indicator is better in IAEA Technical Centre than in other regions.

Regarding VVER, the exposure level in non-OECD countries is higher than that of in European region that may be due to the difference of the generation for this type of reactors.

Figure 3. **2011 PWR average collective dose per reactor by country (man·Sv/reactor)**

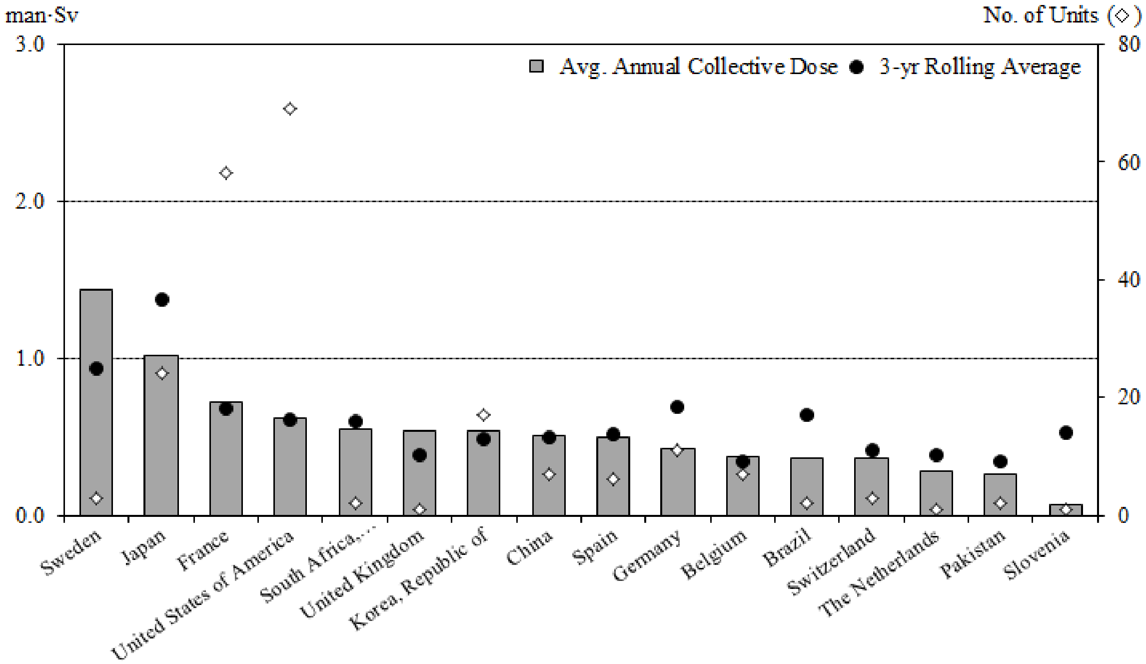


Figure 4. **2011 VVER average collective dose per reactor by country (man·Sv/reactor)**

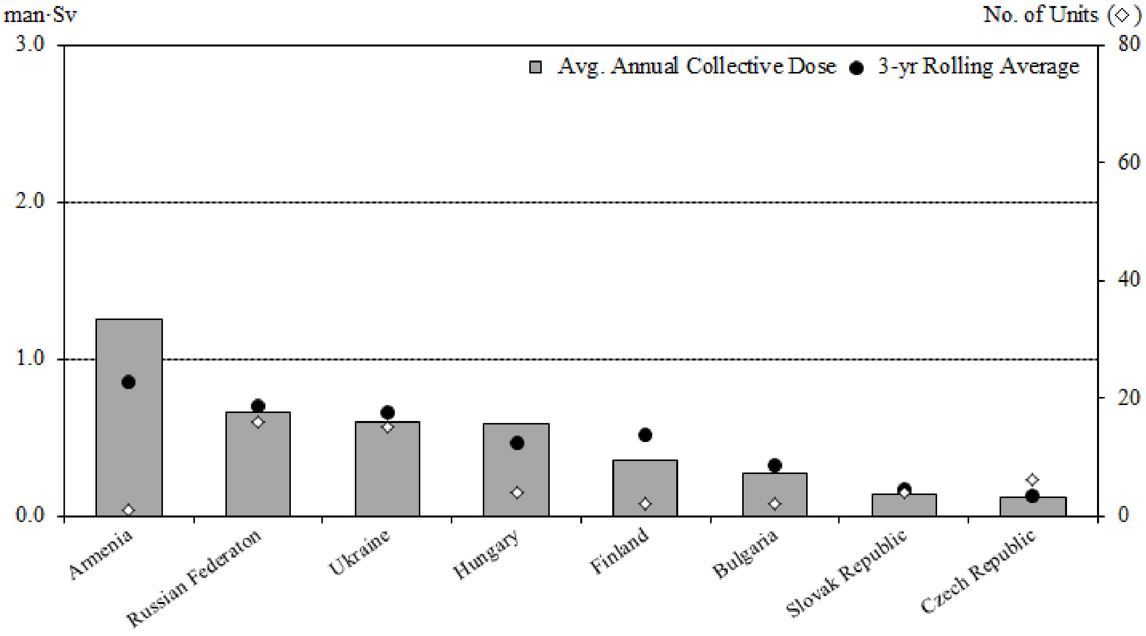


Figure 5. **2011 BWR average collective dose per reactor by country (man·Sv/reactor)**

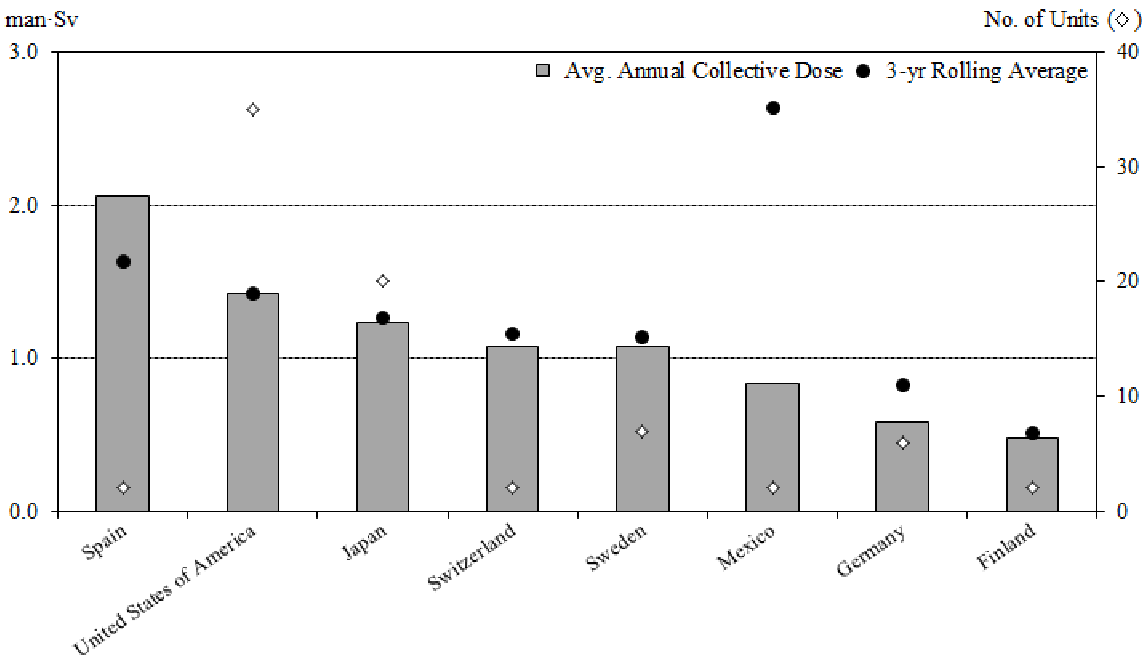


Figure 6. **2011 PHWR average collective dose per reactor by country (man·Sv/reactor)**

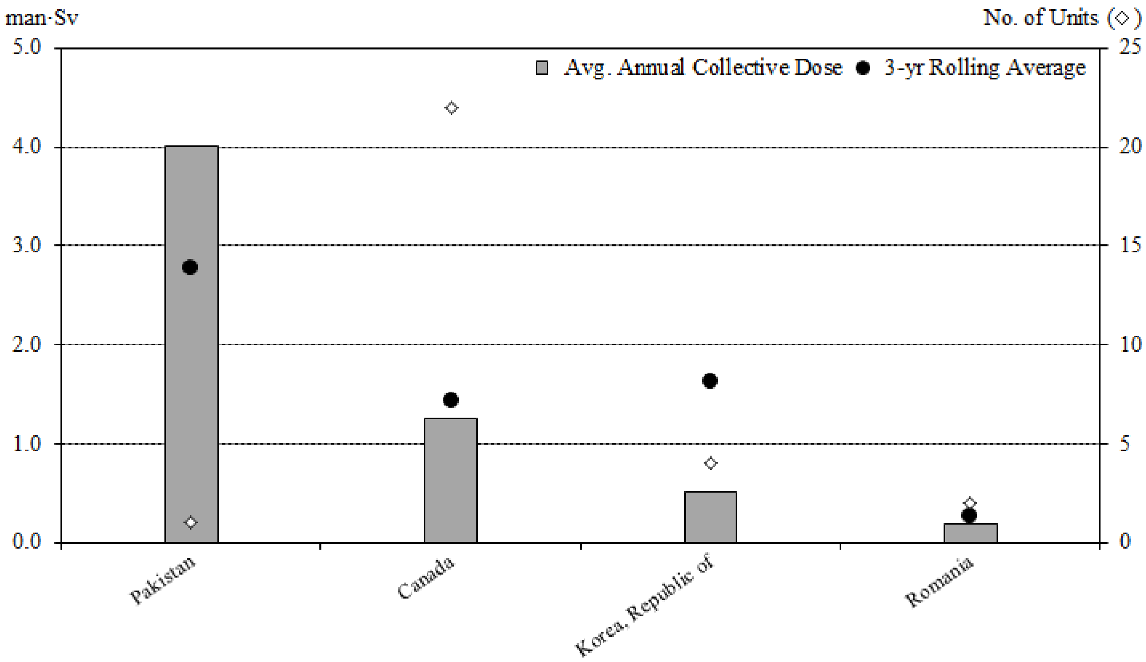
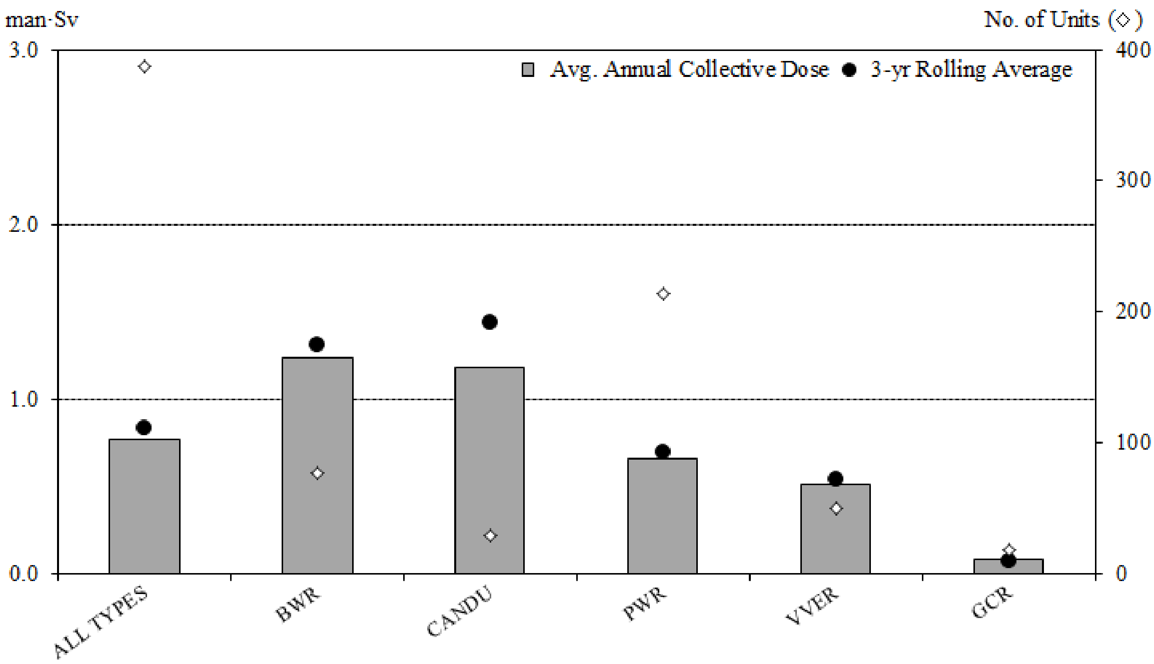


Figure 7. **2011 average collective dose per reactor by reactor type (man·Sv/reactor)**



2.2 Occupational exposure trends: Definitely shutdown reactors

In addition to information from operating reactors, the ISOE database contains dose data from 84 reactors which are shut-down or in some stage of decommissioning. This section provides a summary of the dose trends for those reactors reported during the 2009-2011 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 2011 aimed at improving data collection for shut-down 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 2009-2011, based on data recorded in the ISOE database, supplemented by the individual country reports (Section 5) as required. Figures 8-11 present the average collective dose per reactor for shutdown reactors for 1992-2011 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, 2009-2011 (man·mSv/reactor)**

		2009		2010		2011	
		No.	**Dose**	**No.**	**Dose**	**No.**	**Dose**
PWR	France	1	62.1	1	117.2	1	264.1
	Germany	5	128.0	2	388.4	3	126.3
	Italy	1	1.7	1	3.2	1	1.8
	Spain	1	244.0	1	53.0	1	190.0
	United States	8	1.5	8	2.0	6	49.4
VVER	Bulgaria	4	29.4	4	11.3	4	9.2
	Germany	5	20.0	n/a	n/a	n/a	n/a
	Russian Federation	2	84.0	2	77.6	2	66.3
	Slovak Republic	2	106.0	2	12.4	2	10.1
BWR	Germany	3	138.0	1	427.1	1	289.5
	Italy	2	6.18	2	60.3	2	15.1
	Japan			2	123.8	2	96.9
	The Netherlands	1	0.6	n/a	n/a	1	10.0
	Sweden	2	27.0	2	6.2	2	27.2
	United States	4	4.8	5	21.6	5	24.5
GCR	France	6	8.8	6	1.3	6	2.4
	Germany	2	17.0	n/a	n/a	n/a	n/a
	Italy	1	0	1	1.7	1	10.4
	Japan	1	20.0	1	50.0	1	50.0
	United Kingdom	16	42.0	16	48.0	16	49.0
LWGR	Lithuania	1	144.7	2	236.2	2	304.8
LWCHWR	Japan	1	114.6	1	111.6	1	126.6

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

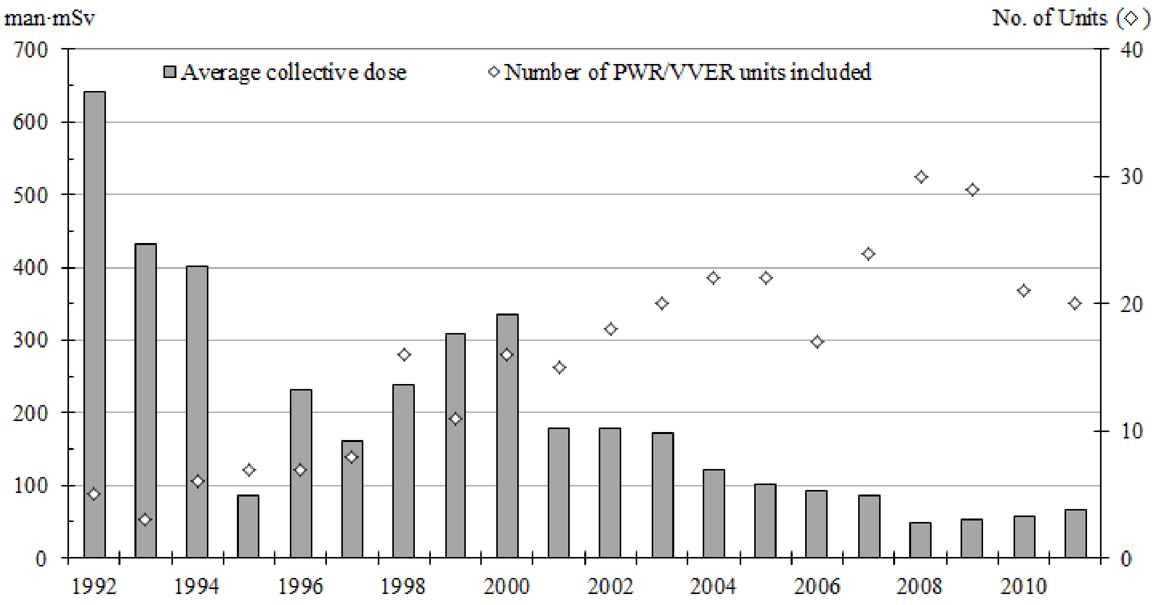


Figure 9. **Average collective dose per shutdown reactor: BWRs (man·mSv/reactor)**

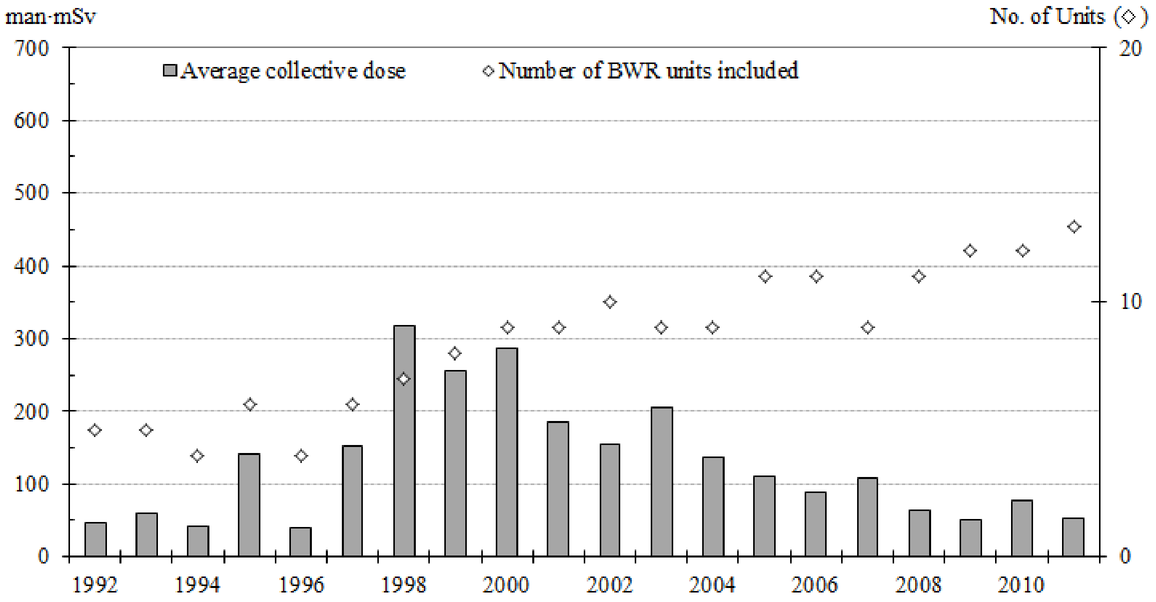


Figure 10. **Average collective dose per shutdown reactor: GCRs (man·mSv/reactor)**

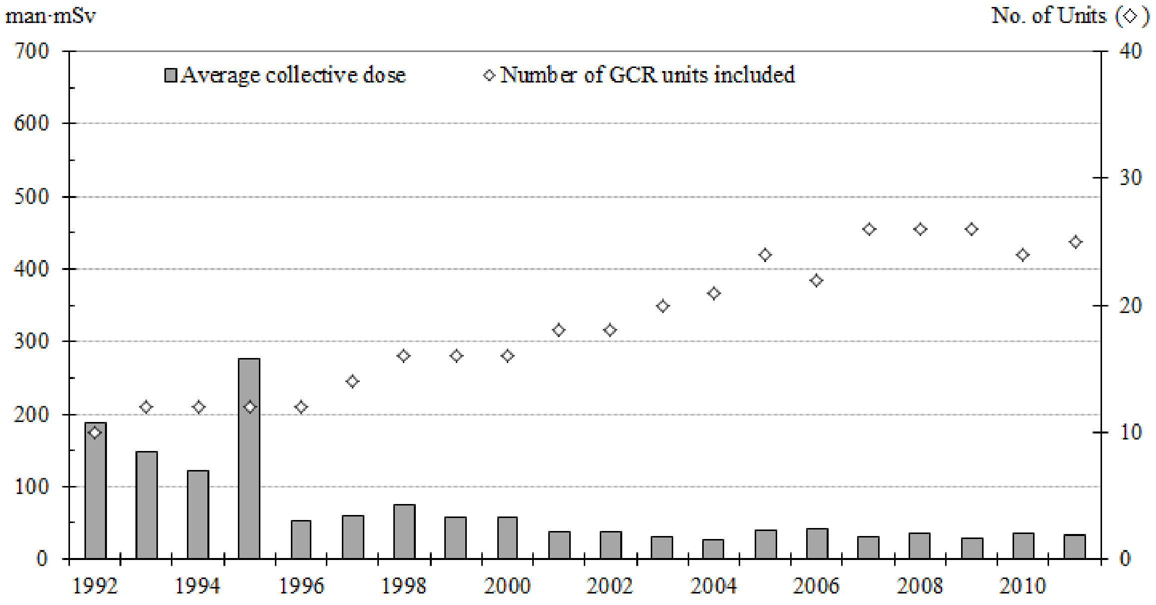
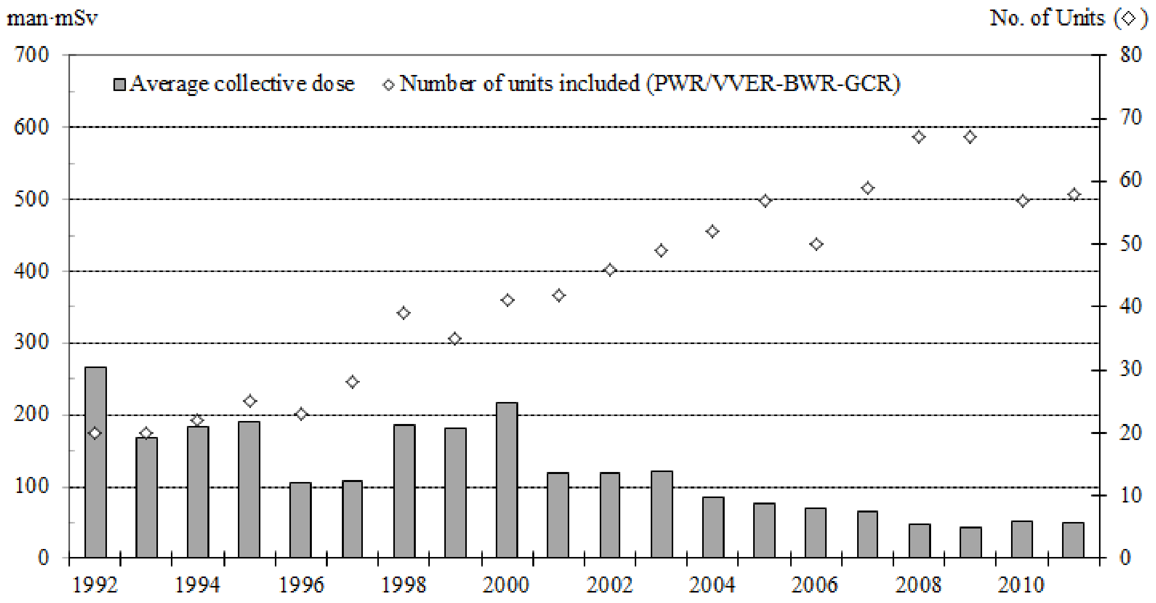


Figure 11. **Average collective dose per shutdown reactor: PWR/VVER, BWR, GCR (man·mSv/reactor)**



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 section provides information on the main information and experience exchange activities within ISOE during 2011.

3.1 ISOE ALARA Symposia

ISOE International ALARA Symposium

There was no ISOE International ALARA Symposium in 2011.

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

ISOE Regional ALARA Symposium

NATC, in co-operation with the Electric Power Research Institute (EPRI), organized and conducted the 2011 ISOE North American ALARA Symposium from 10-12 January 2011 in Fort Lauderdale, USA. Participation included 138 participants from 6 countries. Dresden nuclear station was presented with the World Class ALARA Performance Award. The following awards were noted:

- *Pickering A Unit 4 Boiler 6 – Hot Particle Recovery*, C. Glover (Pickering A NPP, Canada);
- *Lessons learned from an Airborne Alpha Contamination Event Requiring Implementation of In-Vitro Sampling*, A.P. Stevenson (Oconee NPP, USA).

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 online 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.

It has been decided to modify reactor statuses of the database. Only three statuses will be kept: two for operational reactors (pre-operational and operational) and one for shutdown reactors (decommissioning). For decommissioning reactors, four phases have been defined: cold shutdown, safe storage, decommissioning activities and site remediation.

In the ISOE 1 questionnaire, a new internal dose distribution table, similar to the external dose distribution table, has been implemented.

Since 2005, the database statistical analysis module, known as MADRAS, has been available on the 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;
- 3-year rolling average for collective dose per reactor;
- Dose rates; and
- 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 2011, twenty-one new analyses have been developed on MADRAS and a new function has been implemented in order to keep the preferred analyses in memory.

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 2011, the following types of documents were made available:

- Benchmarking reports,
- RP Experience reports,
- RP Management documents,
- Plant information related documents,
- RP Forum syntheses,
- Severe Accident Management documents.

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 2011, the following requests were posted on the network. For requests with more than five answers, a synthesis of all answers was prepared by ETC and made available on the RP Library.

All members:

Date	Country	Title
May 2011	France: EDF	Detection of leakage rate between primary and secondary loop

Utilities only:

Date	Country	Title
Jan. 2011	Sweden: Forsmark	Contamination control outdoors
Feb. 2011	Finland: Olkiluoto	Portable Contamination Monitor
Mar. 2011	Sweden: Ringhals	High Radiation Area
May 2011	France: EDF	Dosimetry associated with spent fuel removal
Jul. 2011	France: EDF	Setting an accurate annual collective dose objective
Aug. 2011	Sweden: Ringhals	SF building, scattered radiation from Core beam
Sep. 2011	USA: Watts Barr	Watts Barr Rad Work Permit Questions
Oct. 2011	France: EDF	Vibrating dosimeters
Oct. 2011	France: CEPN	Occupational exposure associated with effluent management
Dec. 2011	Romania: Cernavoda	EPDs / TLDs monthly readings discrepancies
Dec. 2011	Sweden: Ringhals	Registration and Decontamination assembly point

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 organized 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 2011 are summarized below.

Benchmarking visits organized by ETC

In 2011, a benchmarking visit to Exelon (USA) has been organized by ETC for the French Utility EDF, using ISOE contacts, but no ISOE/ETC resources. The report is available on the ISOE website for utilities only.

The visit took place from 31st October to 4th November 2011. The French team was composed of representatives of EDF and two representatives of CEPN.

The main topics discussed were:

- The Radiation Protection Management at the Corporate level,
- ALARA,
- The on-site work follow-up,
- The training of RP technicians,
- The classification and management of the various radiation areas.

-

Benchmarking visits organized by NATC

Representatives from ISOE NATC and Exelon participated in a benchmarking visit to Gravelines NPP (France) on 4th and 5th March 2011.

- The main topic discussed is the EDF CZT piping measurements for PWRs.
  -

4. ISOE PROGRAMME MANAGEMENT ACTIVITIES DURING 2011

In 2011, 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-organized benchmarking visits (see Section 4 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 2010 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 data entered directly on the web are available as soon as questionnaires are validated and there were regular updates with the data received under Microsoft ACCESS.

ETC continued to manage the official ISOE database, preparing and distributing the CD-ROM /MS-Access version of the database with 2009 data and distributing it in January 2011. 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 ISOE participants who requested it 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 Coordinators or individuals were created and implemented by the ETC and the NEA Secretariat notified users. At the end of 2011, about 661 utility and 110 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 2011, including:

ISOE Meetings	Date
Technical meeting on ISOE Application on the web	Jan. 2011; May 2011
ISOE Bureau	May 2011; Nov. 2011
Working Group on Data Analysis	May 2011; Nov. 2011
NEA-ETC Web Working Group	Oct. 2011
21th ISOE Management Board Meeting	Nov. 2011

Joint NEA/CRPPH-ISOE Activities	
Expert Group on Occupational Exposure	Mar. 2011; Oct. 2011

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 2011 and approving the programme of work for 2012. The 2011 mid-year meeting of the ISOE Bureau focused on the status of the ISOE activities for 2011, the status of the renewal of the ISOE Terms and Conditions, planning for the ISOE annual session 2011 and on the actions following Fukushima accident. It was decided to establish a new Expert Group on occupational radiation protection in Severe Accident Management.

ISOE Working Group on Data Analysis

The Working Group on Data Analysis (WGDA) met in May and November 2011, 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. The WGDA held a topical session at its May 2011 meeting concerning Fukushima accident, its consequences and ISOE actions concerning information on radiation protection in a severe accident. It has also been decided to stop collecting ISOE 2 reports and post all existing reports in RP Library.

Task Team on Decommissioning: The ISOE D questionnaire has been adapted to decommissioning with a minimized number of job/tasks and the possibility to report relevant decommissioning activities after their completion. The implementation of this new proposal will be explored.

ISOE Expert Group on Water Chemistry and Source-Term Management (EGWC)

The EGWC was created following a Management Board decision. The EGWC met for the first time in June 2011 and had a second meeting in November 2011. The objective of this group is to develop a report on radiation protection aspects of primary water chemistry and source-term management, in order to reflect the current state of knowledge, technology and experience on radiation protection issues directly related with radiation protection. Under the Working Group on Data Analysis (WGDA), the EGWC will undertake a review and analysis of current knowledge, technology and experience, and produce a summary report.

The EGWC will undertake its work by:

- Collecting information and practical experience available in the nuclear industry on addressing operational aspects of primary water chemistry and source-term management of nuclear reactors with special emphasis on effects on the management of occupational exposures,
- Identifying factors and aspects which play key roles in achieving good practices in water chemistry management and analysing and quantifying their impact on worker doses and operational costs.

ISOE Expert Group on Occupational Radiation Protection in Severe Accident Management and Post-accident Recovery (EG-SAM)

The Bureau has been decided to create the EGSAM following Fukushima accident. The objective this group is to develop a report on best radiation protection management procedures for proper radiation protection job coverage during severe accident initial response and recovery efforts to identify good radiation protection practices and to organize and communicate radiation protection lessons learned from previous reactor accidents.

The EG-SAM will undertake its work by:

- Collecting information on dose management of high radiation area workers and practical experience available in the nuclear industry on addressing operational aspects, dosimetry, etc with special emphasis on procedures to the control of occupational exposures,
- Identifying factors and aspects which play key roles in achieving good practices on occupational radiation protection in severe accident management and post-accident recovery (knowledge, experience, technology, regulatory requirements and guidance, worker involvement, information

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 once in 2011, with significant participation by ISOE members, including all Technical Centres. The EGOE performed a study, on implementation of ICRP Publication-103, whose scope 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 European Radioprotection Authority Network (ERPAN has also been conducted to collect information on practical information of dose constraints from some countries. The EGOE has issued two case studies on ORP principles and criteria for designing new NPPs and Dose Constraints in Occupational Radiation Protection. The group has begun work on its third cases study on itinerant workers which will include a discussion on implications of different national dose limits, dose tracking and balancing (database) for doses of outside workers, international radiation passbook and management of total risk and position of radiation risk to address management of high radiation risk jobs and jobs with combined workplace risks (radiation, toxic, chemical, etc.).

5. PRINCIPAL EVENTS OF 2011 IN ISOE PARTICIPATING COUNTRIES

As with any summary data, the information presented in Section 2: Occupational Dose Studies, Trends and Feedback, provides only a general overview of average numerical results from the year 2011. 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 2011 and which may have influenced the occupational exposure trends. These are presented as reported by the individual countries[1]. 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	0.76
Reactors in Cold Shutdown or in decommissioning		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv/unit]**
VVER	1	No separate data is available

Summary of National Dosimetric Trends

For the year 2011 the dosimetric trends at the Armenian NPP have not essential changes and was conditioned with works in controlled area, such as works with spent fuel removal and transportation, works with activated in reactor equipments, decontamination works and the works with radioactive wastes. The maximum individual dose was 15.8 mSv. The collective dose for outside workers was 0.140 man·Sv. The value for outside workers dose is very small, because of having the operators own repair workers.

Events influencing dosimetric trends

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

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

Number and duration of outages

For the year 2011, one outage with 45 days duration was performed.

New plants on line/plants shut down

The new plant construction is on line, and siting considerations are currently ongoing, however the new safety improvement approaches in relation to Fukushima Daiichi accident will impact on plant design regulatory requirements and site evaluation consideration. The new regulations on site and design requirement are in approval stage.

Major evolutions

The dose reduction program including ALARA culture implementation is going on slowly, however steps for improvement of old radiation control system is almost finished. The new radiation control pass system is already in operation.

Component or system replacements

During the outage in 2011, 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. The concept on radioactive waste management in Armenia is already approved by Government of Armenia and the works on drafting of National Strategy have been started.

Unexpected events

For the year 2011, unexpected events were not registered.

New/experimental dose-reduction programmes

No new/experimental dose-reduction programmes were applied for in the year of 2011.

Organisational evolutions

The dose planning for the reduction of individual doses of staff is remaining the main tools for ALARA implementation.

Issues of concern in 2012

In 2012 the medium activity solidified liquid radioactive waste storage issues are to be solved.

Technical plans for major work in 2012

Modernization of Radiation Control System for airborne and liquid releases, modernization of system for Control room living environment (additional iodine filters) and dose reduction program for the radioactive waste management.

Regulatory plans for major work in 2012

Improvement of Inspections procedures and new Check list preparation for inspections at ANPP to control compliance with license conditions and regulatory requirements and follow -up actions.

To review the safety assessment report (SAR) in terms of radiation protection and safety of radioactive waste management, submitted by ANPP in their yearly reports and preparation of follow action.

BELGIUM

Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv/unit]**
PWR	7	0.39

Summary of National Dosimetric Trends

Collective doses for the year 2011 (man.mSv):

Tihange 1	Tihange 2	Tihange 3	Total
524	722	21	1265
Doel 12	Doel 3	Doel 4	Total
583	532	210	1415

Events influencing dosimetric trends

Outage Tihange 2 exceeding dosimetry objectives for the following causes:
- Double amount of scaffoldings needed than initially foreseen in RCA
- Underestimated workload for a welding work
- Several welding works not identified in the outage preparation phase
- Additional work on a primary pump
- Problems on the fuel transfer tube.

Outage Doel 3 exceeding dosimetry objectives for the following causes:
- Scope adaptation
- Reworks
- Increased dose rate during ISI

Various installation problems at the Doel auxiliary building for water and waste treatment.

Number and duration of outages

Unit	Outage duration (days)	Number of workers	Collective dose (man.mSv)
Tihange 1	53	1671	481
Tihange 2	54	1675	677
Tihange 3	No outage	No outage	No outage
Doel 1	36	1110	317
Doel 2	18	995	191
Doel 3	36	1093	481
Doel 4	24	738	192

Major evolutions

Zinc injection in the primary circuit of Doel 3 started from April 2011.

New/experimental dose-reduction programmes

Zinc injection in the primary circuit of Tihange 2 is under investigation.

Issues of concern in 2012

From 1st January 2012, introduction of the Optically Stimulated Luminescent (OSL) dosimeters on the site of Tihange, as a replacement of the passive film dosimeters.

Technical plans for major work in 2012

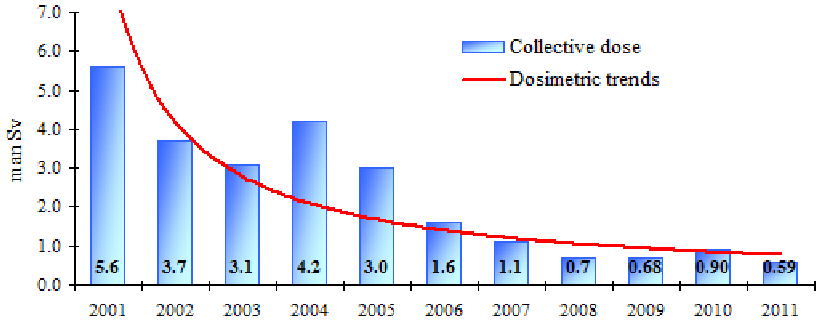
Outage works for Tihange 2, 3, Doel 1, 2, 3, 4.

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	0.274
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	0.0092

Summary of National Dosimetric Trends



Number and duration of outages

Unit No.	Outage duration (days)	Outage information
Unit 5	35 d	Refuelling and maintenance activities
Unit 6	34 d	Refuelling and maintenance activities

Component or system replacements

Replacement of all tubes from the upper reactor head at 5 and 6 units.

Technical plans for major work in 2012

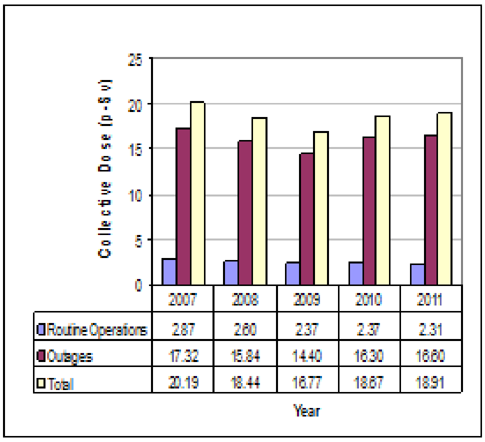
Refuelling and maintenance at unit 5 and 6.

CANADA

2011 Dose Performance

The Canadian collective dose for 2011 for the CANDU fleet of reactors was 27.83 person.Sv for 20 reactors [17 operating units and 3 units in refurbishment], which represents an average of 1.39 person.Sv/reactor.

The total collective dose for the 17 operating units was 18.91 person.Sv with an average of 1.11 person.Sv/reactor or 111 person.rem/reactor in operation. These statistics are shown below in Figures 1 and 2. These values exclude refurbishment collective dose from Bruce A – 1,2 and Point Lepreau.



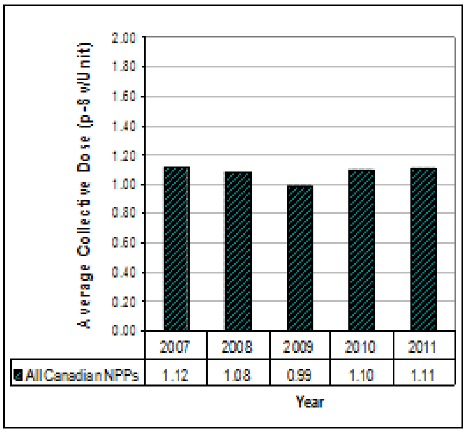


Figure 1: Collective Dose by Operational State from 2007 to 2011

Figure 2: Total Collective Dose per Operational Plant

In 2011, the total collective effective dose from routine operations and outages for operating Canadian NPPs were relatively steady in comparison with previous years. It can be seen that Canada's NPPs have maintained an average annual collective effective dose per reactor unit of approximately 1 p.Sv for the past five years.

Collective dose for units in refurbishment in 2011 (Bruce A Units 1 & 2 and Point Lepreau) was 8.924 p.Sv (average collective dose was 2.975 person.Sv/reactor or 297.5 person.rem/reactor in refurbishment).

In 2009-2011, the 3-year rolling average annual collective dose per reactor for operating and refurbished of Canadian CANDUs was 1.299 p.Sv/reactor (129.9 person.rem/reactor), which represents a ~ 0.3% increase from 2008-2010 three-year rolling average annual collective dose of 1.295 man.Sv/reactor (129.5 person.rem/reactor).

Collective Dose for units in Safe Storage (Pickering-A Units 2&3) was 0 person.Sv in 2011.

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

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 2011 was 1.666 p.Sv or 0.416 p.Sv/unit. The total external dose was 1.556 p.Sv while the collective internal dose was 0.110 p.Sv.

The 2011 total collective dose for outages was 1.333 p.Sv, which is much lower than previous years (2.937 and 3.373 p.Sv in 2009 and 2010, respectively). This is a result of the number and scope of outages.

Darlington continues to strive for improvements in radiation protection through a strategic source term reduction plan scheduled to continue through 2013. Annual collective dose from normal operation was 0.333 p.Sv in 2011.

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& 4)

The total collective dose for these two units was 2.348 p.Sv or 1.174 p.Sv/unit. The External dose was 2.051 p.Sv and internal dose was 0.297 p.Sv.

The 'Collective Dose-Outages' resulted from planned and forced outages in units 1 and 4, was 2.053 p.Sv. Annual dose from routine operations was 0.295 p.Sv.

Units 1 and 4 underwent extensive modifications in order to improve operability and reliability by 2015. This accounts for the relatively high doses received in 2011.

PNGS-A Units (2 & 3) in Safe storage

The units (2 & 3) total collective effective dose was negligible. The transition to safe storage was completed 2010.

Ontario Power Generation / Pickering Nuclear Generating Station-B

Pickering B has four operating units (5 to 8).

The total collective effective dose was 3.741 p.Sv (0.935 p.Sv/unit). This was slightly lower than the collective effective dose of 2010 (3.936 p.Sv).

Annual dose for normal operations was 0.546 p.Sv, whereas total collective dose - outages was 3.195 p.Sv.

The total collective external dose was 3.180 p.Sv and the total collective internal dose was 0.561 p.Sv.

Hydro-Quebec / Gentilly-2 Nuclear Generating station

Hydro-Quebec has one operating unit at Gentilly-2.

The total collective effective dose for 2011 was 0.702 p.Sv. The external component was 0.583 p.Sv and the internal component was 0.119 p.Sv. Total collective dose was down from the 2010 total due to lower doses in normal operations (0.098 p.Sv) and outages (0.604 p.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. This refurbishment is expected to be completed in 2012.

The 2011 total collective effective dose was 1.953 p.Sv with an external dose of 1.923 p.Sv and an internal dose of 0.030 p.Sv. Most of this dose was due to the installation of calandria tubes and fuel channels. Together, these projects composed 88% of the collective effective dose. However, they were both completed under the initial dose estimate.

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 refurbishments (1 and 2).

Bruce A operating units (3 & 4)

The total collective effective dose was 3.348 p.Sv (or 1.674 p.Sv/unit) with an internal component of 0.245 p.Sv and an external dose of 3.103 p.Sv. Dose from outages contributed to 3.038 p.Sv of the total, leaving 0.310 p.Sv from normal operation of these two units.

The collective effective dose was lower than 2010 despite an extended in-service period for Unit 3.

Bruce A Units 1 and 2 Restart Project

Units 1 and 2 are shutdown and have been under refurbishment since 2005. The refurbishment is expected to completed by 2012.

Total effective dose was 6.971 p.Sv for 2011. This is significantly higher than previous years due certain refurbishment activities. Feeder replacement and re-tube activities accounted for 4.932 p.Sv and 0.767 p.Sv, respectively.

External dose amounted to 6.810 p.Sv while internal dose was 0.161 p.Sv.

Bruce Power / Bruce Nuclear Generating Station-B

Bruce B has four operating units (5-8). They have recently established a 5-year plan for dose reduction.

The total collective effective dose was 7.102 p.Sv (1.776 p.Sv/unit) with an external dose of 6.611 p.Sv and an internal dose of 0.491 p.Sv. The total collective dose from the 2011 outages was 6.374 p.Sv.

Annual dose from normal operation in 2011 was 0.728 p.Sv.

Figure 3 displays the outage, normal operation and external/internal dose breakdown for each plant in 2011.

Nuclear Unit	Outage Dose [man.Sv]	Normal Operation [man.Sv]	External Dose [man.Sv]	Internal Dose [man.Sv]	Total Site Dose [man.Sv]	Dose per Reactor [man.Sv]
Bruce - 1	6.971	0.000	6.810	0.161	6.971	3.486
Bruce - 2						3.486
Bruce - 3	3.038	0.310	3.103	0.245	3.348	1.674
Bruce - 4						1.674
Bruce - 5	6.374	0.728	6.611	0.491	7.102	1.776
Bruce - 6						1.776
Bruce - 7						1.776
Bruce - 8						1.776
Darlington - 1	1.333	0.333	1.556	0.110	1.666	0.417
Darlington - 2						0.417
Darlington - 3						0.417
Darlington - 4						0.417
Gentilly - 2	0.604	0.098	0.583	0.119	0.702	0.702
Pickering - 1	2.053	0.295	2.051	0.297	2.348	1.174
Pickering - 2	0.000	0.000	0.000	0.000	0.000	0.000
Pickering - 3						0.000
Pickering - 4	See Pickering Unit 1					1.174
Pickering - 5	3.195	0.546	3.180	0.561	3.741	0.935
Pickering - 6						0.935
Pickering - 7						0.935
Pickering - 8						0.935
Point Lepreau - 1	1.953	0.000	1.923	0.030	1.953	1.953

Figure 1: 2011 Dose data for Canadian nuclear power plants

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 2011 was 0.488 man.Sv which is the second lowest value in the last 5 years. CED was 0.048 man.Sv and 0.440 man.Sv for utility and contractors employees, respectively. The total number of exposed workers was 1884 (572 utility employees and 1312 contractors). The average annual collective dose per unit was 0.122 man.Sv.

The maximum individual effective dose was 1.88 mSv for the utility personnel and 5.44 mSv for contractor employee carrying out insulation works during outages.

Temelín NPP

There are two units of PWR 1000 MWe type V320 in commercial operation since 2004.

The collective effective dose (CED) during the year 2011 was 0.238 man.Sv. CED was 0.041 man.Sv and 0.197 man.Sv for utility and contractors employees, respectively. The total number of exposed workers was 1738 (593 utility employees and 1145 contractors). The average annual collective dose per unit was 0.119 man.Sv.

The maximal individual effective dose 4.23 mSv was received by contractors worker carrying out reactor assembly works during outages.

Number and duration of outages

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

Dukovany	**Outage information**	**CED [man.Sv]**
Unit 1	77 days, standard maintenance outage with refueling including reactor power uprate up to 500 MWe	0.212
Unit 2	22 days, standard maintenance outage with refueling	0.057
Unit 3	34 days, standard maintenance outage with refueling	0.087
Unit 4	20 days, standard maintenance outage with refueling	0.056
Temelín	**Outage information**	**CED [man.Sv]**
Unit 1	66 days, standard maintenance outage with refueling	0.069
Unit 2	82 days, standard maintenance outage with refueling	0.131

All CED values are based on electronic personal dosimeters readings.

Major evolutions

Power uprate of Dukovany Unit 1 (500MW) was achieved in August-November 2011 and consisted mainly of:

- Substitution of high pressure turbine
- Substitution of generator
- Upgrade of the generator protection system
- Upgrade of the SCORPIO control system

Very low values of outages and total effective doses represent results of good primary chemistry water regime, well organized radiation protection structure and strictly 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

There were no unusual or extraordinary radiation events in the year 2011 at Dukovany NPP.

At Temelín NPP, the CED increase compare to last year is due to foreign material exclusion event during Unit 2 reactor internals dismantling. The outage was prolonged for two weeks since there was an additional need for inspection and reparation (grinding, polishing) of the reactor upper internals package, core barrel and reactor vessel surfaces. Despite of high dose rates in the working area and thanks to good ALARA planning, the dose budged increased by 40 mSv only (usage of lead shielded gondola, precise tuning of the water level in the shafts, where the work took place, optimization of the transportation trajectory and time together with careful work preparation).

Technical plans for major work in 2012

Reactor power uprate at Dukovany Unit 2 (Feb-May 2012).

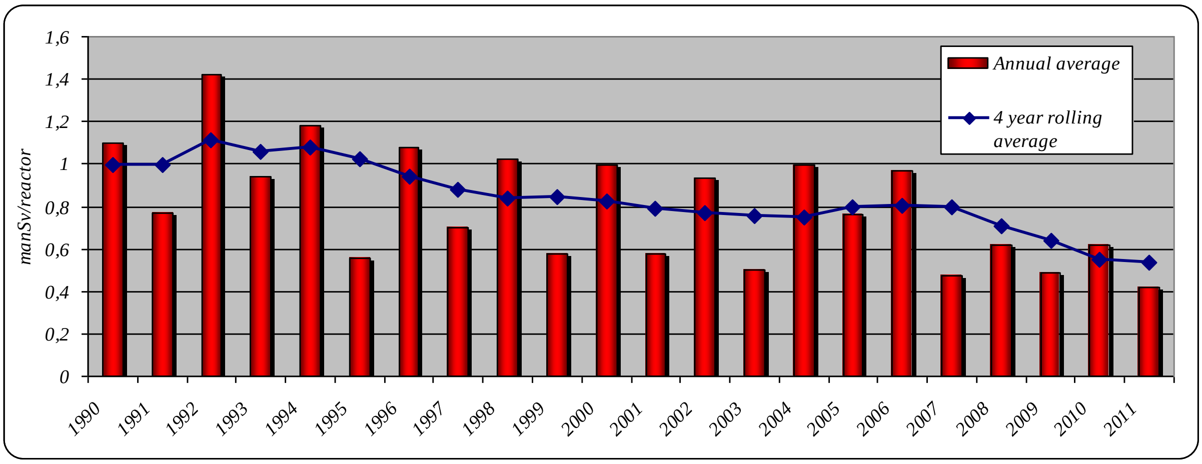
FINLAND

Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv/unit]**
VVER	2	0.357
BWR	2	0.482
Total: All types	4	0.419

Summary of National Dosimetric Trends

Annual collective dose strongly depends on length and type of annual outages. The 2011 collective dose (1.677 man.Sv) of Finnish NPP's was the lowest in operating history, mainly due to short outages at three of four reactors. In the long run the 4-year-rolling average of collective doses shows a slightly decreasing trend since the early 1990's.



Events influencing dosimetric trends

Olkiluoto

The annual outage of 2011 at Olkiluoto 1 unit was a short refuelling outage including some maintenance work as well as inspections and tests were carried out. The outage was completed in nine days and the collective dose was 0.123 man.Sv. This is the lowest outage dose ever of a plant unit at Olkiluoto utilities.

The maintenance outage at Olkiluoto 2 took 29 days and it was the most extensive outage ever in the history of the Olkiluoto NPP. In addition to refuelling the main works were replacements of low-pressure turbines, inner isolation valves of steam lines, steam extraction ducts, generator and its cooling system, I&C for condensate purification, low voltage gears and main sea water pumps. The dose of the OL2 maintenance outage remained quite low despite the extensive modernization work. The collective dose of the OL2 outage was 0.673 man.Sv. During the operating period after the outage a fuel leakage have been detected at OL2.

Loviisa

On both units the 2011 outages were short refuelling outages with durations of some 17 and 20 days. Outage collective doses were among the lowest in plant operating history - 0.40 and 0.25 man.Sv. Main contributors to collective dose accumulation were reactor related tasks (disassembly, assembly), cleaning/decontamination and ancillary work as radiation protection, insulation and scaffolding.

Technical plans for major work in 2012

Olkiluoto 1: maintenance outage, scheduled duration 16 days, main works will be replacement of generator, low voltage gears and I&C for condensate purification.

Olkiluoto 2: refuelling outage, scheduled duration 8 days.

Olkiluoto 3: under construction, estimated regular operation in 2014

Loviisa 1: an extensive inspection outage of 39 days where all main components will be inspected and some major maintenance and modification work will be conducted, including inspection of all 6 SGs and modification of pressure control system.

Loviisa 2: a 21 days short maintenance outage, includes among other things maintenance of reactor pressure vessel main flange sealing face.

Regulatory plans for major work in 2012

Work concerning the up-dating of regulatory guides has continued in 2011. The process will take into account i.e. experiences achieved during the licensing of new NPPs. Target is also to create a new structure for the guides and to minimize the number of guides by combining the existing ones. The Majority of the guides should be issued by the end of 2012.

Olkiluoto 3 unit is under construction. Major civil works are already completed. Installation of the primary components has been completed. An operating license application is expected to be filed in 2012.

Parliament in July 2010 ratified Government’s Decision in Principle to construct two new units in Finland. Fennovoima selected a site in October 2011 and decided to build its nuclear power plant in Pyhäjoki. STUK has started preparations for the construction license phase.

The Ministry of Employment and the Economy on the 15th of March 2011 requested from STUK an investigation into how Finnish NPPs are prepared for the effects of floods and other extreme natural phenomena on the functionality of plants and how the plants have ensured the availability of electricity during various fault and malfunction situations. STUK has assessed the submittals from the licensees in response to these “stress tests”.

STUK will take part to an IRRS-mission (Integrated Regulatory Review Service). The assessment is due to be completed by the end of 2012.

FRANCE

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/reactor]**
PWR	58	0.71

Reactors in cold shutdown or in decommissioning		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/reactor]**
PWR	1	0.264
GCR	6	0.002
CANDU	1	0.003
Fast neutron	1	0.005

Annual collective dose

The 2011 average collective dose was 0.71 man·Sv/reactor for a target of 0.72 man·Sv/reactor. The average collective dose for the 3-loop reactors (34 reactors) was 0.91 man·Sv/reactor; the average collective dose for the 4-loop reactors (24 reactors) was 0.44 man·Sv/reactor.

In 2011, there were 24 short outages, 17 standard outages, 9 ten-yearly outages, 2 forced outages, 1 steam generator replacements and 8 reactors had no outage. The outage collective dose represents 84% of the total annual collective dose. The collective dose from the operating period represents 16% of the total annual collective dose. The neutron total collective dose was 0.274 man·Sv (0.223 man·Sv from the spent fuel transport).

Individual doses

At the end of 2011, nobody received a dose higher than 16 mSv on 12 rolling months. 69% of the exposed population received a cumulative dose on 12 rolling months lower than 1 mSv. 99% of the exposed population received a cumulative dose on 12 rolling months lower than 10 mSv.

Main events influencing dosimetric trends

The main events influencing dosimetric trends are the following:

- 0.168 man·Sv: Additional works during forced outage at Tricastin 1 (+86 man·mSv) DDG brushing and GI longer than expected (alpha risk) at Tricastin 2 (+82 man·mSv)
- 0.113 man·Sv: penetrant testing of all fuel assemblies et fortuit sur colonnes de guidage at Nogent 2

Moreover, there were 2 atypical outages at Bugey 3:

- Start in 2009: short outage (from 04/25/09 to 05/16/10 for a collective dose of 624 man·mSv)
- Start in 2010: short outage/SGR (from 05/17/10 to 01/08/11 for a collective dose of 937 man·mSv)

EDF 3-loop reactors

In 2011, the 3-loop reactors outage programme was composed of 15 short outages, 12 standard outages and 6 ten-yearly outages (one with SGR). It can be noted that 1 reactor had no outage and that there was one forced outage at Tricastin 3 (21.70 man·mSv).

The lowest collective doses for the various outages types were:

- Short outage: 0.147 man·Sv for Dampierre 2
- Standard outage: 0.467 man·Sv for Chinon B3
- Ten-yearly outage: 1.407 man·Sv for Dampierre 1

The lowest SGR collective dose in 2011 was 0.855 man·Sv for Fessenheim 2.

EDF 4-loop reactors

In 2011, the 4-loop reactors outage programme was composed of 9 short outages, 5 standard outages and 3 ten-yearly outages. It can be noted that 7 reactors had no outages and 1 reactor had a forced outage (Civaux 2 with a total collective dose of 0.001 man·Sv).

The lowest collective dose for the various outages types were:

- Short outage: 0.197 man·Sv for Cattenom 4.
- Standard outage: 0.369 man·Sv for Chooz 1.
- Ten-yearly outage: 1.052 man·Sv for Penly 1.

RP Incidents

In 2011, 2 RP events (ESR) reported to the French Authority were classified INES 1:

- At Penly: one event on unit 1 dealing with a worker receiving a skin dose of 430 mSv during radiological protection removal of the steam generator upper part on secondary side
- At Chinon: one event on unit 1 dealing with the increase of surface and atmospheric contamination in the reactor building due to containment loss of the primary circuit during electrical works

Goals for 2012

The new collective dose goal for 2012 is 0.67 man·Sv /reactor. For individual dose, the objective is changed to a 10% reduction within 3 years of the individual dose of the most exposed workers. EDF DPN also keeps the goal: nobody with an individual dose above 18 mSv.

Future activities in 2012

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.

French Nuclear Safety Authority (ASN)

For 2011

In 2011, the French Nuclear Safety Authority (ASN) carried out twenty-nine specific inspections on the subject of radiation protection, five of which were part of an in-depth review of how the four NPPs on the banks of the Loire integrate radiation protection and the interface between these NPPs and the EDF head office departments.

In the light of the various ASN findings during these inspections and the analyses of significant radiation protection events, ASN considers that the radiation protection results of the NPPs in operation have been improved but could be better.

Generally speaking, ASN considers that the radiation protection organisation defined and implemented by the NPPs is on the whole satisfactory.

ASN in particular notes that the industrial radiography operations are well prepared and that the efforts made by EDF since 2010 to give renewed impetus to the ALARA approach on the sites have been maintained.

ASN does however note that the collective dosimetry per reactor rose in 2011 because of a large number of reactor ten-yearly outage inspections. The volume of maintenance work will remain high and may even increase in the coming years. ASN therefore considers that during the future reactor outages, EDF must enhance its efforts to optimise collective and individual dosimetry.

ASN also observes that the "prohibited" areas access process could still be further improved: accidental entry or failure to lockout prohibited areas is still observed.

Finally, ASN recalls that EDF needs to improve the quality and the integration of risk analyses, its management of contamination in controlled areas, monitoring of application of radiation protection rules, adequate staffing levels of the radiation protection department present in the field and deployment of experience feedback and good practices to the intervention personnel.

With regard to radiation protection, ASN also continued to examine the commissioning process of the Flamanville 3 EPR, in particular concerning activities where radiological issues are of great importance and the "two rooms" concept, which involves a new area in the reactor building enabling certain maintenance operations to be carried out while the reactor is operating.

For 2012

In 2012, ASN conducted, as in 2011, an in-depth inspection of three sites of the same area (Blayais, Civaux and Golfech) regarding radiation protection and radiological cleanliness. This inspection gave the opportunity to observe discrepancies among the implementations of the radiation protection requirements on these sites.

One incident related to radiation protection of personnel should be mentioned. It occurred on 19th march 2012, during an outage in the reactor building of the Blayais NPP. A 2.4 TBq iridium-192 source was stuck outside its container during a gamma radiography testing. This incident had few consequences in terms of exposures but the stuck source was very hard to retrieve because of access difficulties (cramped space with duckboards, crinoline ladder, etc.) with a high level of radiations. It took weeks to retrieve this source safely. The experience feedback of this event is still in progress.

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.

GERMANY

Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv/unit]**
PWR	11	0.43
BWR	6	0.58
Total: All types	17	0.48
Reactors in cold shutdown or decommissioning		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv/unit]**
PWR	3	0.12
BWR	1	0.29
Total: All types	4	0.17

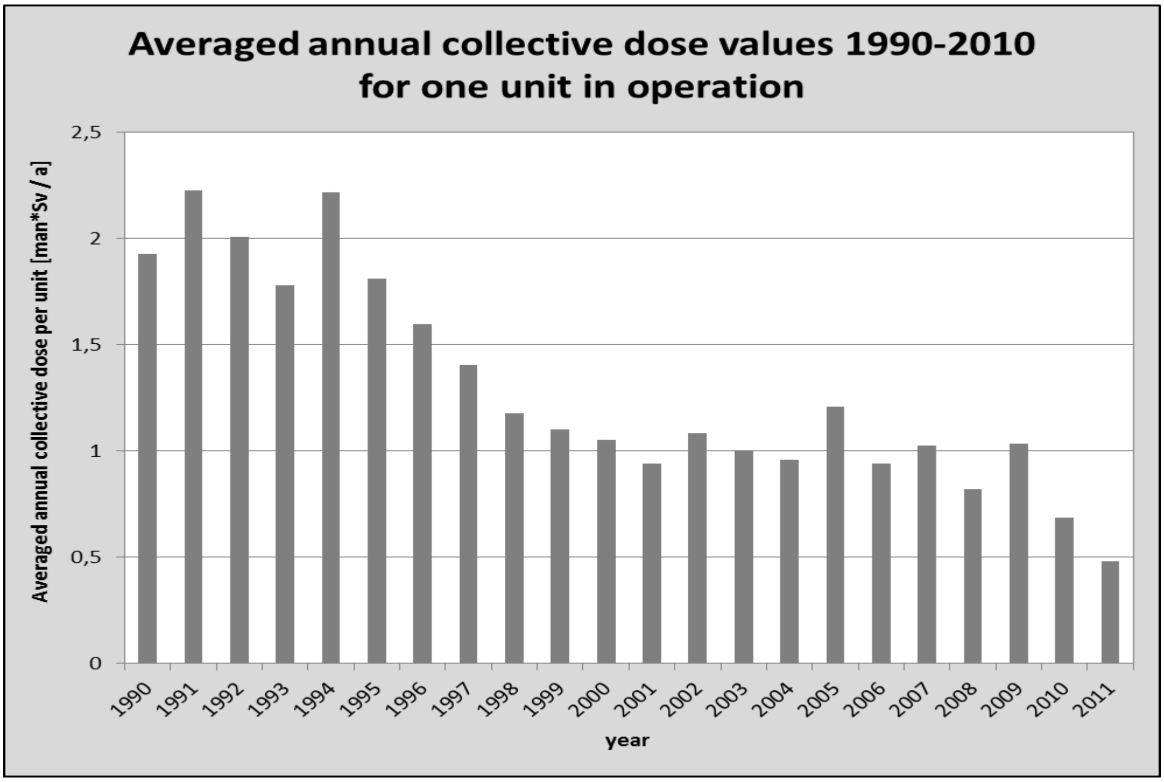
Summary of National Dosimetric Trends

In 2011 Germany had 17 nuclear power plants (11PWR, 6 BWR) in operation. The average annual collective dose per unit was 0.48 man.Sv and so compared to the value of 0.69 man.Sv in the year 2010 (with the same power plants in operation) 30% lower. The trend in the average annual collective dose from 1990 to 2011 is presented in the following figure.

Events influencing dosimetric trends

The main influence on dosimetric trend in 2011 was the political situation in Germany. After the Fukushima Accident the German Government decided to shut down eight power plants. Since March 2011 the plants Unterweser, Biblis A, Biblis B, Neckarwestheim 1, Philippsburg 1, Krümmel, Brunsbüttel and Isar 1 are no longer in operation.

So only nine power plants had a whole year of normal operation. For these nine plants in normal operation the average annual collective dose per unit was 0.56 man.Sv.



Number and duration of outages

Due to the political decision to shut down eight power plants, these plants had a forced outage. Two out of the eight power plants already were in a forced outage because of former technical and political problems. The other six plants were in a forced outage since March.

Beside these forced outages we had 11 typical outages for the plants in operation.

New plants on line/plants shut down

There are no plans for any new power plants in Germany. Due to the political situation we had eight shut downs in 2011: Unterweser, Biblis A, Biblis B, Neckarwestheim 1, Philippsburg 1, Krümmel, Brunsbüttel and Isar 1.

HUNGARY

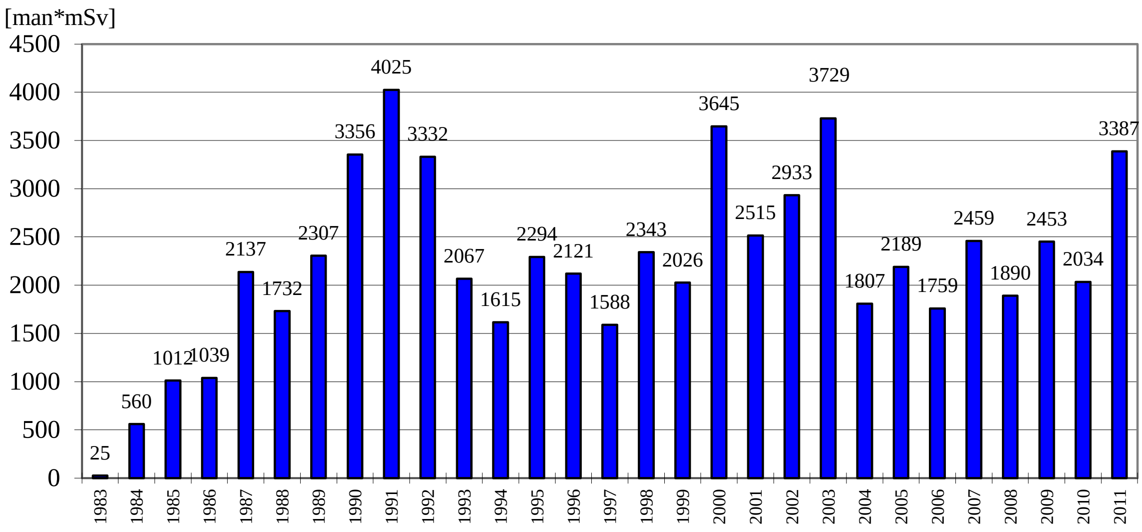
Dose information

Operating Reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv/unit]**
VVER	4	0.749 (with electronic dosimeters) 0.847 (with film badges)

Summary of national dosimetric trends

Upon the result of operational dosimetry the collective radiation exposure was 2997 man·mSv for 2011 at Paks NPP (2352 man·mSv with dosimetry work permit and 645 man·mSv without dosimetry work permit). The highest individual radiation exposure was 12.6 mSv, which was well below the dose limit of 50 mSv/year, and our dose constrain of 20 mSv/year.

The collective dose increased in comparison to the previous year. The higher collective exposures were mainly ascribed to all the outages especially the one “so called” long outages at Unit 1.



From 2000, this data shall be quoted as individual dose equivalent /Hp(10)/

Development of the annual collective dose values at Paks Nuclear Power Plant (according to the results of the film badge monitoring by the authorities)

Events influencing dosimetric trends

There was one general overhaul (long maintenance outage) in 2011. The collective dose of outage was 1255 man·mSv on Unit 1. We made several modifications on Unit 1 with highest collective doses because of the lifetime extension project.

Number and duration of outages

The duration of outages were 61 days on Unit 1, 32 days on Unit 2, 39 days on Unit 3 and 26 days on 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 shut down between 2013 and 2017. In possession of our present technical knowledge it can be considered as a real long-term goal to extend the designed lifetime of the units with at least ten years.

ITALY

Dose information

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	0.002
BWR	2	0.014
GCR	1	0.010

JAPAN

Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv/unit]**
PWR	24	0.96
BWR	22(*1)	1.05
Total: All types	46(*1)	1.01

*1 Note: "BWR" and "Total" include Hamaoka Unit No.1 & No. 2 that have been decommissioning since Nov.18, 2009 and exclude 10 BWRs of Fukushima Dai-ichi and Fukushima Dai-ni for which exposure is under estimation by the utility due to 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	0.13

Summary of National Dosimetric Trends

Fukushima Dai-ichi and Fukushima Dai-ni nuclear power stations had damage by the Tohoku District - off the Pacific Ocean Earthquake of Magnitude 9.0 occurred on March 11, 2011 and huge tsunami. Exposure data of these stations in FY 2011 are under estimation by the utility. Therefore the following exposure data in FY 2010 and FY 2011 do not include the data from 10 BWRs of these power stations. Total collective dose in FY 2011 for all PWRs and BWRs was 46.29 man.Sv, and this was lower by 14.8 man.Sv than the FY 2010 value (61.07 man.Sv). The average annual collective doses per reactor for "BWRs + PWRs", BWRs, and PWRs were 1.01 man.Sv, 1.05 man.Sv and 0.96 man.Sv respectively. All of these collective doses per reactor in FY 2011 were lower than previous year. Especially the PWR average collective dose in FY 2011 decreased from the previous year by 0.55 man.Sv.

Events influencing dosimetric trends

The decrease in collective dose for the FY 2011 was mainly due to the decrease of the improvement works in FY 2011. Main events influencing collective dose are replacements of reactor recirculation system piping for BWRs and seismic margin improvement of high temperature piping support for PWRs.

Number and duration of outages

Nuclear power plants in Japan did not restart their operation after they stopped for the periodic inspection due to the influence of the accident of the Fukushima Dai-ichi NPS. Therefore, the plant which completed the periodic inspection and restarted in FY 2011 is Tomari unit 3 only which had been under test operation after inspection when the Fukushima accident occurred. Duration of the inspection was 225 days.

New plants on line/plants shut down

TEPCO decided to decommission Fukushima Dai-ichi Units 1 to 4 which were seriously damaged due to Tohoku-Chihou-Taiheiyou-Oki Earthquake and the tsunami that followed after on March 11, 2011 on May 20, 2011.

Safety-related issues

In the Fukushima Dai-ichi NPS, the work for an early emergency response, reactor core cooling stabilization and subsequent restoration were performed. Since the environment in these work had the high dose rate and the high contamination of radioactive materials, measures for exposure reduction, such as maintenance of work environment or protective equipment, decontamination and removal of rubble, and mechanization of work, were taken for a worker's radiological protection.

Dose distribution of occupational exposure after the accident In the Fukushima Dai-ichi NPS at the end of FY 2011 (March 2012) is as follows:

Distribution of exposure dosage of workers engaged in emergency work in the Fukushima-Daiichi of TEPCO
(Cumulative doses from March 2011 to March 2012[1,2])

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	22	2	24
100 < D ≤ 150	117	17	134
50 < D ≤ 100	441	364	805
20 < D ≤ 50	619	2,357	2,976
10 < D ≤ 20	482	2,812	3,294
D ≤ 10	1,700	12,048	13,748
Total (person)	3,388	17,602	20,990
Maximum dose (mSv)	678.80	238.42	678.80
Mean dose (mSv)	24.80	9.59	12.04

1) Cumulative doses include the external exposure and internal exposure.
2) As of May 31 in 2012.

Since the reactors were brought to a condition equivalent to "cold shutdown" and radiation dose is being significantly held down, emergency dose limit was reduced from 250 mSv to 100 mSv which is the original values in December 2011. Furthermore, except for a part of work, the dose limit at the time of usual, 100 mSv per 5 years (50 mSv per year), was applied after this.

Organisational evolutions

In Japan, review of nuclear regulation system is performed based on lessons from Fukushima accident. Regarding the new regulation system, “Additional Report of the Japanese Government to the IAEA - The Accident at TEPCO’s Fukushima Nuclear Power Stations - (Second Report)” issued in September 2011 says as follows:

“Due to the unification of administrative organizations over the utilization and regulation of nuclear power and the non-centralized administrative organizations for ensuring nuclear safety, it was unclear until recently which organization has primary responsibility for disaster prevention and the protection of public safety. Reviews of such bodies and the enhancement of nuclear regulatory bodies need to be done promptly.”

Therefore, the Japanese Government decided on the "Basic Concept of Structural Reform of Nuclear Safety Regulations" at the Cabinet Meeting of August 15 this year and decided on the launch of a new safety regulatory body. Specifically, considering international discussions in the past, and on the basis of the principle of "separating regulation from utilization," the nuclear safety regulatory divisions of NISA will be separated from the Ministry of Economy, Trade and Industry, with "Nuclear Safety and Security Agency (tentative name)" aimed to be established by April 2012 as an external agency of the Ministry of Environment by integrating into it the functions of the NSC. For this purpose, the capabilities of this regulatory body will be enhanced by centralizing nuclear safety regulatory activities, a dedicated risk management division will be established to enable this Nuclear Safety and Security Agency to take quick initial responses, and efforts will be made to recruit highly qualified personnel from both the public and private sectors to adequately execute the regulatory activities. In addition, a "Task Force for the Reform of Nuclear Safety Regulations and Organizations," was established on August 26 for the preparation of the bill necessary to establish the new organization.

Issues of concern for 2012

In the Fukushima Dai-ichi NPS, the work for restoration is continued including work for reactor cooling, accumulated water processing, mitigation of sea water contamination, radioactive waste management, dose reduction at the site boundaries, decontamination within the site and preparation of fuel removal from the spent fuel pool. Since the work is still done in the high dose rate and high contamination environment, it is important to secure safety and reduce exposure.

Technical plans for major work in 2012

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)

Regulatory plans for major work in 2012

New regulatory body will be established in 2012, and new safety standards will be decided in consideration of the lessons from Fukushima accident. Nuclear power plants will be re-examined by the new safety standards.

LITHUANIA

Dose information

Reactors in cold shutdown or in decommissioning		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv/unit]**
LWGR	2	0.3157

Summary of National Dosimetric Trends

In 2011, the occupational doses at the Ignalina NPP (INPP) were uphold as low as possible, taking into account all economic and social conditions: 2.59 man.Sv in 2007, 3.29 man.Sv in 2008, 0.93 man.Sv in 2009, 0.52 man.Sv in 2010 and 0.6314 man.Sv (50% of planned dose) in 2011. The collective dose for INPP personnel was 0.5777 man.Sv (57% of planned dose) and for outside workers was 0.0537 man.Sv (21% of planned dose).

The average annual effective individual dose for INPP staff was 0.38 mSv, and for outside workers – 0.07 mSv. The highest annual individual effective dose for INPP staff was 13.78 mSv, and for outside workers – 8.56 mSv.

Events influencing dosimetric trends

The main works that contributed to the collective dose during technical service and decommissioning of Units 1 and 2 at the INPP were fuel handling (221.38 man.mSv), repairing of the spent fuel storage pool, reactor auxiliary, fuel building (145.32 man.mSv), waste and liquid waste handling (58.91 man.mSv).

New plants on line/plants shut down

In 2011 the dismantling and decontamination of Unit 1 Emergency Core Cooling System was finished. The dismantling works in ancillary buildings are being carried out, the dismantling preparation works were started in the building of the central heating plant and in the turbine hall.

The construction of the Buffer Storage of the Landfill Facility for Short-lived Very Low Level Waste (project B19) was completed and it is being prepared for operation.

In 2011 the new Interim Spent Fuel Storage Facility (project B1) technical design development and the works performance, designing and manufacturing of the CONSTOR RBMK-1500/M2 casks were analyzed.

Further preparatory works for construction of new Visaginas NPP are ongoing. In 2011 site evaluation activities for Visaginas NPP in accordance with IAEA safety standards were finished. The potential strategic investor for Visaginas NPP was chosen and further negotiations with this investor and other regional project partners started. For new NPP ABWR technology is proposed.

Major evolutions

Goals for 2012 are listed below:

- Continuing the safe decommissioning of Unit 1 and Unit 2;
- Evaluation and upgrading the level of safety culture;
- Extension and support to the effectiveness of the quality improvement system;
- Highest annual individual dose shall be below 18 mSv;
- The collective dose shall not exceed 1.22 man.Sv (for INPP personnel will not exceed 1.02 man.Sv and for outside workers will not exceed 0.20 man.Sv);
- Continuous implementation of ALARA principle.

Safety-related issues

In 2011 was developed and coordinated with State Nuclear Power Safety Inspectorate (VATESI) concept of safety factors for shutdown units. At present, the system of the analysis of the events, important for INPP safety, is in the process of implementation.

The INPP results of the stress testing confirmed, that INPP provides necessary measures, used for safe decommissioning of INPP, operation of storage facilities.

Results of efficiency analysis of the management of the ageing of the equipment confirm the safety criteria. The process of the ageing of the equipment does not have nay influence to the INPP operation safety.

New/experimental dose-reduction programmes

The doses were reduced by employing new principles of organization of work, by doing extensive work on modernization of plant equipment, and by using automated systems and implementing programs of introduction ALARA principle in practice during work activities.

Organisational evolutions

In 2011 the changing of the enterprise structure was continued to achieve the higher quality of the management of decommissioning. The priority of further INPP work is nuclear and radiation safety, transparent and efficient work, personnel responsibility and high professional qualities, social responsibility.

Issues of concern for 2012

Decommissioning of LWGR type reactors and technological installations and systems is executed for the first time in the world, therefore high attention must be paid this kind of activity.

Technical plans for major work in 2012

In 2012 will be continued building activity of new Interim Spent Fuel Storage Facility and of the Radioactive Waste Treatment Facility. The building of the Buffer Storage of the Landfill Facility for Short-lived Very Low Level Waste will be completed and is handed over in operation. Designing of the Low and Intermediate Level Radioactive Waste Disposal Facility works will be continued. The works for the preparing for decommissioning of reactor gas circuit and special venting system as well as control, electrical and deaerator rooms of Unit 1 will be held. Radiological investigations and scaling factors of Unit 1 working zones of the reactor shaft designing will be continued. Spent fuel unloading from the 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 Reactors and Spent Nuclear Fuel Storage Pools.

Regulatory plans for major work in 2012

Due to planned development of nuclear energy in Lithuania the new set of Laws (new Nuclear Safety Law, amendment of Nuclear energy Law, Radioactive Waste Management Law and Radiation Protection Law) came into force as of 1 October 2011. Regulation and supervision of radiation protection and safety of nuclear facilities were transferred from Radiation Protection Centre to State Nuclear Power Safety Inspectorate (VATESI). VATESI became responsible for supervision of radiation protection and safety within nuclear power field including radiation protection of workers as well as those engaged in the practices in the area of nuclear power involving sources of ionising radiation.

In 2012 VATESI will continue supervision and control of nuclear safety of decommissioning of INPP, management of radioactive waste, including the construction and operation of new nuclear facilities, as well as the radiation protection of these activities and facilities. To assure that the Visaginas NPP would be safely operated and would comply with the highest safety level, it is necessary to develop the legal framework enabling to accomplish these goals and be prepared for the review of licensing documentation.

MEXICO

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit and reactor type [man·Sv/unit]**
BWR	2	0.83

Summary of national dosimetric trends

Annual doses at Laguna Verde NPP

Year	Unit 1	Unit 2	Total
2007	3.056	2.420	5.476
2008	8.728	0.658	9.386
2009	1.177	2.980	4.157
2010	6.231	3.778	10.009
2011	0.782	0.882	1.664

Events influencing dosimetric trends

- Refuelling outages increase annual doses.
- During year 2011 Laguna Verde Source Term reduction and work management Plans helped to have the lowest dose year.

Number and duration of outages

No refuelling outages al Laguna Verde during year 2011

Major evolutions

No important evolutions

New/experimental dose-reduction programmes

Development of an Alpha contamination program

Issues of concern in 2012

Refuelling outages in both units at Laguna Verde

Technical plans for major work in 2012

Reactor Pressure Vessel extended inspections due Jet pumps cracking indications in previous outages.

Regulatory plans for major work

Supplementary surveillances to get plant authorization for Extended Power Uprate (EPU).

THE NETHERLANDS

Dose information

Operating reactors

Reactor type	Number of reactors	Average annual collective dose per unit and reactor type [man·Sv/unit]
PWR	1	0.25
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	1	0.01

Number and duration of outages

1 outage during 4 weeks

Unexpected events

3 INES 1 incidents; none of them related to radiation protection

Technical plans for major work in 2012

Measurements due to post Fukushima during the coming 5 years.

ROMANIA

Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv/unit]**
CANDU	2	0.197

Summary of National Dosimetric Trends

Occupational exposure at Cernavoda NPP 2000 - 2011			
	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 (2 units)	209.3	479.34	688.6
2009 (2 units)	67.6	417.7	485.3
2010 (2 units)	210.3	577	787.3
2011 (2 units)	56.0	337	393

Events influencing dosimetric trends

Normal operation of the plant (U1 & 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 2011:

- There were 101 employees with individual doses exceeding 1 mSv; 3 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 5.13 mSv;
- The contribution of internal dose due to tritium intake was 14.2%.

Planned Outage

A 26 days planned outage was done at Unit#2 between May 8th and June 1rst 2011. Activities with major contribution to the collective dose were as follows:

- Fuelling machine bridge components preventive maintenance;
- Steam Generator's Eddy current inspection;
- Feeder thickness measurements, feeder clearance measurements, feeder - yoke measurements, elbow UT examination;
- Snubbers inspection; piping supports inspection.

Total collective dose at the end of the planned outage was 130.2 man.mSv (117.2 man.mSv external dose and 13 man.mSv internal dose due to tritium intakes).

Finally this planned outage had a 33% contribution to the collective dose of 2011.

Planned Outages dose history

Year	**Unit**	**Interval date**	**External collective dose received (man.mSv)**	**Internal collective dose (^{3}H 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
2011	2	07.05 - 01.06	117.2	13	130.2

Unplanned outages

Unit 1 – January 8 - 10: Unit was orderly shutdown in order to replace gland seals 33340 Y1, Y2 and Y3 on Primary Heat Transport System, with new ones. (24.72 man.mSv external dose for all the activities performed).

Unit 2 – September 17 - 18: Fuelling Machine unable to unclamp from fuel channel end fitting due to an interrupted electrical circuit. (minor radiological impact; 0.031 mSv)

Unit 2 - December 19-20: Hot feedwater leak identified from PT2G impulse line connection to main feedwater line upstream to BO2 check valve 4323-V2. (3.58 man.mSv external dose for all the activities performed).

Radiation protection-related issues

Outage Activity Transport Monitoring (OATM) surveys permit component radionuclide activities and their radiation field contributions to be trended with reactor operation. These data are required to perform various assessments such as the effects of chemistry changes on radiation fields, evaluation of the source term reduction technologies and decontamination planning.

Dose rate and gamma spectra surveys were performed for the first time at the reactor faces, vertical feeder and moderator heat exchanger of Cernavoda Unit 1 during Outage in May 2010, 19 days after reactor shutdown.

Significant differences were observed between “A” and “C” reactor faces, due to Co-60 and Nb/Zr-95. The radionuclides contributors to the fields were Co-60, Zr/Nb-95, Sb-124, and Fe-59.

The radiation field across the reactor faces was affected by hot spots and the overhead sources. The analyses suggest that in order to effectively decrease the radiation field near the reactor face the shielding has to be installed in the space between the end fittings.

The intensity of the radiation fields at the reactor faces of Cernavoda Unit 1 is similar to that at Darlington units; the radionuclides distributions are, however, unique.

Similar determinations were performed at Cernavoda Unit 2, during planned outage in May 2011.

Issues of concern in 2011

The main concerns for 2011 were important works, with high radiological impact, performed during Planned Outage of Unit 2.

Issues of concern in 2012

The main concerns for 2012 are activities with high radiological impact, to be performed during a 46 days Planned Outage of Unit 1:

- Replacement of vertical neutron flux detectors;
- Replacement of horizontal neutron flux detectors;
- Fuelling machine bridge components preventive maintenance;
- Piping supports inspection;

- Snubbers replacement;
- Feeder – yoke clearance measurements and correction;
- Inspection for tubbing and supports damages in the feeder cabinets;
- Planned outages systematic inspections

RUSSIAN FEDERATION

Dose information

<table>
<tr><th colspan="3">Operating reactors</th></tr>
<tr><th>Reactor type</th><th>Number</th><th>Average annual collective dose per unit and reactor type [man·Sv/unit]</th></tr>
<tr><td>PWR (VVER)</td><td>15</td><td>0.657</td></tr>
<tr><th colspan="3">Reactors in cold shutdown or in decommissioning</th></tr>
<tr><th>Reactor type</th><th>Number</th><th>Average annual collective dose per unit and reactor type [man·Sv/unit]</th></tr>
<tr><td>PWR (VVER)</td><td>2</td><td>0.066</td></tr>
</table>

Summary of national dosimetric trends

Collective doses

In 2011, the total effective annual collective dose of utilities employees and contractors at 16 operating VVER type reactors was 10.518 man·Sv. This result is more at 0.737 man·Sv or 7% than the total collective dose of 9.781 man·Sv for the year 2010.

It should be noted a considerable difference between average annual collective doses for the groups of VVER-440 MWe and VVER-1000 MWe reactors. In 2011, the results were as follows:

0.839 man·Sv /reactor with respect to the group of 6 operating VVER-440 reactors.

0.548 man·Sv /reactor with respect to the group of 10 operating VVER-1000 reactors.

Comparative analysis shows that average annual collective doses were relatively constant near 0.500 man·Sv/reactor (0.496, 0.511, 0,548 man·Sv/reactor in 2009-2011 respectively) for the group of VVER-1000 reactors. At the same time, average annual collective doses changed in more wide range of values (1.254, 0.863, 0.839 man·Sv/reactor in 2008-2010 respectively) for the group of VVER-440 reactors.

However, certain distinctions in the values of annual collective doses for reactors relating to the groups VVER-440 and VVER-1000 were observed. For the group of VVER-440 reactors, 3-year (2009-2011) rolling annual collective doses changed from 0.584 man·Sv/reactor for Kola 1-4 (V-213 and V-230 models) to 1.787 man·Sv/reactor for Novovoronezh 3-4 (V-179 model). For the group of VVER-1000 reactors, 3-year (2009-2011) rolling annual collective doses changed from 0.122

man·Sv/reactor for Rostov 1 (V-320 model) to 0.930 man·Sv/reactor for Novovoronezh 5 (V-187 model).

Individual doses

With respect to 2011, nobody exceeded the main national dose limit of 100 mSv averaged over defined periods of 5 years as well as the control dose level of 18 mSv per year which was installed by Concern Rosenergoatom (Russian operating utility) starting from 01 January 2011.

The maximum recorded individual dose was 17.89 mSv. This dose was gradually received during full-year 2011 by the worker of Novovoronezh plant maintenance department during technical equipment repairing.

The annual individual doses in the range 15-18 mSv received 57 persons from three NPPs (47 persons at Novovoronezh NPP, 8 – at Kalinin NPP, 2 – at Kola NPP). Nobody exceeded 15 mSv level at Balakovo NPP and 5 mSv level at Rostov NPP.

Events influencing dosimetric trends

The major maintenance outage and refueling combined with the activity of extending the reactor lifetime took place at Novovoronezh 5 from 25 September 2010 to 16 September 2011. As a result, Novovoronezh 5 operating lifetime was extended from thirty years to fifty five. The total effective collective dose of utilities employees and contractors over the 357 days was 1.909 man·Sv.

2011 was the first year of occupational exposure registration at Rostov 2 which was put in commercial operation 10 December 2010. The total effective annual collective dose of utilities employees and contractors at Rostov 2 was 0.107 man·Sv in 2011.

Planned outages duration and collective doses

Reactor	Duration (days)	Collective dose (man·Sv)
Balakovo 1	50	0.711
Balakovo 2	52	0.641
Balakovo 3	no outage	--
Balakovo 4	41	0.359
Kalinin 1(*)	44	0.750
Kalinin 2	45	0.568
Kalinin 3	54	0.287
Kola 1	38	0.417
Kola 2	40	0.387
Kola 3	88	0.699
Kola 4	53	0.294
Novovoronezh 3	43	1.111
Novovoronezh 4	60	1.608
Novovoronezh 5	259	1.428
Rostov 1	43	0.155
Rostov 2	34	0.084

New plants on line

In December 2011, the power raising until 50% from the full capacity was reached at Kalinin 4 under construction reactor of VVER-1000 MWe for the following experimental-industrial operation.

Issues of concern in 2012

- Development of the system of personal radiation risk management for NPP employees and contractors.
- Development of the method and software for direct estimation of personal radiation risk coefficients for NPP employees and contractors.
- Development of the Guideline for optimization of occupational exposure based on ALARA methodology.
- Development of the automatic workstation for the prompt estimation of occupational exposure from different radiation sources.

SLOVAK REPUBLIC

Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv/unit]**
VVER	4	0.160
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	2	0.010

Summary of National Dosimetric Trends

Bohunice NPP (2 units – Bohunice 3rd and 4th): The total annual effective dose in Bohunice NPP in 2011 calculated from legal film dosimeters was 253.304 man.mSv (employees 128.605 man.mSv, outside workers 124.699man.mSv). The maximum individual dose was 2.900 mSv (outside worker).

Mochovce NPP (2 units): The total annual effective dose in Mochovce NPP in 2011 evaluated from legal film dosimeters and E50 was 388.425 man.mSv (employees 124.884 man.mSv, outside workers 166.759 man.mSv). The maximum individual dose was 3.293 mSv (outside worker).

JAVYS NPP (2 units – Bohunice 1st and 2nd): The total annual effective dose in JAVYS NPP in 2011 calculated from legal film dosimeters was 20.101 man.mSv (employees 3.534 man.mSv, outside workers 16.567 man mSv). The maximum individual dose was 0.826 mSv (outside worker).

Events influencing dosimetric trends

Bohunice NPP: Standard operation and planned outages without anomalies. Installation of “severe accident modifications” also influenced the dosimetric results

Mochovce NPP: Both units were in standard operation. Unit 1 had a standard maintenance outage. Unit 2 had also a standard maintenance outage

JAVYS NPP:
- Transport of the nuclear spent fuel from the Unit 2nd was finished on the 21 January 2011. Since this date the both Units are without nuclear spent fuel.
- Sampling of the activated components and structures (reactor pressure vessel, reactor internals assemblies, activated civil structure) was realized within the radiological characterisation of the Units prior to decommissioning in August and September 2011.

Number and duration of outages

Bohunice NPP:

- Unit 3 - 36 days standard maintenance outage. The collective exposure was 153.015 man.mSv from electronic dosimeters.
- Unit 4 - 22.3 days standard maintenance outage. The collective exposure was 89.527 man.mSv from electronic dosimeters.

Mochovce NPP:

- Unit 1 - 21.6 days standard maintenance outage. The collective exposure was 120.657 man.mSv from electronic dosimeters.
- Unit 2 - 22.1 days standard maintenance outage. The collective exposure was 114.286 man.mSv from electronic dosimeters.

JAVYS NPP:

- Unit 1 – out of operation since 01.01.2007
- Unit 2 – out of operation since 01.01.2009

New plants on line/plants shut down

New NPP: completion of the Mochovce unit 3 and 4 in the year 2011 continued. Main work was performed on secondary and auxiliary circuit. Twelve month delay of unit 3 start-up was announced.

Major evolutions

Bohunice + Mochovce NPP: Renewing of the radioactive discharge licences for both sites

JAVYS NPP: The first stage of decommissioning begun on 19 July 2011. During this stage non-activated assemblies and structures were to be released only.

Component or system replacements

Bohunice NPP:

- Replacement of old personal contamination monitors by new ones at the exit from the change rooms
- Enhancement of EPP operational dosimetry terminals including EPDs into the security office at the main plant gate for external intervention brigades
- Installation of new RP equipment (continual noble gas, aerosol, iodine monitor and dose rate monitor and EPDS) into the new emergency response shelter

Mochovce NPP:

- New third portal monitor was installed at exit from the RCA.

JAVYS NPP:

- New free release equipment preparation

Safety-related issues

JAVYS NPP:

Preparation of the license for the 2nd stage decommissioning

Organisational evolutions

Bohunice NPP:

Staff reduction by 2

Issues of concern for 2012

Bohunice NPP:

Further RP staff reductions and insufficient number of RP technicians for outages

Technical plans for major work in 2012

Bohunice NPP: Two outages: 19 and 21 days planned duration

Mochovce NPP: Two outages: 21 and 21 days planned duration

Regulatory plans for major work in 2012

Licensing process

- Renewing of the basic licenses for Bohunice and Mochovce NPP.
- Second phase of NPP V1 JAVYS decommissioning.

SLOVENIA

Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv/unit]**
PWR	1	0.068

Summary of National Dosimetric Trends

Maximum individual annual dose in the year 2011 was 2.7 mSv, average dose per person was 0.11 mSv.

Three years' collective dose average was 0.476 man.mSv for the period 2009-2011.

Events influencing dosimetric trends

Krško NPP fuel cycle is an 18-month fuel cycle.

Number and duration of outages (or forced outage)

No regular outage was scheduled in 2011; there was one forced outage of 7 days.

Major evolutions and dose-reduction programme

Replacement of reactor vessel head will include a new permanent gamma shield and removable neutron shields as well as some other improvements to simplify the procedure of opening and closing the reactor vessel head.

Project for removal of RTD by-pass pipes used for reactor coolant temperature measurement is under preparation.

Technical plans for major work in 2012

All short-term post-Fukushima improvements of Krško NPP were completed already in 2011.

Krško NPP is going to replace reactor vessel head in 2012 outage and will start post-Fukushima projects in accordance with the requirements of the regulator. Commissioning of the third diesel generator is also scheduled in 2012.

Regulatory plans for major work in 2012

Slovenian Radiation Protection Administration plans to conclude the approval process of Krško NPP dosimetry service for neutron dose measurements.

REPUBLIC OF SOUTH AFRICA

Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv/unit]**
PWR	2	0.533 (TLD)

Summary of National Dosimetric Trends

The total Collective Radiation Exposure (CRE) for Koeberg in 2011 was 1.067 man.Sv. This is similar to the CRE of 1.034 man.Sv in 2010. The dose trend is therefore stable after a marked decrease from 1.488 man.Sv in 2009.

Events influencing dosimetric trends

An unplanned shutdown due to a fuel leak took place from 12/19/2010 to 1/18/2011 on unit 1. The CRE accrued during the 2011 portion was 0.042 man.Sv. The total dose for the unplanned shutdown was 0.065 man.Sv. A planned maintenance shutdown took place on unit 2. The total CRE for this shutdown was 0.876 man.Sv. Six dose intensive modifications were performed in this shutdown totalling 0.143 man.Sv.

Number and duration of outages

1 planned maintenance shutdown totalling 63 days and 1 forced shutdown totalling 31 days.

Component or system replacements

Replacement of the primary system Chemical and Volume Control pump.

Regulatory plans for major work in 2012

The Radioactive Waste Policy is in the process of being revised.

SPAIN

Dose information

Operating reactors		
Plant	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv/unit]**
Almaraz	2	0.289
Ascó	2	0.649
Cofrentes	1	2.97
Garoña	1	1.029
Trillo	1	0.265
Vandellos II	1	0.887
Total: All types	**8**	**0.761**
Reactors in cold shutdown or in decommissioning		
Plant	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv/unit]**
Jose Cabrera	1	0.190
Vandellos I	1	0

Events influencing dosimetric trends

Almaraz

- Power upgrade in both units to 110% of the original rate. The current rate is 1054 MWe per unit.
- Establishment of very low dose rate areas called "ALARA ZONES".
- Continuous optimization of radiation protection procedures and measures that has led to the lowest rate dose per day during 2nd outage of Unit 1.
- Setting new dose objectives for specific Jobs

Cofrentes

Source term increase in recirculation systems and reactor clean-up system placed in the drywell and dose rate increase in refuelling floor during vessel closing. Both issues contributed to a higher collective dose during the 18th outage. A work group has been created in order to analyze this increase. This group has the support of EPRI experts and there is a corrective actions programme on going.

Number and duration of outages

Almaraz

- 19th outage of ALMARAZ Unit 2 (started on November 11th, 2010 - finished on January 25th, 2011):
  - Duration 65 days.
  - Collective dose 0.694 man.Sv
  - Maximum individual dose: 4.867 mSv

- 21st outage of ALMARAZ Unit 1:
  - Duration 36 days.
  - Collective dose 0.416 man.Sv
  - Maximum individual dose: 3.690 mSv

Ascó

- 19th outage of Ascó Unit 1
  - Duration 62 days
  - Collective dose: 0.551 man.Sv
- 21st outage of Ascó Unit 2:
  - Duration 74 days.
  - Collective dose 0.661 man.Sv

Cofrentes

- 18th outage
  - Duration 49 days.
  - Collective dose 0.694 man.Sv

Vandellos II

Outage Duration: 68 days

Major evolutions

Almaraz: Slight decrease of the activity index observed during 21st outage of the Unit 1.

Cofrentes: Second noble metals online injection during April.

Component or system replacements

Almaraz: During 19th outage of unit 2 and 21st outage of unit 1 there have been replaced two reactor coolant pump motors (one per unit).

Cofrentes: During 18th outage, a recirculation pump motor has been replaced with a dose impact of 0.16 Sv.p. TIP tubing and machines has been replaced with an dose impact of 0.11 Sv.p.

Safety-related issues

Almaraz

- On 23rd October 2011, at 06.00 hours, the Unit 2 reactor was shut down due to a very high temperature indication of the lower bearing of the RCP-2.
- On 20th May 2011, at 11.45 hours, the Unit 1 reactor tripped as a result of an inadequate opening of the 52/BYA switch, while the 52/RTA was open.
- On 2nd June 2011, at 11.16 hours, the Unit 2 reactor tripped as a result of a P-7 turbine trip (greater than 10% power). The turbine trip was caused by activation of the 86-2/G2 group relay without real cause, during installation work on two support power supplies in the main alternator excitation regulation system.

Ascò

During 21st Ascó 1 outage, 2 events were produced:

- Loss of coolant of Reactor Cooling System (RCS) during shutdown due an unexpected opening of a motor-driven valve placed in the suction intake of one reactor heat removal (RHR) pump. Event caused a flooding on floor 36 due safeguards sinks overflow at reactor building.
- Water outlet on train B in spray system (SP) at the reactor building

Unexpected events

Almaraz

Fuel rod leak detected in the Unit 1.

New/experimental dose-reduction programmes

Almaraz

Use of Centralized Aspiration Units.

Cofrentes

During 18th outage, permanent shielding programme has entered into 3rd stage.

- Source term reduction with replacement or elimination of cobalt components, like valves.
- Improvement & adaptation controlled area rooms during power operation and outage.

Organisational evolutions

Almaraz

Incorporation of another ALARA technician.

Issues of concern for 2012

Almaraz

- Modification of the ventilation filter train of the spent fuel building.
- Implementation of a Contamination Control Project based on an effective control of the contamination at the source. This project is supported on the information acquired by workers feedback before leaving the Controlled Area.
- Increased in the emphasis oversight of radiation protection by a Radiation Protection staff reorganisation that will provide more in-field services.

Cofrentes

- No outage year
- Collective dose goal 0.4 Sv.p
- Planned shutdown for inspection in feedwater system lines and inspection of heater 5B tubing.

Technical plans for major work in 2012

Almaraz

- 20th outage of Almaraz of the Unit 2. Estimated duration of 39 days.

- 21st outage of Almaraz of the Unit 1. Estimated duration of 43 days.

Cofrentes

Different ALARA studies:

- Decontamination and hot workshop update
- Waste building tubing and lines changes
- Replacement of temporal shielding to permanent shielding
- Reactor heat removal system “online” maintenance

Regulatory plans for major work in 2012

Almaraz

- Modification of non-official control criteria for inner exposures.

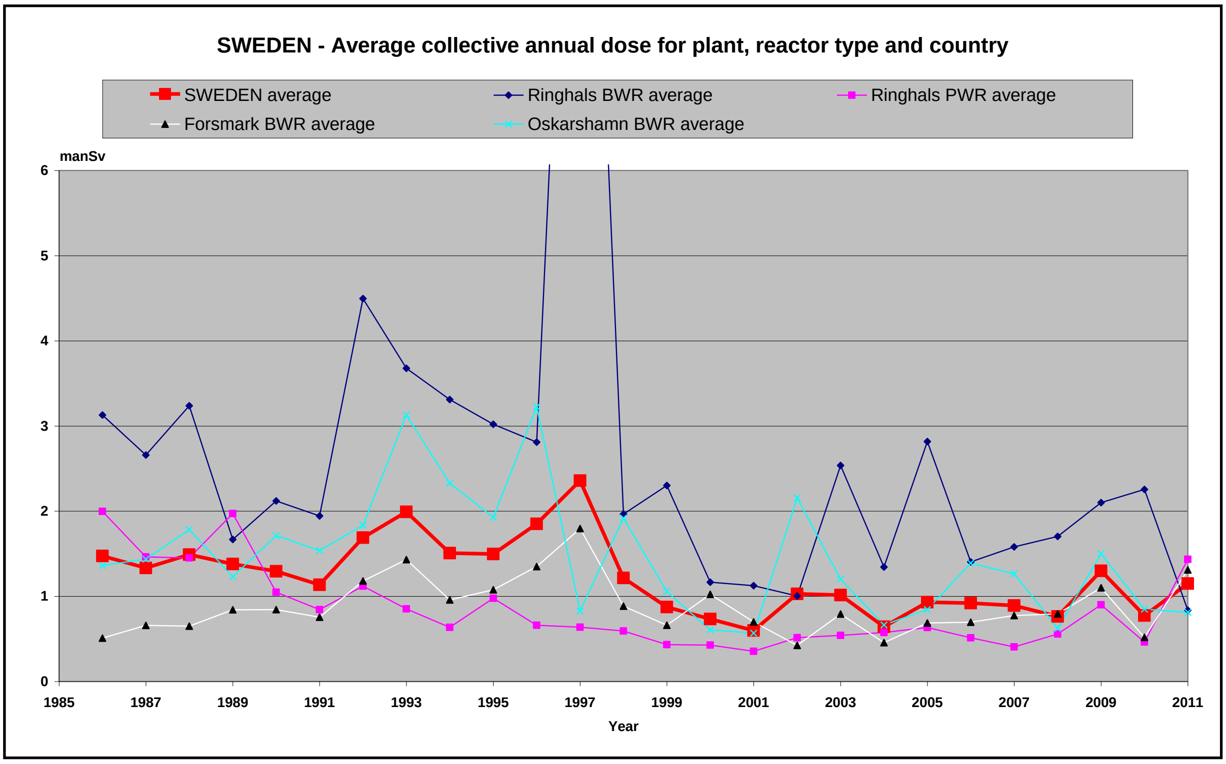
Cofrentes

- Dose reduction programme

SWEDEN

Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv/unit]**
PWR	3	1.435
BWR	7	1.072
Total: All types	**10**	**1.181**
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	0.027



Summary of National Dosimetric Trends

Collective and individual doses at the Swedish Nuclear Power Plants show normally a fluctuating trend due to variation in workload. During 2011, approximately 5840 persons at the NPP´s 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 11.863 man.Sv, a country average individual dose of 1.98 mSv. In 2011 the highest country annual individual dose was 19.3 mSv (highest plant individual dose 19.3 mSv). Note that the values presented here include the doses received at the two closed reactor units at Barsebäck NPP (82 persons with dose > 0.1 mSv, collective dose: 49.9 man.mSv, average individual dose: 0.61 mSv and max. dose: 3.6 mSv).

Events influencing dosimetric trends

In general — There are many projects in progress for modernization, 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.

Forsmark — A system decontamination (CORD-UV) executed at F3 on systems 321/331, 2 decontamination cycles – DF = 115 for system 321 (RH), DF = 41 for system 331 (RWCU).

Ringhals 2 — Cleaning activities after a fire in containment during CAT (Containment Air Test, ILRT = Integrated Leak Rate Test). Total dose for cleaning was 1663 man.mSv.

Oskarshamn 3 — During autumn internals, that were replaced 2009, were cut into smaller peaces and put into waste packages for final storage. Internals were steam separators, steam dryer, shroud head and core spray. The used technique was diamante wire cutting, total collective dose was 296 man.mSv.

Number and duration of outages 2011

Plant	Type of Reactor	Length of Outage (Days)	Collective Dose (man.mSv)	Comments
Forsmark 1	BWR	73	2935	
Forsmark 2	BWR	20	308	
Forsmark 3	BWR	43	519	
Oskarshamn 1	BWR	27	649	
Oskarshamn 2	BWR	55	598	
Oskarshamn 3	BWR	37	431	Extended 13 days, installation of vibration monitors on the turbine.
Ringhals 1	BWR	55	648	
Ringhals 2	PWR	272	1907	Extended 234 days (2011) because of cleaning after a fire in containment. Total dose for cleaning was 1664 man.mSv.
Ringhals 3	PWR	30	283	
Ringhals 4	PWR	168	2008	Extended 78 days, replacement of Steam Generators and PRZ.

(Outage collective dose is registered EPD dose)

Component or system replacements

Forsmark 1 Steam Reheaters (system 418) replaced during outage.
Ringhals 4 Replacement of Steam Generators (SG) and Pressurizer (PRZ).
Barsebäck Cutting CR (Control Rods) and transportation to intermediate storage, decommissioning.
Oskarshamn 1 Replacement of two valves in the Reactor Cooling system, dose rates of 3-4 mSv/h, using a thin cutting layer resulting in shorter work time and corresponding collective dose.
Oskarshamn 3 Replacement of Turbine bearings due to vibrations.

Safety-related issues

General employee training for personnel working in the RCA (Radiological Controlled Area) was extended with practical training in a step-over mock-up. This is to be a new course executed at all Swedish nuclear power plants. The Swedish NPP will have implemented this during 2012.

Unexpected events

Forsmark Poor welding quality during Steam Reheater (system 418) replacement and other extensive work in the turbine plant caused more man-hours and a greater dose than planned for, both collective and individuals.
Ringhals 2 Cleaning activities after a fire in containment during CAT (Containment Air Test, ILRT = Integrated Leak Rate Test). Total dose for cleaning was 1664 man.mSv.

New/experimental dose-reduction programmes

Ringhals The efforts to more clearly turn over the RP responsibility to each department manager including planning and calculating department annual collective doses continues and has been complemented with ALARA sub groups (Thermal insulation, Scaffolding, Cleaning, Maintenance, Fuel, NDT etc. Ringhals also founded a new ALARA committee which will be running during 2012.
Barsebäck Forced ALARA implementation in project HINT (segmentation of Reactor Internals).

Issues of concern for 2012

Forsmark	Work to be executed during outage at F2 would cause high doses, both collective and individuals, therefore a system decontamination of systems 321/331 will be executed.
Ringhals 1	The Turbine system will be rebuilt to FPHD (Forward Pumped Heat Drainage).
Ringhals 3	The Charging pumps deaeration will be rebuild and completed in order to lower discharge of radioactive gaseous by physical delay.

Regulatory (Swedish Radiation Safety Authority) plans for major work in 2012

A new regulation concerning clearance of material, rooms, buildings and ground at nuclear facilities came in force 1st of January 2012 (SSMFS 2011:2, not yet translated to English).

A revised version of the regulation "The Swedish Radiation Safety Authority's Regulations concerning Safety in Nuclear Facilities" (SSMFS 2008:1) came partly in force 1st of April 2012 and will come fully in force 1st of November 2012.

The revision of the "The Swedish Radiation Safety Authority's Regulations on Protection of Human Health and the Environment in connection with Discharges of Radioactive Substances from certain Nuclear Facilities" (SSMFS 2008:23) is in progress.

The Swedish Radiation Safety Authority's regulations will be published in English at www.ssm.se.

In 2011 The Swedish Radiation Safety Authority made inspections at all three nuclear power plant facilities in operation concerning optimization of radiation protection. The conclusions from the inspections are that the authority calls for more short and long term concrete and proactive goals for the optimization of radiation protection.

SSM has during 2011-2012 made the "Periodic safety reviews" for Ringhals 3 and 4 and Forsmark 1 and 2. During 2012 SSM started the Periodic safety reviews for Oskarshamn 1.

SWITZERLAND

Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv/unit]**
PWR	3	0.359
BWR	2	0.952
Total: All types	**5**	**0.596**

Summary of National Dosimetric Trends

The average collective dose per reactor unit results with 0.596 man-Sv/y at the lowest value since the beginning of nuclear energy production in Switzerland. Also the average individual dose for personnel in nuclear facilities at about 0.6 mSv/y is the lowest ever determined. On the other hand these values have not changed significantly in recent years. The maximum individual dose (10.9 mSv) in NPP Leibstadt was far below the regular annual dose limit of 20 mSv/y showing efficient optimization processes in the Swiss nuclear facilities. All 5800 monitored persons had no measurable intake of radioactivity (evidence level < 0.1 mSv). No fixed skin contamination was registered.

Events influencing dosimetric trends

NPP Beznau 1: Local dose rates of closure legs in the primary loop system have in contrast to measurements of last year risen at the primary coolant pipes by some 20%. Thus there is a constant yearly rise since 2005. Local dose rates measured at hot legs still show a low level although there is a minimal increase to be seen. The analysis of nuclides specific measurements on relevant piping gives reason to assume two different ways of contamination, a younger and older contamination. The younger contamination is clearly dominated by 95Zr with 55% and 60Co (29%). The older contamination shows a domination of 60Co and 137Cs.

NPP Beznau 2: Mean local dose rates on the casings of steam generators are still low compared to the results of last year. Compared to last year local dose rates at the primary coolant pipes have increased on average by 10%. Thus there seems to be a similar trend as in Beznau 1 although Beznau 2 has lower local dose rates and a lower increase.

NPP Gösgen: Injection of depleted zinc into the primary loop system had a very positive effect on dose rates and accumulated personal dose. Dose rates of selected primary components decreased on average by 44% compared to the beginning of zinc injection in 2005. Compared to the year before the decrease of dose rates was 9%.

Due to fuel core cladding leakages from 2007 until 2010 resulting in tramp uranium an intensified monitoring program concerning radiation protection had to be carried out during outage 2011.

NPP Leibstadt: During the 27th cycle the concentration of 60Co in the water of the primary coolant system has risen from 6.5 E+6 Bq/m3 to 1.3 E+7 Bq/m3. Due to this an increase of local dose rates on several systems was expected. Reference data on jet pump loops delivered a local dose rate on average of 2.43 mSv/h (2010: 1.14mSv/h). In the drywell´s accessible areas local dose rates increased to some 50%.

Number and duration of outages

Each NPP had one planned outage during 2011:

- NPP Beznau 1: 7. June - 20. June 2011 (13 days)
- NPP Beznau 2: 12. August - 1. October 2011 (50 days)
- NPP Gösgen: 4. June - 30. June 2011 (27 days)
- NPP Mühleberg: 30. June - 9. September 2011 (72 days)
- NPP Leibstadt: 3. August - 30. August 2011 (27 days)

New plants on line/plants shut down

There has been a fundamental shift in the way the public regards nuclear facilities in Switzerland after the catastrophic events at the Fukushima NPP in Japan on 11 March 2011. 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 the phasing out of nuclear energy. 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.

Component or system replacements

None with significant job dose.

Unexpected events

None with radiological consequences.

UKRAINE

Dose information

Operating reactors		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv/unit]**
VVER	15	0.67

Summary of National Dosimetric Trends

The level of collective dose of NPP personnel in 2011 amounted to 10.12 man.Sv per year, slightly below 2010's level (11.43 man.Sv/year)

Events influencing dosimetric trends

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

Number and duration of outages

Number of outages in 2011: 15. The average outage duration in 2011 was 62 days.

Major evolutions

Steady positive irradiation dose trends in recent ten years

Component or system replacements

Replacement of out-of-date components and expansion of the radiation monitoring system functions

Safety-related issues

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

New/experimental dose-reduction programmes

There are Radiation Safety Improvement Programs for 2011-2015 in place at all NPPs operated by the Company.

Technical plans for major work in 2012

There is a Program for Reconstruction of the Radiation Monitoring 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	0.536
GCR (AGR)	14	0.084
GCR (Magnox)	4	0.053
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	0.049

Summary of National Dosimetric Trends

With the exception of the Sizewell B PWR all of UK's nuclear power plants are gas-cooled. Doses were higher than the previous year on the Advanced Gas Cooled Reactors (AGRs) because of the need for more in-vessel work at a number of the AGRs. The Collective Radiation Exposure for the British Energy reactor fleet was approximately 1.18 man.Sv. The collective dose for the remaining operating Magnox type reactors (two reactors each at Oldbury and Wylfa) was 0.212 man.Sv. Decommissioning doses remained low, averaging less than 0.1 man.Sv per shutdown site.

Events influencing dosimetric trends

Gas reactor doses increased in 2011 because the AGRs at Hinkley Point and Hunterston performed extended vessel entries in support of boiler inspection and repairs. More than 90% of the annual CRE at Sizewell was received during the eleventh Refuelling Outage which took place in the autumn.

Number and duration of outages

The gas-cooled reactors operate to 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 0.38 man.Sv and 0.5 man.Sv respectively. The AGR at Heysham 2 also had to carry out emergent in-vessel work however this were limited in duration and only resulted in a collective radiation dose of around 0.02 man.Sv.

The annual dose at Sizewell B was dominated by the eleventh Refuelling Outage. This was an extensive outage, lasting 51 days, that required the Reactor Coolant System to be fully drained. The work scope included replacement of the majority of the Pressuriser heaters, replacement of one Reactor Coolant Pump impellor, Steam Generator primary side inspections etc.

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. Of the original Magnox reactor fleet two sites remain in power operation at the end of calendar year 2011, Oldbury and Wylfa. At Oldbury one reactor shutdown for the final time near the end of 2011 and the second reactor is expected to permanently shutdown at the end of February 2012. Of the permanently shutdown sites some are completely defueled and are at various stages of decommissioning. Other sites are shutdown with the reactors undergoing defueling and with air cooling. Defueling of these sites continue to be rate limited by the capacity of the Sellafield reprocessing plant to receive and process irradiated fuel.

UK New Nuclear Build

Generic designs for two nuclear reactors proposed for construction in the UK have been granted interim design acceptance by the independent nuclear safety, security and environment regulators.

The Office for Nuclear Regulation and the Environment Agency confirmed they are satisfied with how the designers of both EDF and Areva's UK EPR and Westinghouse’s AP1000 reactors plan to resolve a number of remaining issues. It is anticipated that the New Nuclear Build licensing process will increasingly focus on site-specific issues.

Currently EDF Energy have well-advanced plans to construct twin Areva EPRs at Hinkley Point and Sizewell. Horizon Power (an EON/RWE consortium) have plans to build new reactors at Wylfa and Oldbury.

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	1.42
Total: All types	**104**	**0.84**

Summary of National Dosimetric Trends

The total collective dose in the United States was 87.713 person.Sv for 104 units in 2011. This is five percent lower than the 2010 total 91.961 person.Sv. The resulting average collective dose per reactor for USA LWR was 0.843 person.Sv per unit.

The total collective dose for US boiling water reactors in 2011 was 49.765 person.Sv for 35 reactors. The resulting average collective dose for BWRs in 2011 was 1.421 person.Sv. The resulting average collective dose for BWRs in 2010 was 1.292 person.Sv. This is nine percent higher than the 2010 total collective dose

In 2011, the total collective dose for US pressurized water reactors was 37.948 person.Sv for 69 reactors. The resulting average collective dose per reactor for PWRs in 2011 was 0.549 person.Sv per reactor. The average US PWR collective dose per reactor in 2010 was 0.677 person.Sv per unit

Events influencing dosimetric trends

During the past five years, the trend for reducing collective radiation exposure (CRE) has not been acceptable. Several units remain well over the current United States industry CRE goal and have not made significant progress toward reducing collective dose. The boiling water reactors as a group did not meet the 2010 CRE annualized cycle dose goal of less than1.20 person.Sv.

Figure 1. BWR Two Year Rolling Average Dose 2005-2011

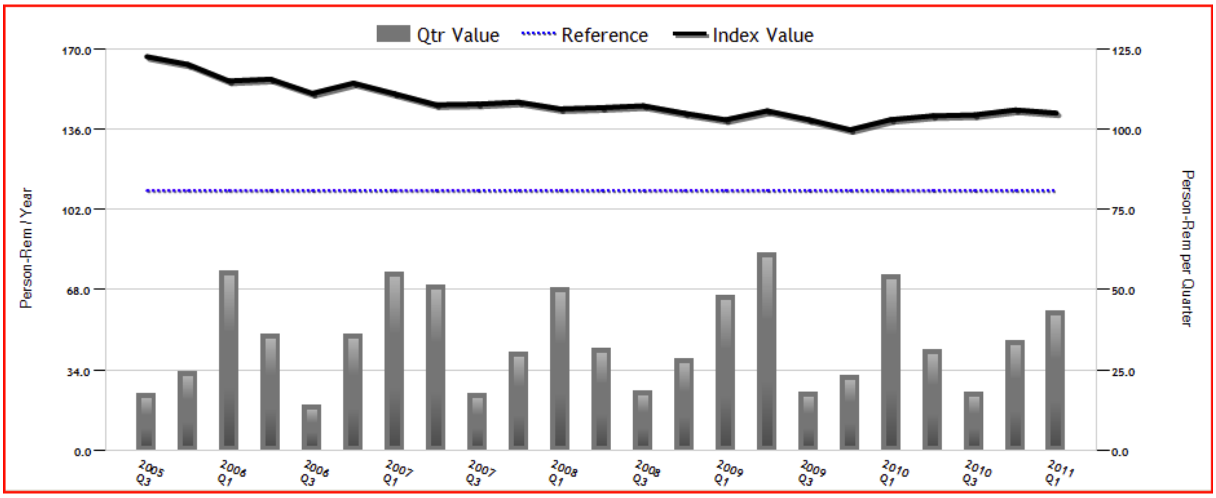
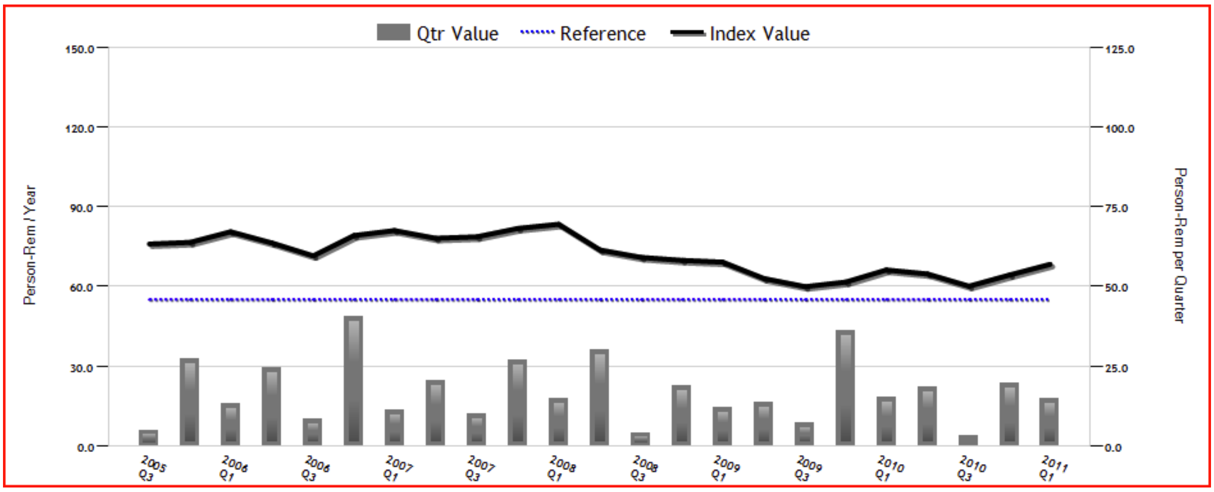


Figure 2. PWR Two Year Rolling Average Dose 2005-2011



The graphs illustrate that although CRE performance has improved since 2005, the current industry trends are not on track to meet the more challenging 2015 industry goals of 0.55 person.Sv per year for PWRs and 1.10 person.Sv per year for BWRs.

Two of the primary reasons stations are not meeting industry dose goals are high source term and weaknesses in managing reactor shutdown crud bursts. A principal contributor to high source term is that large inventories of components containing nickel and cobalt in the reactor primary systems (and secondary systems of BWRs) wear during plant operation, resulting in activation when transported to the reactor core. This process contributes to elevated concentrations of cobalt-58 and cobalt-60 in the reactor coolant and the subsequent incorporation into the oxide layers of primary system piping and components. Although zinc injection helps mitigate the effects of the high cobalt levels to manage dose rates, the best way to reduce dose is to remove the source. Each year between 2004 and 2010, the industry experienced five crud bursts that were either unanticipated or poorly managed, resulting in outage collective doses significantly greater than predicted

Number and duration of outages

In 2011, there were 66 BWR and PWR refuelling outages in 2011 out of the 104 US operating reactors. The average 2011 refuelling duration was 43 days compared to 40 days in 2010 and 41 days in 2009.

New plants on line/plants shut down

During 2011, four units were shutdown due to equipment issues. These included Crystal River, Fort Calhoun, and San Onofre Units 2 and 3.

- Crystal River remained shutdown throughout 2011 as a result of a multi-year outage due to containment concrete problems. This issue was discovered during a steam generator replacement project.
- Fort Calhoun was shut down for a refuelling outage in April of 2011. As a result of flooding in June 2011, the unit remained shut down through the rest of 2011 to address equipment issues resulting from this event.
- Late in 2011, San Onofre 2 &3 in Southern California shut down due to leakage that occurred in the recently replaced steam generators. The units remain shut down until federal regulators can determine why tubes carrying radioactive water in the plant's massive generators developed the leakage.

Unexpected events

Two recent unplanned personnel exposure events have occurred during work under the reactor vessel that involved irradiated components.

<u>*Event 1*</u>

Three instrument and control (I&C) technicians at Cooper Unit 1 were unexpectedly exposed to high radiation levels when they manually withdrew an irradiated intermediate-range monitor shuttle tube while working under the reactor vessel. When the tube was lowered into the area, the workers' electronic dosimeters alarmed and they immediately exited the area. The maximum dose rate any worker was exposed to was calculated to be 0.30 Sv per hour. The worker closest to the tube, which had a measured contact dose rate of 32 Sv per hour, received an unplanned whole-body dose of 0.4 mSv and 31.50 mSv to his hand.

Normally, the shuttle tube is removed underwater from the refuel floor; however, the workers and their supervisor discussed the potential for removing the shuttle tube from beneath the reactor if they could not locate a device to prepare it for underwater removal. Radiation protection (RP) personnel were not present at the maintenance prejob briefing and were not informed of this alternative removal method during the radiological prejob briefing or when the decision was made to remove the shuttle tube from below the vessel.

Significant aspects of the event include the following:

- A non-conservative decision was made by the I&C supervisor and outage control center management representative to implement the alternate method of removal.
- Weaknesses in the work order planning process resulted in ineffective management of the radiological risk posed by the job. .
- Shortfalls in the implementation of ALARA process controls created a situation in which radiation protection personnel were unaware that the shuttle tube was being removed from undervessel.

Event 2

Three supplemental I&C workers and an RP technician were unexpectedly exposed to extremely high radiation levels when they manually withdrew a source range monitor (SRM) detector cable too far while working under the reactor vessel. The worker closest to the cable, which was later measured to have a 30-centimeter dose rate of 10 Sv per hour, received an unplanned whole-body dose of 0.98 mSv. Although the detector remained inside the drive/shuttle tube, the irradiated cable caused elevated dose rates in the work area and the workers had to pass through dose rates as high as 0.16 Sv per hour when exiting the area.

Personnel involved in the activity were aware the detector and cable had been stuck in the core for many months and would have elevated dose rates, but they underestimated the magnitude of the radiation levels. Their work instructions directed them to slowly withdraw approximately 9 feet of the detector cable by hand before cutting it and attaching the remaining cable to a remotely operated device to complete withdrawal of the remaining cable and detector into a shielded cask. However, the workers did not accurately measure the cable and withdrew it approximately 19 to 22 feet. Coincident with stopping the withdrawal, electronic dosimeters alarmed and the workers immediately exited the area

Significant aspects of the event include the following:

- Several procedure quality issues contributed to the event and had the potential to result in personnel exposure beyond what was received.
- The severity of the event could have been worse if additional cable was pulled. An excessive rate of cable withdrawal did not allow sufficient time to detect an increase in dose rates. The dose rates from the SRM detector and cable were estimated to be in the order of 50 Sv/hr.
- The risk of removing the SRM detector was not adequately recognized. Potential dose rates from an SRM that had been stuck in the core during power operations were inaccurately estimated. As a result, appropriate controls were not put in place.

New/experimental dose-reduction programmes

The continued low average collective doses reflect the US nuclear industry's continuing commitment to the lowering of occupational doses by implementing effective exposure reduction initiatives such as source term reduction programs, efficient outages, enhanced reactor coolant chemistry control, and effective ALARA programs in the traditional areas of control of time, distance, and shielding.

Organisational evolutions

Duke Power acquired Progress Energy adding the following nuclear power units to their existing fleet: Crystal River, Robinson, Harris, and Brunswick 1 and 2.

Issues of concern for 2012

Fukushima related issues and potential changes to the rules that govern emergency preparedness. These potential changes may result in additional doses to complete plant upgrades to address lesson learned from this significant event.

Regulatory plans for major work in 2012

In 2011, the United States Nuclear Regulatory Commission (USNRC) continued to review the potential to change the regulations for radiation protection. The major change in this revision includes: (1) to lower the individual collect dose limit from the current value of 50 mSv/year to a value more in alignment with the individual dose limits as published in ICRP 103; (2) to lower the embryo/fetal dose to a value in alignment with the embryo/fetal dose limit as published in ICRP 103; and (3) to lower the current lens dose equivalent limit to a value more in alignment with the lens dose limit in ICRP 103. It is expected that the USNRC staff will receive Commission direction on how best to proceed with potential radiation protection regulatory changes by December 2012. During 2011 and 2012, the USNRC staff will continue to engage all licensee categories, industry groups, radiation protection professional organizations, State governments, and public interest groups for input related to the potential changes to the radiation protection regulations

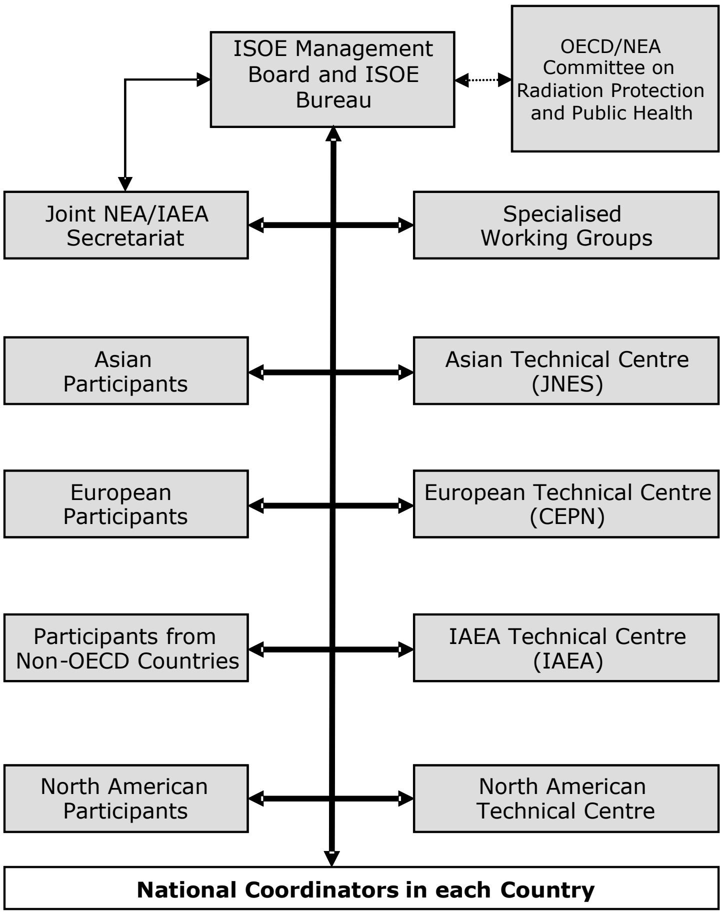
Annex 1

ISOE ORGANISATIONAL STRUCTURE AND PROPOSED PROGRAMME OF WORK FOR 2012

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 point 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 Management Board and ISOE Bureau
OECD/NEA Committee on Radiation Protection and Public Health
Joint NEA/IAEA Secretariat
Specialised Working Groups
Asian Participants
Asian Technical Centre (JNES)
European Participants
European Technical Centre (CEPN)
Participants from Non-OECD Countries
IAEA Technical Centre (IAEA)
North American Participants
North American Technical Centre
National Coordinators in each Country

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 2011, the ISOE programme included:

- 70 Participating Utilities[1] in 29 countries, covering 323 operating units; 40 shutdown units),
- Regulatory authorities of 24 countries (3 countries participate with 2 authorities).

Objective: During 2011, the ISOE Technical Centres and ISOE Joint Secretariat continued to pursue the formal renewal of previous participants under the current ISOE Terms and Conditions and seek the involvement of new participants.

ISOE PROGRAMME ACTIVITIES

1) ISOE Database Management

Data collection and management

Objective: Collection of ISOE 1 data: ISOE participants will provide their 2011 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 has been 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 2011 data, will be released at the end of the 2012.

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;
- MADRAS: Implementation of new analyses;

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.

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

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 shut-down 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 2012. Products will be made available through the ISOE Network as appropriate.

- **ISOE Annual Reports**
  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 2x per 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 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 January 2012), organised by NATC

Regional Symposia:

- 2012 ISOE European ALARA Symposium, Prague, Czech Republic (20-22 June 2012), organised by ETC
- 2012 ISOE Asian ALARA Symposium, Japan (October / November 2012), organised by ATC

4) ISOE Network Website Management and Technical Centre Input

Network Website Management

Objective: ETC will continue the website management. 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 RP Library.

5) Reports and Documents, Information Sheets, and Information Exchange

Objective: Effectively support information exchange activities between ISOE participants

Technical Centre Information Sheets planned for 2012:

Objective: The following technical centre information sheets will be prepared:

Technical Centre Information Sheets planned for 2012				
Yearly analyses	**ATC**	**ETC**	**IAEA TC**	**NATC**
ATC: Japanese dosimetric results for 2012	X			
ETC: European dosimetric results for 2012		X		
Special analyses				
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 utility or authority member.

6) ISOE-organised Benchmarking Visits

The following site benchmarking visits will be organized under ISOE in 2012 by the technical centres in coordination with the ISOE WGDA and Management Board:

Benchmarking visits for 2012	
ETC	None planned under ISOE. CEPN-EDF visits will be organized using ISOE contacts, but not ISOE finances (One or two NPPs).
ATC	Not decided
NATC	Not decided

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 Cooperation 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., 13th International Congress of the International Radiation Protection Association in May 2012).

OVERALL SCHEDULE OF ISOE MEETINGS FOR 2012

ISOE Meetings for 2012	**Jan**	**April**	**June**	**Sept**	**Nov**
Technical Centre Coordination meeting					
ISOE Bureau/Technical Centres		X			X
Working Group on Data Analysis		X			X
20th ISOE Management Board Meeting					X
ISOE International ALARA Symposium	X				
ISOE European ALARA Symposium			X		
ISOE Asian ALARA Symposium				X	

Annex 2

LIST OF ISOE PUBLICATIONS

Reports

1. Occupational Exposures at Nuclear Power Plants: Eighteenth Annual Report of the ISOE Programme, 2009, OECD, 2011.
2. *L'organisation du travail pour optimiser la radioprotection professionnelle dans les centrales nucléaires*, OCDE, 2010.
3. *Occupational Exposures at Nuclear Power Plants: Eighteenth Annual Report of the ISOE Programme, 2008,* OECD, 2010.
4. *Work Management to Optimise Occupational Radiological Protection at Nuclear Power Plants*, OECD, 2009.
5. *Occupational Exposures at Nuclear Power Plants: Seventeenth Annual Report of the ISOE Programme, 2007*, OECD, 2009.
6. *Occupational Exposures at Nuclear Power Plants: Sixteenth Annual Report of the ISOE Programme, 2006*, OECD, 2008.
7. *Occupational Exposures at Nuclear Power Plants: Fifteenth Annual Report of the ISOE Programme, 2005*, OECD, 2007.
8. *Occupational Exposures at Nuclear Power Plants: Fourteenth Annual Report of the ISOE Programme, 2004*, OECD, 2006.
9. *Occupational Exposures at Nuclear Power Plants: Thirteenth Annual Report of the ISOE Programme, 2003*, OECD, 2005.
10. *Optimisation in Operational Radiation Protection*, OECD, 2005.
11. *Occupational Exposures at Nuclear Power Plants: Twelfth Annual Report of the ISOE Programme, 2002*, OECD, 2004.
12. *Occupational Exposure Management at Nuclear Power Plants: Third ISOE European Workshop, Portoroz, Slovenia, 17-19 April 2002,* OECD 2003.
13. *ISOE – Information Leaflet,* OECD 2003.
14. *Occupational Exposures at Nuclear Power Plants: Eleventh Annual Report of the ISOE Programme, 2001,* OECD, 2002.
15. *ISOE – Information System on Occupational Exposure, Ten Years of Experience*, OECD, 2002.
16. *Occupational Exposures at Nuclear Power Plants: Tenth Annual Report of the ISOE Programme, 2000,* OECD, 2001.
17. *Occupational Exposures at Nuclear Power Plants: Ninth Annual Report of the ISOE Programme, 1999*, OECD, 2000.
18. *Occupational Exposures at Nuclear Power Plants: Eighth Annual Report of the ISOE Programme, 1998*, OECD, 1999.
19. *Occupational Exposures at Nuclear Power Plants: Seventh Annual Report of the ISOE Programme, 1997*, OECD, 1999.
20. *Work Management in the Nuclear Power Industry*, OECD, 1997 (also available in Chinese, German, Russian and Spanish).
21. *ISOE – Sixth Annual Report: Occupational Exposures at Nuclear Power Plants: 1969-1996*, OECD, 1998.

22. *ISOE – Fifth Annual Report: Occupational Exposures at Nuclear Power Plants: 1969-1995,* OECD, 1997.
23. *ISOE – Fourth Annual Report: Occupational Exposures at Nuclear Power Plants: 1969-1994*, OECD, 1996.
24. *ISOE – Third Annual Report: Occupational Exposures at Nuclear Power Plants: 1969-1993,* OECD, 1995.
25. *ISOE – Nuclear Power Plant Occupational Exposures in OECD Countries: 1969-1992,* OECD, 1994.
26. *ISOE – Nuclear Power Plant Occupational Exposures in OECD Countries: 1969-1991,* OECD, 1993.

ISOE News

2011	No. 17 (September), No. 18 (December)
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. 35: Nov. 2011	Japanese Dosimetric Results: FY 2010 data and trends
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. 53: Feb. 2011	European dosimetric results for 2009
No. 52: Apr. 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: Sep. 2009	Outage duration and outage collective dose between 1996 – 2006 for VVERs
No. 49: Sep. 2009	Outage duration and outage collective dose between 1996 – 2006 for BWRs
No. 48: Sep. 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: March 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 data base – 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	U.S. PWR - Reactor Head Replacement Dose Benchmarking Study
2003-5: July 2003	North American BWR - 2002 Occupational Dose Benchmarking Charts
2003-4: July 2003	U.S. PWR - 2002 Occupational Dose Benchmarking Chart
2003-2: July 2003	3-Year rolling average annual dose comparisons - U.S. BWR 2000-2002 Occupational Dose Benchmarking Charts
2003-1: July 2003	3-Year rolling average annual dose comparisons - U.S. PWR 2000-2002 Occupational Dose Benchmarking Charts
2002-5: July 2002	U.S. BWR - 2001 Occupational Dose Benchmarking Chart
2002-4: July 2002	U.S. PWR - 2001Occupational Dose Benchmarking Chart
2002-2: July 2002	3-Year rolling average annual dose comparisons - U.S. BWR 1999-2001 Occupational Dose Benchmarking Charts
2002-1: Nov. 2002	3-Year rolling average annual dose comparisons - U.S. PWR 1999-2001 Occupational Dose Benchmarking Charts
2001-7: Nov. 2001	US PWR 5-Year Dose Reduction Plan: Donald C. Cook Nuclear Power Plant
2001-5: Dec. 2001	U.S. BWR - 2000 Occupational Dose Benchmarking Chart
2001-4: Dec. 2001	U.S. PWR - 2000 Occupational Dose Benchmarking Chart
2001-3: Nov. 2001	3-Year rolling average annual dose comparisons - Canada reactors (CANDU) 1998-2000 Occupational Dose Benchmarking Charts
2001-2: July 2001	3-Year rolling average annual dose comparisons - U.S. BWR 1998-2000 Occupational Dose Benchmarking Charts

2001-1: July 2001 3-Year rolling average annual dose comparisons - U.S. 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
Sep. 2009 (Aomori, Japan)	2009 ISOE Asian ALARA Symposium
Nov. 2008 (Tsuruga, Japan)	2008 ISOE International ALARA Symposium
Sept. 2007 (Seoul, 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)	2010ISOE 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. 2011 (Ft. Lauderdale, FL, USA)	2011 ISOE North American ALARA Symposium
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)

Note: This annex provides the status of ISOE official participation as of December 2011

Officially Participating Utilities: Operating reactors

Country	Utility[1]	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, 3, 4 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

1. Where multiple owners and/or operators are involved, only Leading Undertakings are listed.

Country	**Utility**[1]	**Plant name**	
Germany	E.ON Kernkraft GmbH	Brokdorf Grafenrheinfeld Grohnde	Isar 1, 2 Unterweser
	EnBW Kernkraft AG	Philippsburg 1, 2	Gemeinschaftskraftwerk-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 Daiichi 1, 2, 3, 4, 5, 6 Fukushima Daini 1, 2, 3, 4	Kashiwazaki Kariwa 1, 2, 3, 4, 5, 6, 7
Korea	Korean Hydro and Nuclear Power	Kori 1, 2, 3, 4 Shin-Kori 1 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	
Switzerland	Forces Motrices Bernoises (FMB)	Mühleberg	
	Kernkraftwerk Gösgen-Däniken (KGD)	Gösgen	
	Kernkraftwerk Leibstadt AG (KKL)	Leibstadt	
	Axpo AG	Beznau 1, 2	
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

Country	Utility[1]	Plant name	
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
	Dominion Generation	Kewaunee	
	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	
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	

Country	Utility	Plant name
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	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	U.S. 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, Rep. 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		

* Note: 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, U.S.A.
	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
8270 Krško, Slovenia

Tel: +386 7 4802 287
Eml: borut.breznik@nek.si

Annex 5

ISOE WORKING GROUPS (2011)

Working Group on Data Analysis (WGDA)

Chair: HENNIGOR, Staffan (Sweden); Vice-Chair: STRUB, Erik (Germany)

CANADA	
DJEFFAL, Salah	Canadian Nuclear Safety Commission
McQUEEN Maureen	Bruce Power
CZECH REPUBLIC	
FARNIKOVA, Monika	Temelin NPP
FRANCE	
BELTRAMI, Laure-Anne	CEPN (ETC)
D'ASCENZO, Lucie	CEPN (ETC)
SCHIEBER, Caroline	CEPN (ETC)
COUASNON, Olivier	ASN
ROCHER, Alain	EDF
GERMANY	
KAULARD, Jorg	Gesellschaft für Anlagen-und Reaktorsicherheit mbH
STRUB, Erik	Gesellschaft für Anlagen-und Reaktorsicherheit mbH
JENTJENS, Lena	VGB-PowerTech
BASCHNAGEL, Michael	Biblis NPP
JAPAN	
HAYASHIDA, Yoshihisa	Japan Nuclear Energy Safety Organization (ATC)
MIZUMACHI, Wataru	Japan Nuclear Energy Safety Organization (ATC)
SUZUKI, Akiko	Japan Nuclear Energy Safety Organization (ATC)
KOREA (REPUBLIC OF)	
CHOI, Won-Chul	Korea Institute of Nuclear Safety (KINS)
JUNG, Kyu-Hwan	Korea Institute of Nuclear Safety (KINS)
ROH, Hyun-Suk	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
SPAIN	
Miguel Angel de la Rubia Rodiz	CSN
SWEDEN	
HENNIGOR, Staffan	Forsmarks Kraftgrupp AB
SOLSTRAND, Christer	OKG AB
SVEDBERG, Torgny	Ringhals AB
UNITED STATES OF AMERICA	
HAGEMEYER, Derek	Oak Ridge Associated Universities (ORAU)
LEWIS, Doris	US Nuclear Regulatory Commission
MILLER, David .W.	D.C. Cook Plant (NATC)
HARRIS, Willie	Exelon

Expert Group on Water Chemistry and Source-Term Management (EGWC)

Chair: ROCHER, Alain (France)

FRANCE	
RANCHOUX, Gilles	EDF
ROCHER, Alain	EDF
VAILLANT, Ludovic	CEPN (ETC)
KOREA (REPUBLIC OF)	
YANG, Ho-Yeon	Korean Hydro & Nuclear Power Co. (KHNP)
SONG, Min-Chui	Korea Institute of Nuclear Safety (KINS)
SLOVAK REPUBLIC	
SMIEŠKO, Ivan	Bohunice NPP
SWEDEN	
BENGTSSON, Bernt	Ringhals NPP
OLSSON, Mattias	Forsmark NPP
UNITED STATES OF AMERICA	
CHRZANOWSKI, Ronald	Exelon
WELLS, Daniel M.	Electric Power Reasearch Institute (EPRI)

Annex 6

ISOE MANAGEMENT BOARD AND NATIONAL CO-ORDINATORS (2010-2011)

Note: ISOE National Co-ordinators identified in **bold**.

ARMENIA	
PYUSKYULYAN Konstantin	Armenian Nuclear Power Plant Company
AVETISYAN, Aida	Armenian Nuclear Regulatory Authority
BELGIUM	
NGUYEN Thanh Trung	Electrabel (Tihange NPP)
SCHRAYEN, Virginie	FANC-Federal Agency for Nuclear Control
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 Nucleaire 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
CHEVALIER, Sophie	ASN
COUASNON, Olivier	ASN
GUZMAN LOPEZ-OCON, Olvido	ASN
GERMANY	
JENTJENS, Lena	VGB PowerTech e.V.
BASCHNAGEL, Michael	RWE Power AG, Kraftwerk Biblis
FRASCH, Gerhard	Bundesamt für Strahlenschutz
KAULARD, Jörg	Gesellschaft für Anlagen-und Reaktorsicherheit mbH (GRS)
STRUB, Erik	Gesellschaft füer Anlagen-und Reaktorsicherheit mbH (GRS)
HUNGARY	
BUJTAS, Tibor	PAKS NPP
ITALY	
MANCINI, Francesco	SOGIN Spa

JAPAN	
HAYASHIDA, Yoshihisa	Japan Nuclear Energy Safety Organization (ATC)
KOBAYASHI, Masahide	Japan Nuclear Energy Safety Organization (ATC)
MIZUMACHI, Wataru	Japan Nuclear Energy Safety Organization (ATC)
SUZUKI, Akira	Tokyo Electric Power Company
TSUJI, Masatoshi	Nuclear and Industrial Safety Agency (NISA)
YONEMARU, Kenichi	Kyushu Electric Power Company
KANEOKA, Tadashi	The Chugoku Electric Power Co., Inc.
KOREA (REPUBLIC OF)	
KIM Byeong-Soo	Korea Institute of Nuclear Safety (KINS)
CHOI, Won-Chul	Korea Institute of Nuclear Safety (KINS)
AN, Yong Min	Korea Hydro and Nuclear Power. Co. Ltd
LEE, Hee-hwan	Korea Hydro and Nuclear Power. Co. Ltd
NA, Seong Ho	Korea Institute of Nuclear Safety (KINS)
LITHUANIA	
TUMOSIENE Kristina	State Nuclear Power Safety Inspectorate (VATESI)
PLETNIOV, Victor	Ignalina NPP
BALCYTIS, Gintautas	Radiation Protection Centre
MEXICO	
ARMENTA Socorro	Central Laguna Verde
MEDRANO, Marco	National Nuclear Research Institute
THE NETHERLANDS	
MEIJER, Hans	Borssele NPP
BREAS, Gerard	Ministry For Environment
PAKISTAN	
NASIM, Bushra	Pakistan Nuclear Regulatory Authority
MUBBASHER, Makshoof	Chashma NPP (Unit1)
ROMANIA	
SIMIONOV, Vasile	Cernavoda NPP
RODNA, Alexandru	National Commission for Nuclear Activities Control
VELICU, Oana	National Commission for Nuclear Activities Control
RUSSIAN FEDERATION	
BEZRUKOV, Boris	Energoatom Concern OJSC
GLASUNOV, Vadim	Russian Research Institute for Nuclear Power Plant Operation (VNIIAES)
SLOVAK REPUBLIC	
DOBIS, Lubomir	Bohunice NPP
VIKTORY, Dusan	Public Health Institute of the Slovak Republic
SLOVENIA	
BREZNIK, Borut	Krsko NPP
JANZEKOVIC, Helena	Slovenian Nuclear Safety Administration
JUG, Nina	Slovenian Radiation Protection Administration
CERNILOGAR RADEZ, Milena	Slovenian Nuclear Safety Administration
SOUTH AFRICA (REPUBLIC OF)	
MAREE, Marc	Koeberg NPS
SPAIN	
HERRERA Borja Rosell	Almaraz NPP
LABARTA, Teresa	Consejo de Seguridad Nuclear
ROSALES CALVO, Maria Luisa	Consejo de Seguridad Nuclear
DE LA RUBIA, Miguel Angel	Consejo de Seguridad Nuclear
SWEDEN	
SVEDBERG, Torgny	Ringhals NPP
FRITIOFF, Karin	Swedish Radiation Safety Authority
LINDVALL, Carl Göran	Barsebäck NPP
SOLSTRAND, Christer	Oskarsham NPP
HENNIGOR, Staffan	Forsmark NPP
SWITZERLAND	
TAYLOR Thomas	Muhleberg NPP
JAHN, Swen-Gunnar	ENSI
UKRAINE	
BEREZHNAYA Tatiana	ENERGOATOM
RYAZANTSEV, Viktor	SNRCU

UNITED KINGDOM	
RENN, Guy	Sizewell B Power Station
ZODIATES, Anastasios	British Energy
UNITED STATES OF AMERICA	
MILLER, David	D.C. Cook Plant (NATC)
GREEN, Bill	Clinton Power Station
LEWIS, Doris	U.S. Nuclear Regulatory Commission
BROCK, Terry	U.S. Nuclear Regulatory Commission
HARRIS, Willie	Exelon – Corporate
DALY, Patrick	Exelon - Braidwood
JONES, Patricia	Constellation Energy - Calvert Cliffs
OHR, Kenneth	Exelon - Quad Cities Station
HUNSICKER, John	South Carolina Electric - V.C Summer