Radiological Protection

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Occupational Exposures at Nuclear Power Plants

Twenty-second Annual Report of the ISOE Programme, 2012

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Radiological Protection

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

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NUCLEAR ENERGY AGENCY

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

The mission of the NEA is:

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

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

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

FOREWORD

Throughout the world, occupational exposures at nuclear power plants have steadily decreased since the early 1990s. Regulatory pressures, technological advances, improved plant designs and operational procedures, ALARA culture and experience exchange have contributed to this downward trend. However, with the continued ageing and possible life extensions of nuclear power plants 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-Second Annual Report of the ISOE Programme (2012) presents the status of the ISOE programme for the year of 2012.

"... 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, 2012-2015).

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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 22nd Annual Report of the ISOE Programme (2012) presents the status of the ISOE programme for the calendar year 2012.

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 2012-2015 came into force on 1 January 2012. At the end of 2012, the ISOE programme included 66 Participating Utilities in 28 countries (320 operating units; 46 shutdown units), as well as the regulatory authorities of 24 countries. The ISOE occupational exposure database itself included information on occupational exposure levels and trends at 396 operating reactors; covering about 91% 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 2012 average annual collective doses per reactor and 3-year rolling averages per reactor (2010-2012) were:

	2012 average annual collective dose (man·Sv/reactor)	**3-year rolling average for 2010-2012 (man·Sv/reactor)**
Pressurised water reactors (PWR)	0.52	0.60
Pressurised water reactors (VVER)	0.50	0.51
Boiling water reactors (BWR)	0.90	1.12
Pressurised heavy water reactors (PHWR/CANDU)	1.14	1.34

In addition to information from operating reactors, the ISOE database contains dose data from 81 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 2012 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 2012, 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 international / regional symposia, which in 2012 included the ISOE International symposium in Fort Lauderdale, USA, organised by the North American Technical Centre, European regional symposium in Prague, Czech Republic, organized by the European Technical Centre and Asian regional symposium in Tokyo, Japan organized by the Asian Technical Centre. These regional and international symposia provide a global forum to promote the exchange of ideas and management approaches for maintaining occupational radiation exposures as low as reasonably achievable.

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

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

Principal events in the ISOE participating countries are summarised in Section 3 of this report.

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 (2012-2015). 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 2012, the ISOE programme included: 66 Participating Utilities[1] in 28 countries, covering 320 operating units and 46 shutdown units, and the Regulatory Authorities of 24 countries. Table 1 summarises total participation by country, type of reactor and reactor status as of December 2012. A complete list of reactors, utilities and authorities officially participating in ISOE at the time of publication of this report is provided in Annex 1.

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 478 reactor units in 28 countries (396 operating; 82 in cold-shutdown or some stage of decommissioning), covering about 91% 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 leading utilities; in some cases, plants are owned/operated by multiple enterprises.

Table 1. The Official ISOE Participants and the ISOE Database (as of December 2012)

Note: The list of the Official ISOE Participants at the time of the publication of this report is provided in Annex 1.

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	19	–	–	4	–	–	23
Mexico	–	–	2	–	–	–	2
The Netherlands	1	–	–	–	–	–	1
Romania	–	–	–	2	–	–	2
Russian Federation	–	17	–	–	–	–	17
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	**172**	**51**	**69**	**28**	**–**	–	**320**

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	**267**	**82**	**29**	**18**	–	**396**

Table 1. The Official ISOE Participants and the ISOE Database (as of December 2012) (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
Spain	1	–	–	1	–	–	2
Sweden	–	2	–	–	–	–	2
Ukraine	–	–	–	–	3	–	3
United States	2	1	–	1	–	–	4
Total	**14**	**13**	**2**	**11**	**5**	**1**	**46**
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	**22**	**18**	**2**	**34**	**5**	**1**	**82**

Total number of reactors included in the ISOE database							
	PWR/ VVER	**BWR**	**PHWR**	**GCR**	**LWGR**	**Other**	**Total**
Total	**289**	**100**	**31**	**52**	**5**	**1**	**478**

Number of **Participating Countries**	**28**
Number of **Participating Utilities**[2]	**66**
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 EXPOSURE TRENDS

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, and
  - 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.

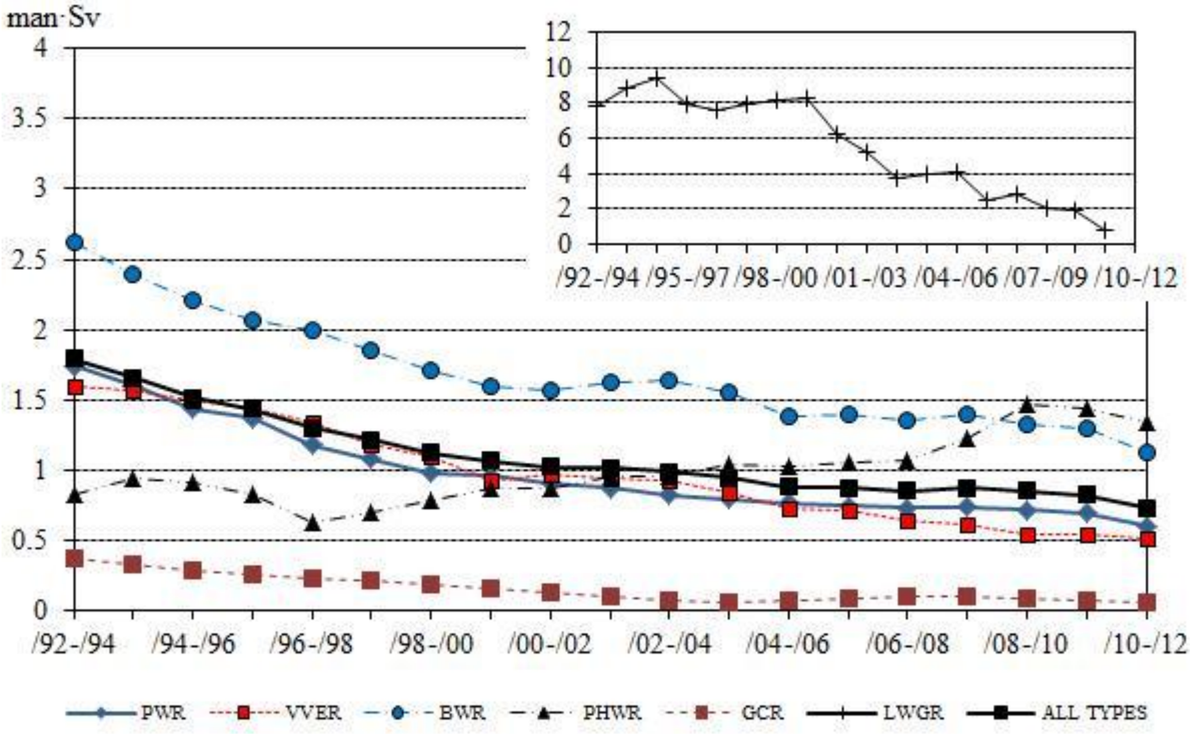
2.1 Occupational exposure trends: Operating reactors

a) Global trends by reactor type

Figures 1 shows the trend in 3-year rolling average collective dose per reactor, by reactor type, for 1992-2012. 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.

Average annual collective dose per reactor by country and reactor type for the period of 2010-2012 and 3 year rolling average annual collective dose per reactor, by country and reactor type for the period of 2008-2010 to 2010-2012 are given in table 2 and 3 respectively. These results are based primarily on data reported and recorded in the ISOE database during 2012, supplemented by the individual country reports (Section 3) as required. Figure 2 to 5 provide information on average collective dose per reactor by country for PWR, VVER BWR and PHWR reactors. In all figures, the "number of units" refers to the number of reactor units for which data has been reported for 2012.

Figure 1. **3-year rolling average collective dose per reactor for all operating reactors included in ISOE by reactor type, 1992-2012 (man·Sv/reactor)**



b) Average annual collective dose trends by country

Table 2 provides information on average annual collective dose per reactor by country and reactor type for the last three years.

Table 2. **Average annual collective dose per reactor, by country and reactor type, 2010-2012 (man·Sv/reactor)**

	PWR			VVER			BWR		
	2010	**2011**	**2012**	**2010**	**2011**	**2012**	**2010**	**2011**	**2012**
Armenia				0.77	1.25	0.89			
Belgium	0.30	0.37	0.33						
Brazil	0.50	0.37	0.08						
Bulgaria				0.43	0.27	0.18			
Canada									
China	0.44	0.51	0.45						
Czech Republic				0.12	0.12	0.12			
Finland				0.81	0.36	0.84	0.45	0.48	0.36
France	0.62	0.72	0.68						
Germany	0.61	0.43	0.23				0.88	0.58	1.07
Hungary				0.37	0.59	0.45			
Japan	1.51	0.91	0.18				1.23	1.05	0.29
Korea, Republic of	0.45	0.54	0.42						
Mexico							5.01	0.83	4.26
The Netherlands	0.62	0.28	0.33						
Pakistan	0.61	0.26	0.07						
Romania									
Russian Federation				0.65	0.66	0.62			
Slovak Republic				0.17	0.14	0.17			
Slovenia	0.85	0.07	0.88						
South Africa, Rep. of	0.52	0.55	0.77						
Spain	0.33	0.50	0.47				0.52	2.05	0.25
Sweden	0.46	1.43	0.54				0.93	1.07	0.67
Switzerland	0.53	0.36	0.43				1.25	1.07	1.49
Ukraine				0.66	0.59	0.59			
United Kingdom	0.27	0.54	0.04						
United States	0.56	0.61	0.56				1.35	1.42	1.20
Average	**0.66**	**0.65**	**0.50**	**0.53**	**0.51**	**0.50**	**1.29**	**1.12**	**0.90**

Note: Data provided directly from country report, rather than calculated from the ISOE database: UK (2010, 2011, and 2012: GCR) and USA (2012; PWR and BWR).
BWR dose in 2010, 2011 and in 2012 for Japan does not include Fukushima Daiichi Units 1-6.

	PHWR			GCR		
	2010	**2011**	**2012**	**2010**	**2011**	**2012**
Canada	1.69	1.27	1.30			
Korea, Republic of	2.18	0.52	0.64			
Pakistan	2.47	4.01	1.31			
Romania	0.39	0.20	0.46			
United Kingdom				0.03	0.08	0.06
Average	**1.70**	**1.18**	**1.14**	**0.03**	**0.08**	**0.06**

	2010	**2011**	**2012**
Global Average	**0.81**	**0.75**	**0.61**

Figure 2. **2012 PWR average collective dose per reactor by country (man·Sv/reactor)**

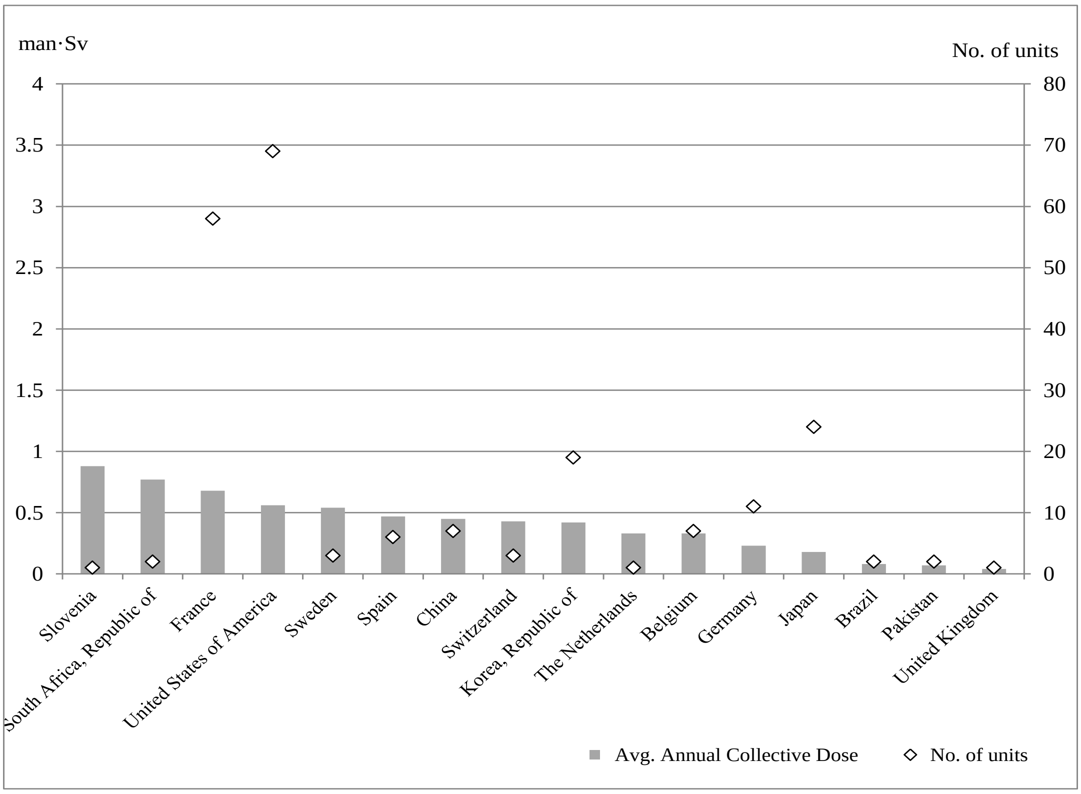


Figure 3. **2012 VVER average collective dose per reactor by country (man·Sv/reactor)**

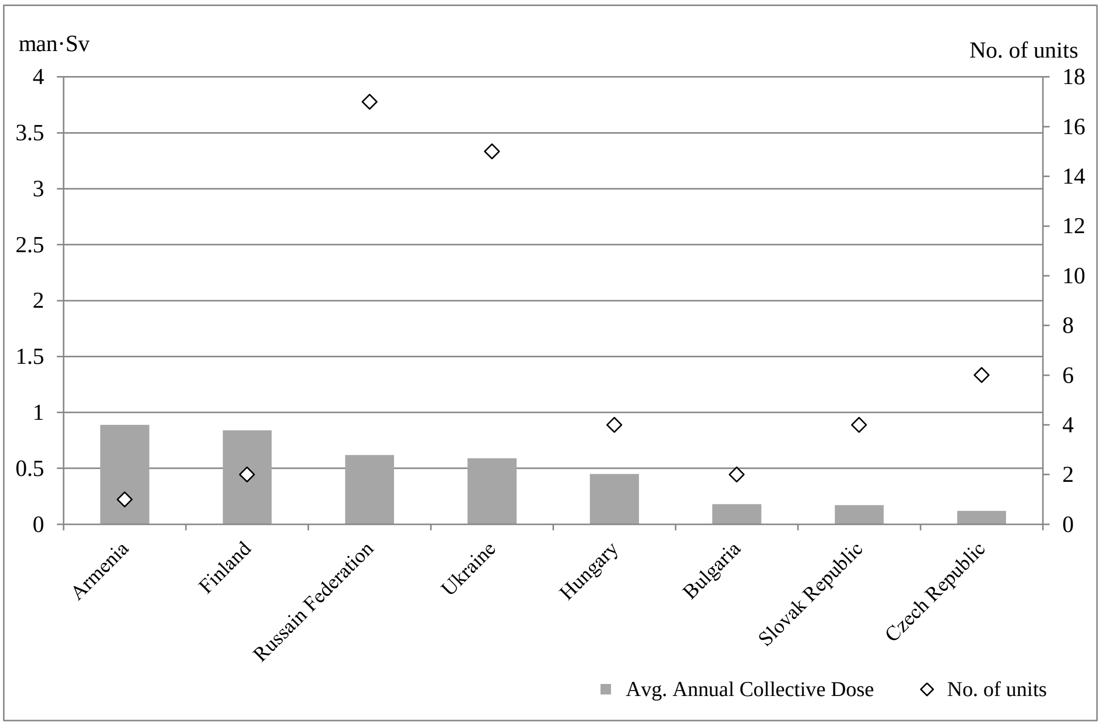


Figure 4. **2012 BWR average collective dose per reactor by country (man·Sv/reactor)**

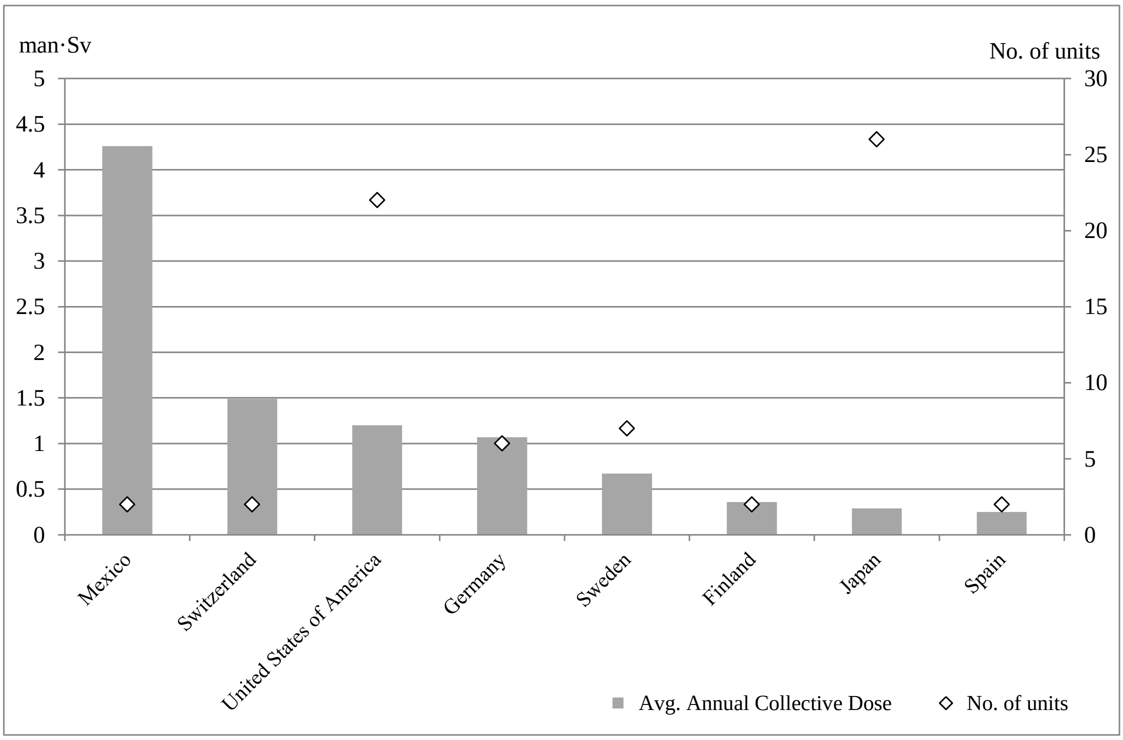
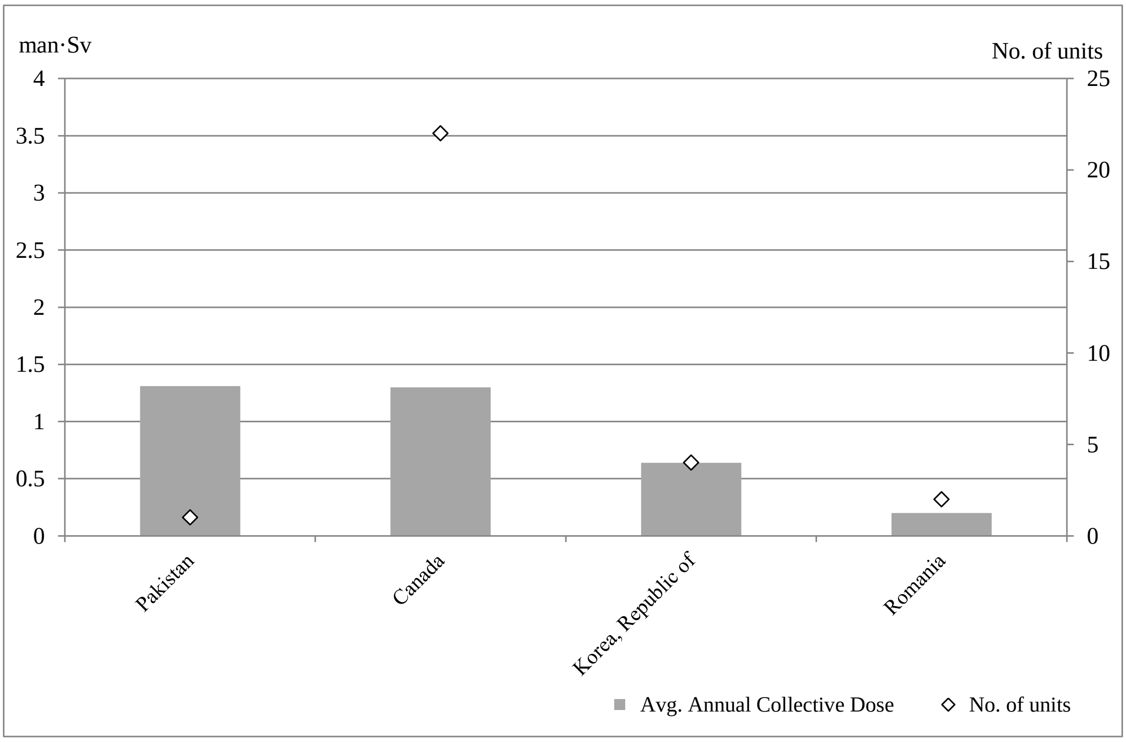


Figure 5. **2012 PHWR average collective dose per reactor by country (man·Sv/reactor)**



c) 3-year rolling average collective dose trends by country

Table 3 provides information on 3-year rolling average annual collective dose per reactor, by country and reactor type for the period of 2008-2010 to 2010-2012. Figures 6-14 present the 3 -year rolling average annual collective dose from 1999 to 2012 in different countries by taking into account the reactor types, including PWR, VVER, BWR and PHWR.

Table 3. **3-year rolling average annual collective dose per reactor, by country and reactor type, 2008-2010 to 2010-2012 (man·Sv/reactor)**

	PWR			VVER			BWR		
	/08-/10	/09-/11	/10-/12	/08-/10	/09-/11	/10-/12	/08-/10	/09-/11	/10-/12
Armenia				0.86	0.86	0.97			
Belgium	0.35	0.34	0.33						
Brazil	0.76	0.64	0.32						
Bulgaria				0.32	0.33	0.29			
Canada									
China	0.51	0.49	0.46						
Czech Republic				0.13	0.13	0.12			
Finland				0.65	0.51	0.67	0.50	0.51	0.43
France	0.66	0.68	0.67						
Germany	0.76	0.69	0.42				1.03	0.82	0.85
Hungary				0.38	0.47	0.47			
Japan	1.59	1.36	0.88				1.33	1.21	0.85
Korea, Republic of	0.47	0.48	0.47						
Mexico							3.93	2.64	3.37
The Netherlands	0.38	0.38	0.41						
Pakistan	0.48	0.37	0.31						
Romania									
Russian Federation				0.71	0.70	0.64			
Slovak Republic				0.18	0.17	0.16			
Slovenia	0.55	0.52	0.60						
South Africa, Rep. of	0.67	0.60	0.61						
Spain	0.45	0.52	0.43				1.11	1.63	0.94
Sweden	0.65	0.94	0.81				1.06	1.14	0.89
Switzerland	0.45	0.42	0.44				1.18	1.16	1.27
Ukraine				0.68	0.66	0.61			
United Kingdom	0.29	0.38	0.28						
United States	0.63	0.61	0.58				1.36	1.42	1.32
Average	**0.72**	**0.69**	**0.60**	**0.54**	**0.54**	**0.51**	**1.33**	**1.29**	**1.12**

	PHWR			GCR			LWGR		
	/08-/10	/09-/11	/10-/12	/08-/10	/09-/11	/10-/12	/08-/10	/09-/11	/10-/12
Canada	1.49	1.44	1.41						
Korea, Republic of	1.66	1.63	1.11						
Lithuania							1.94	0.79	-
Pakistan	2.68	2.78	2.59						
Romania	0.33	0.28	0.35						
United Kingdom				0.09	0.07	0.06			
Average	1.47	1.44	1.34	0.09	0.07	0.06	1.94	0.79	-

	/08-/10	/09-/11	/10-/12
Global Average	**0.85**	**0.82**	**0.73**

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

Figure 6. **3-Year rolling average collective dose by country from 1999 to 2012 for PWRs (1)**

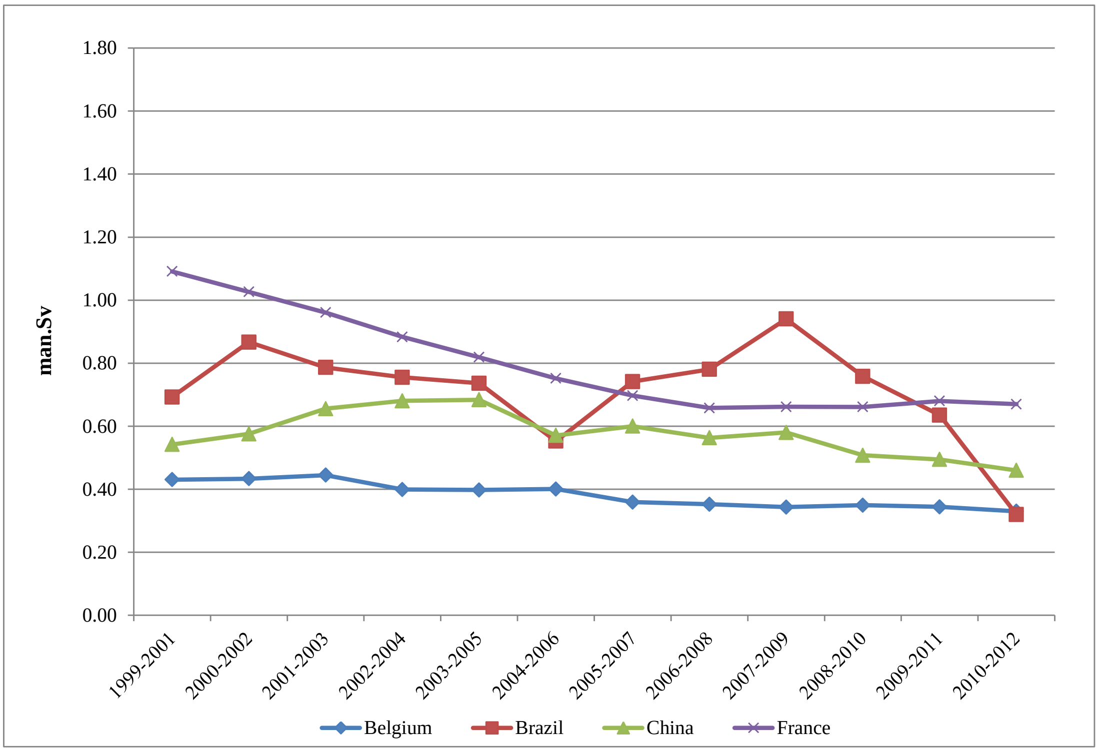


Figure 7. **3-Year rolling average collective dose by country from 1999 to 2012 for PWRs (2)**

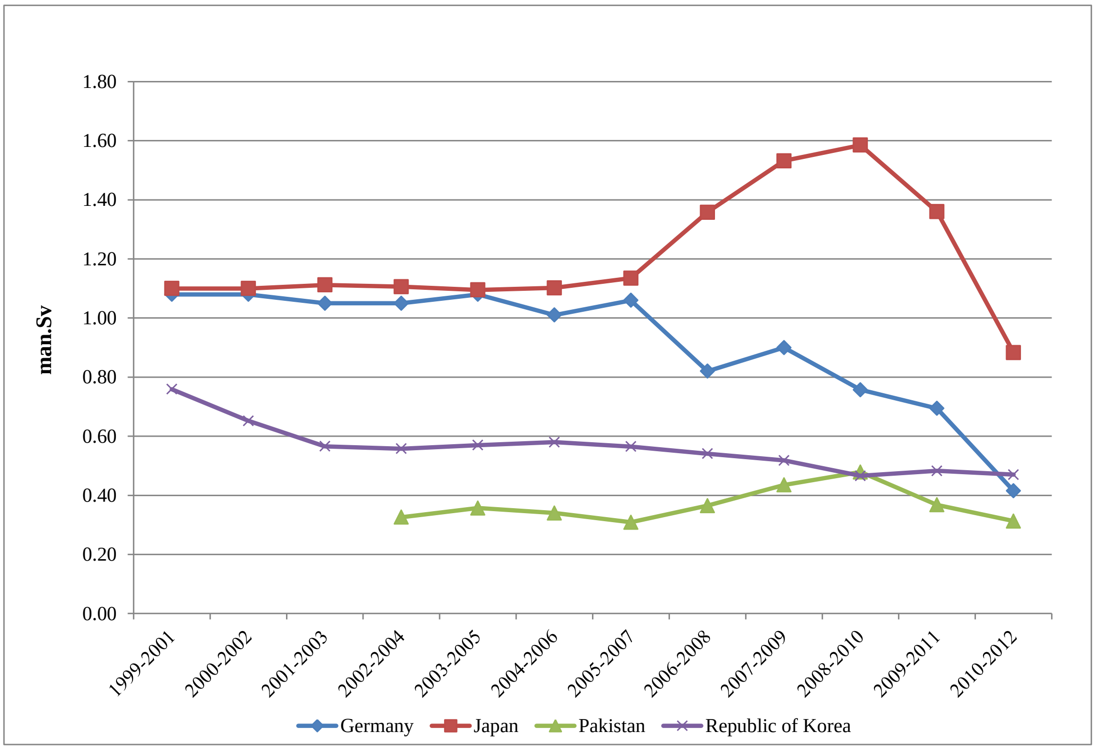


Figure 8. **3-Year rolling average collective dose by country from 1999 to 2012 for PWRs (3)**

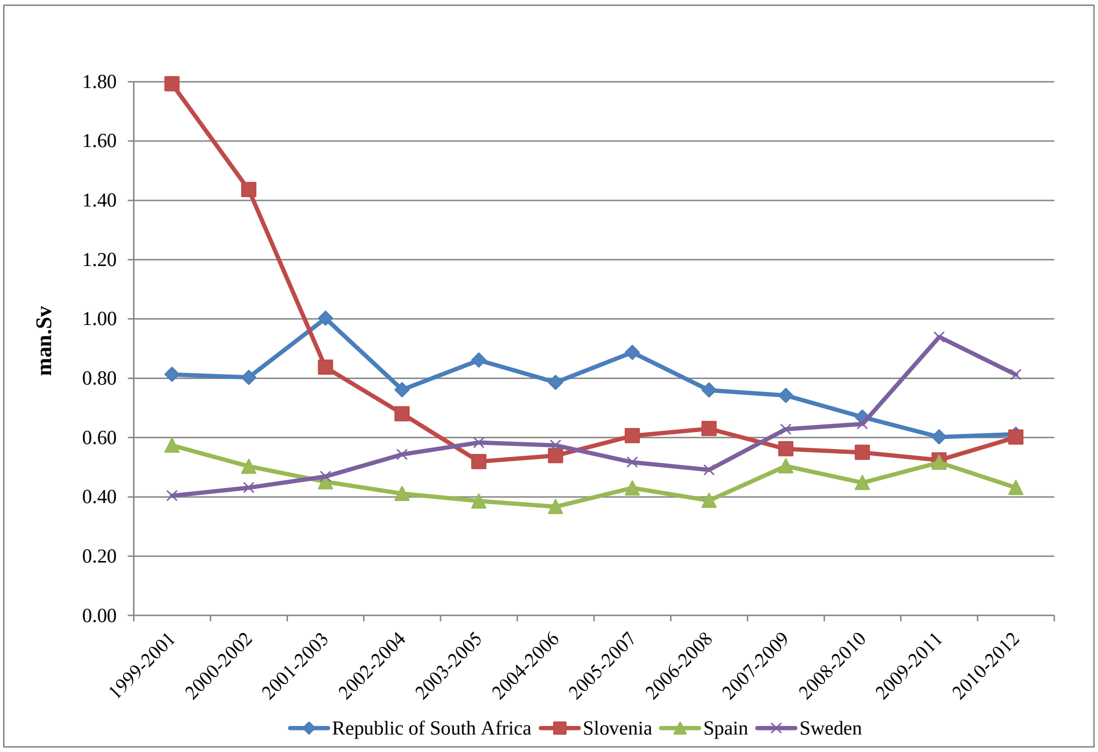


Figure 9. **3-Year rolling average collective dose by country from 1999 to 2012 for PWRs (4)**

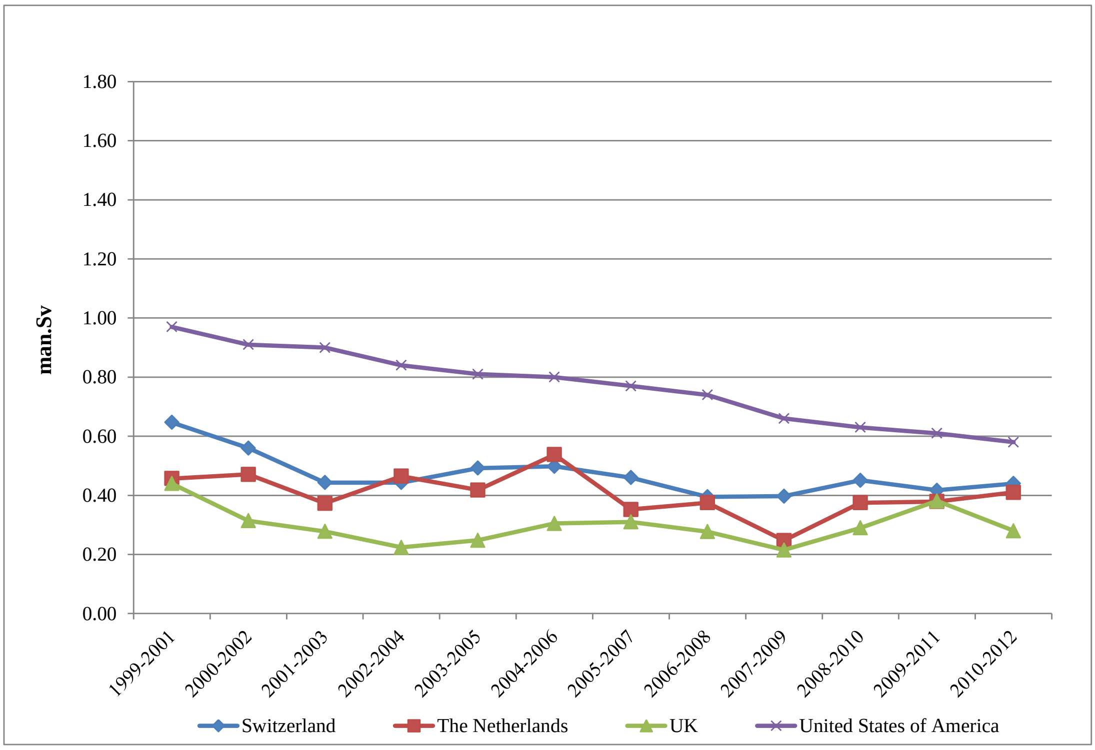


Figure 10. **3-Year rolling average collective dose by country from 1999 to 2012 for VVERs (1)**

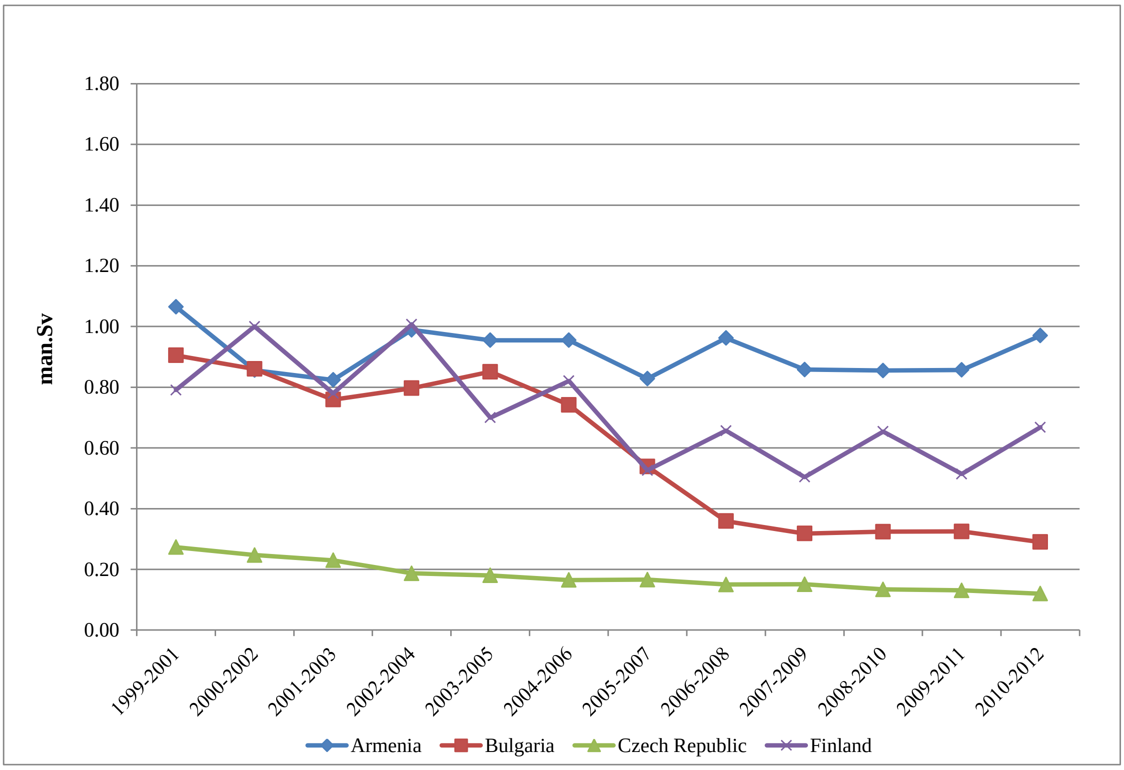


Figure 11. **3-Year rolling average collective dose by country from 1999 to 2012 for VVERs (2)**

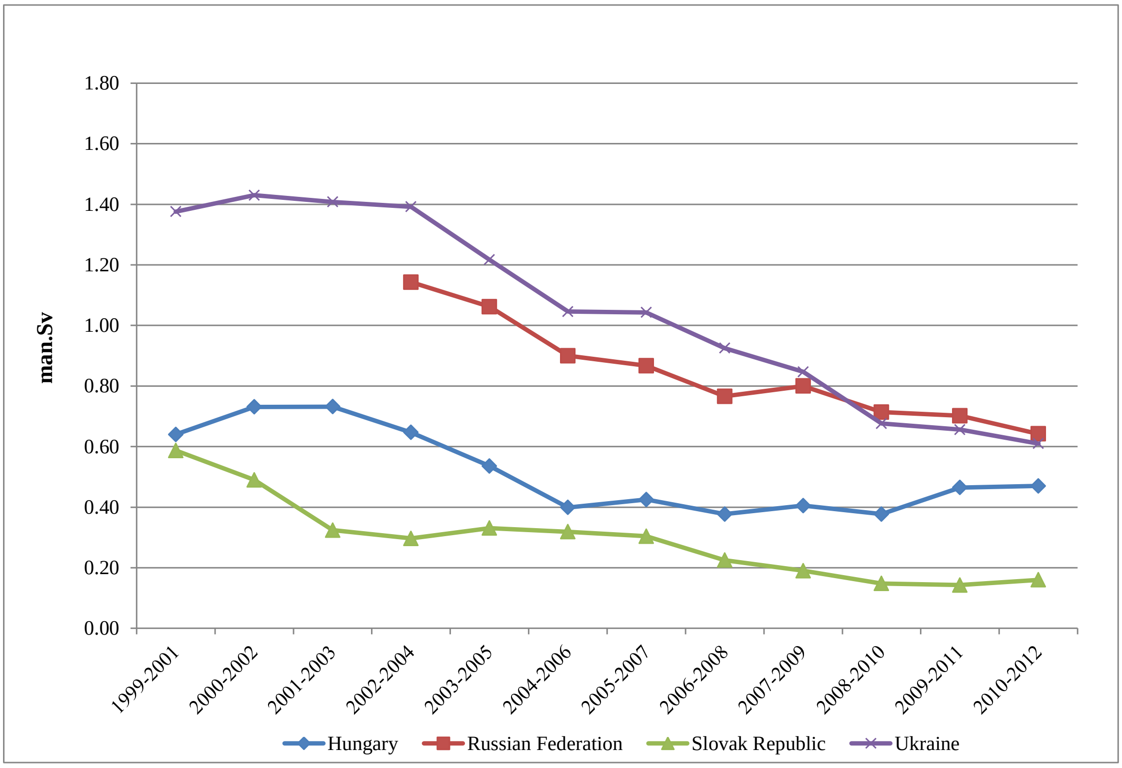


Figure 12. **3-Year rolling average collective dose by country from 1999 to 2012 for BWRs (1)**

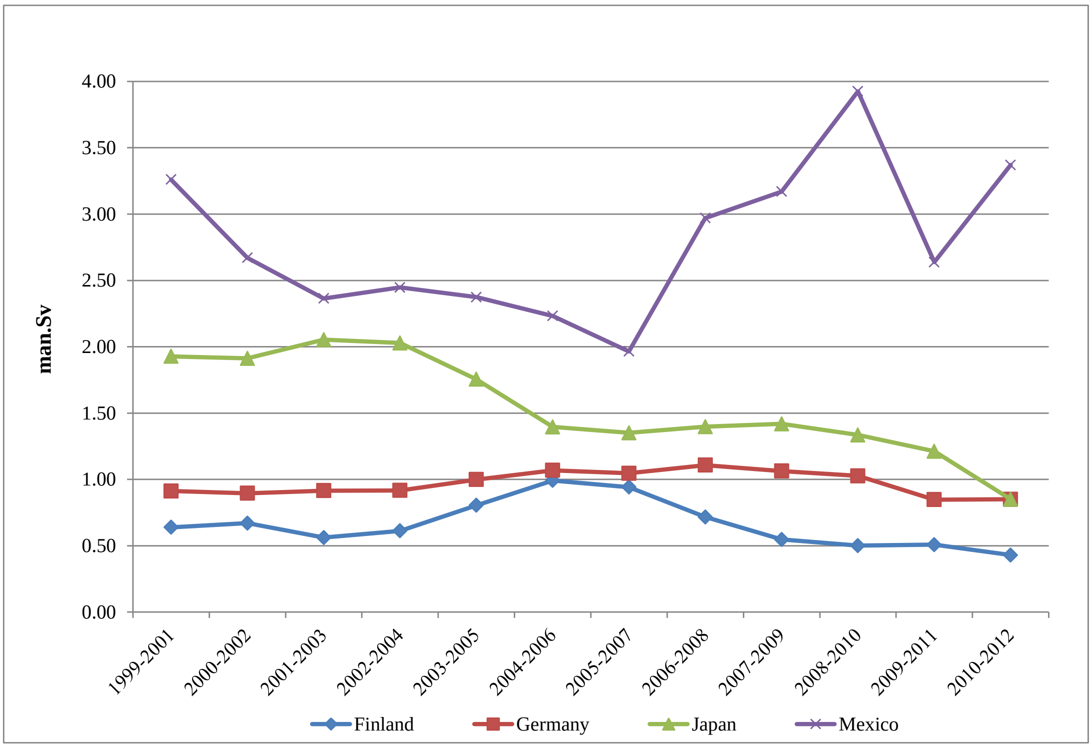


Figure 13. **3-Year rolling average collective dose by country from 1999 to 2012 for BWRs (2)**

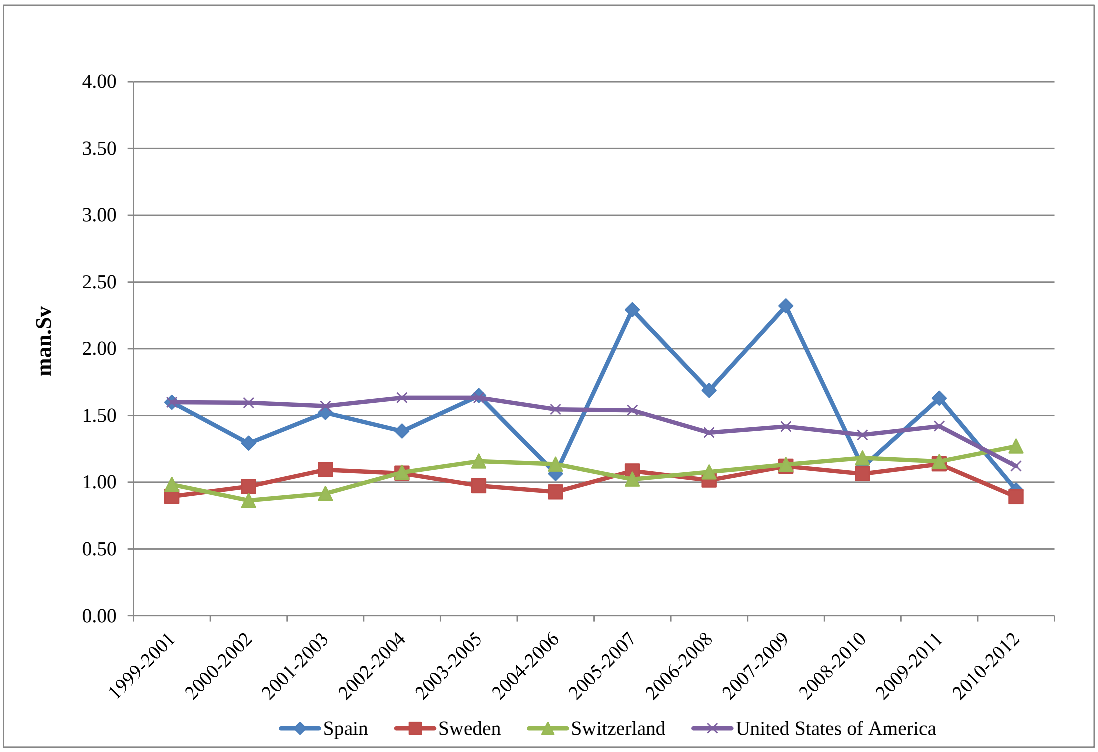
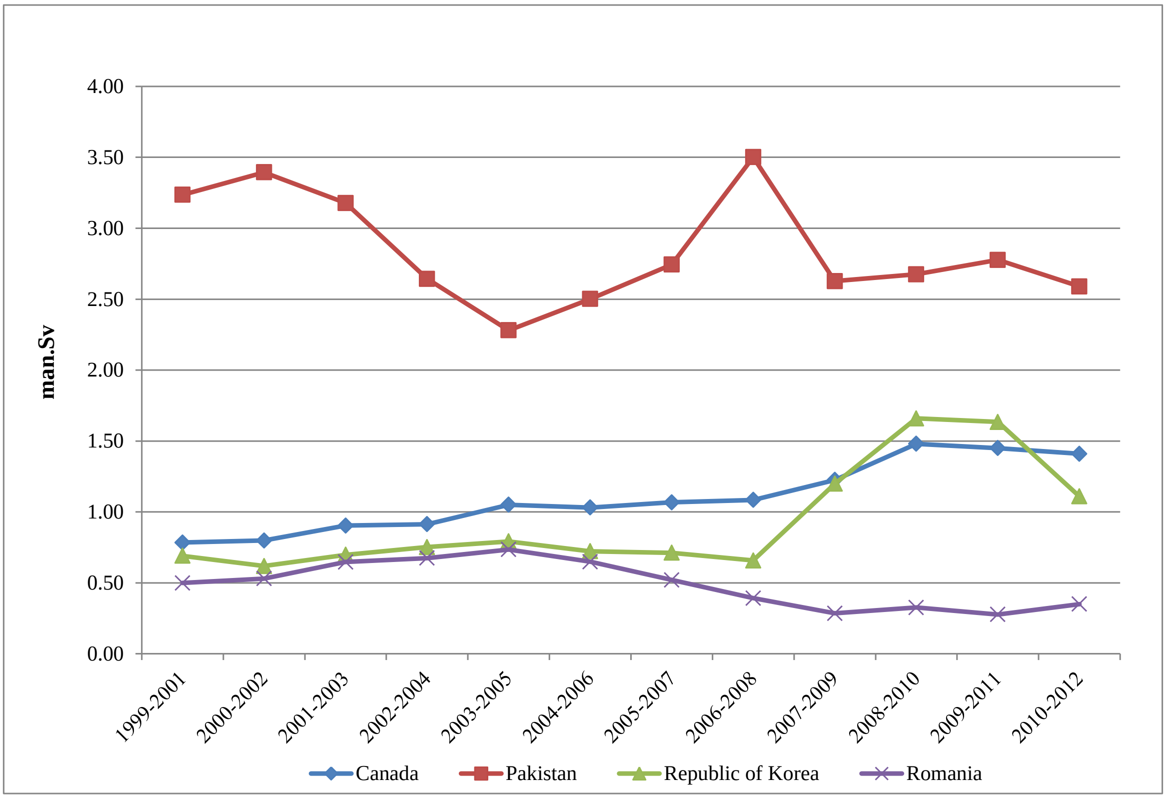


Figure 14. **3-Year rolling average collective dose by country from 1999 to 2012 for PHWRs**



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 2010-2012 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 2012 aimed at improving data collection for shut-down and decommissioned reactors in order to facilitate better benchmarking.

Table 4 provides average annual collective doses per unit for definitely shutdown reactors by country and reactor type for 2010-2012, based on data recorded in the ISOE database, supplemented by the individual country reports (Section 3) as required. Figures 15-18 present the average annual collective dose by country for definitely shutdown reactors for 2008-2012 periods by reactor type (PWR, VVER, 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 4. **Number of units and average annual dose per reactor by country and reactor type for definitely shutdown reactors, 2010-2012 (man·mSv/reactor)**

		2010		2011		2012	
		No.	**Dose**	**No.**	**Dose**	**No.**	**Dose**
PWR	France	1	117.2	1	264.1	1	275.6
	Germany	2	388.4	3	126.3	8	20.0
	Italy	1	3.2	1	1.8	1	3.0
	Spain	1	53.0	1	190.0	1	307.9
	United States	8	2.0	6	49.4	6	127.0
	Average	*13*	*74.3*	*12*	*94.3*	*17*	*79.4*
VVER	Bulgaria	4	11.3	4	9.2	4	10.1
	Russian Federation	2	77.6	2	66.3	2	79.2
	Slovak Republic	2	12.4	2	10.1	2	4.2
	Average	*8*	*28.2*	*8*	*23.7*	*8*	*25.9*
BWR	Germany	1	427.1	1	289.5	4	70.0
	Italy	2	60.3	2	15.1	2	18.4
	Japan	2	123.8	2	96.9	2	41.2
	The Netherlands	n/a	n/a	1	10.0	1	0
	Sweden	2	6.2	2	27.2	2	20.0
	United States	5	21.6	5	24.5	3	78.0
	Average	*12*	*76.3*	*13*	*53.9*	*14*	*48.1*
GCR	France	6	1.3	6	2.4	6	7.4
	Italy	1	1.7	1	10.4	1	0.2
	Japan	1	50.0	1	50.0	1	70.0
	Spain	n/a	n/a	1	0	1	0
	United Kingdom	16	48.0	16	49.0	19	56.0
	Average	*24*	*34.5*	*25*	*34.4*	*28*	*42.1*
LWGR	Lithuania	2	236.2	2	304.8	2	264.9
LWCHWR	Japan	1	111.6	1	126.6	1	148.8

Figure 15. **Average annual collective dose by country from 2008 to 2012 for PWRs**

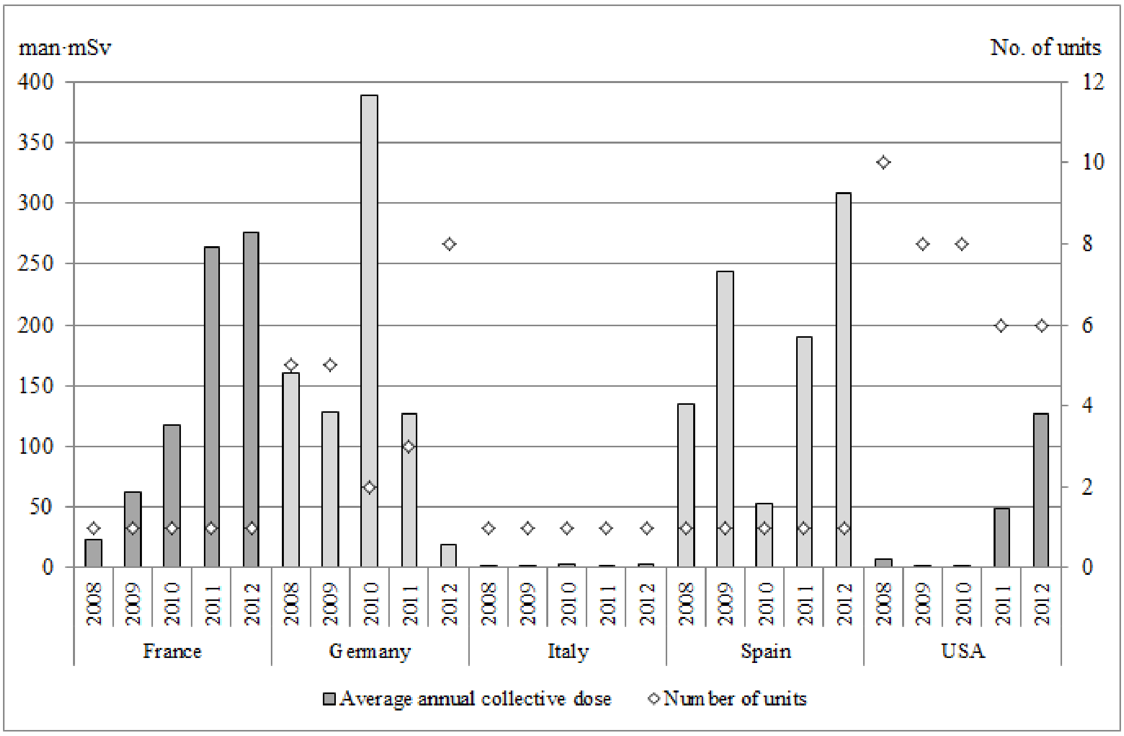


Figure 16. **Average annual collective dose by country from 2008 to 2012 for VVERs**

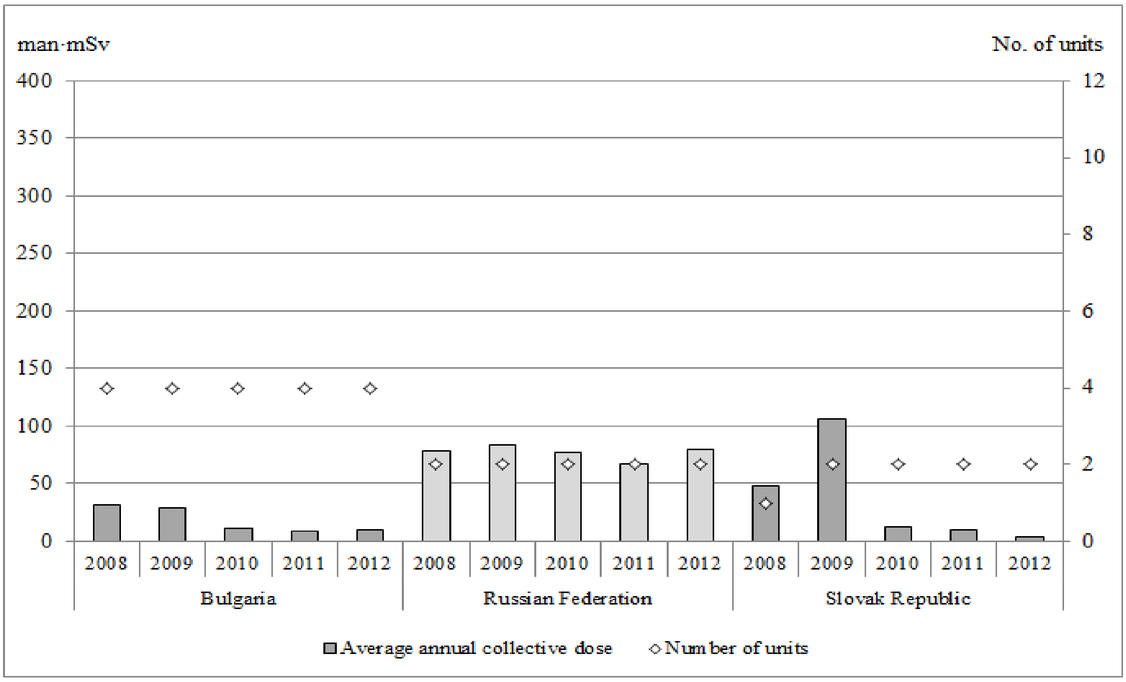


Figure 17. **Average annual collective dose by country from 2008 to 2012 for BWRs**

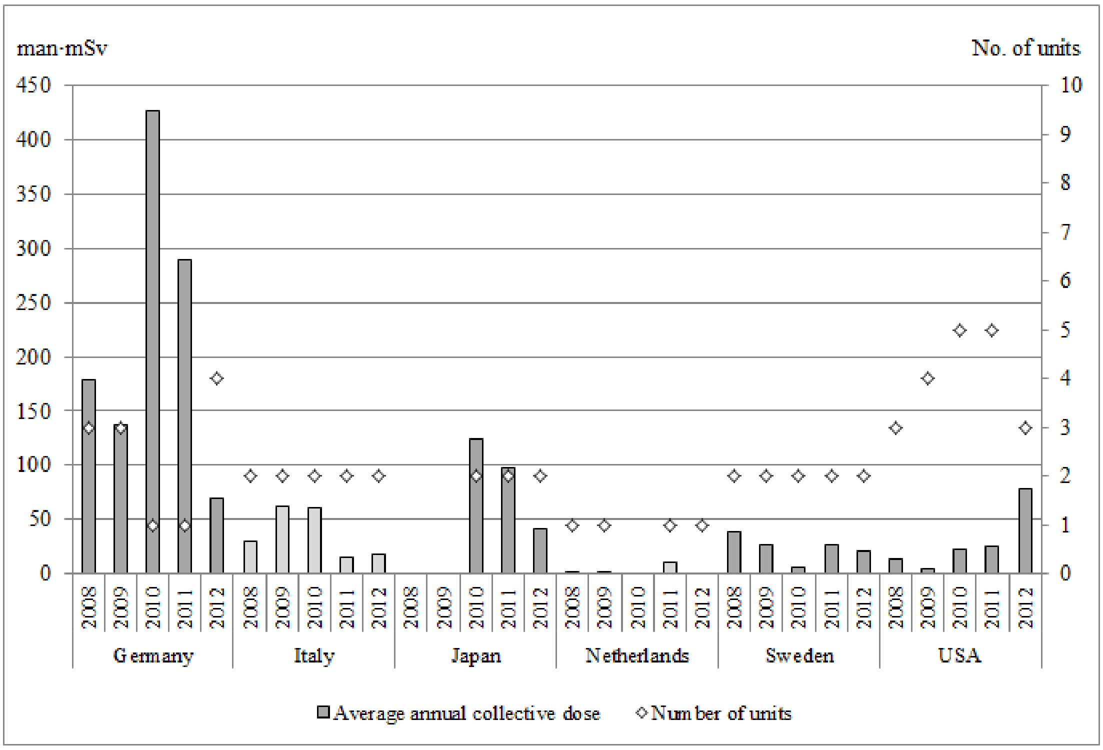
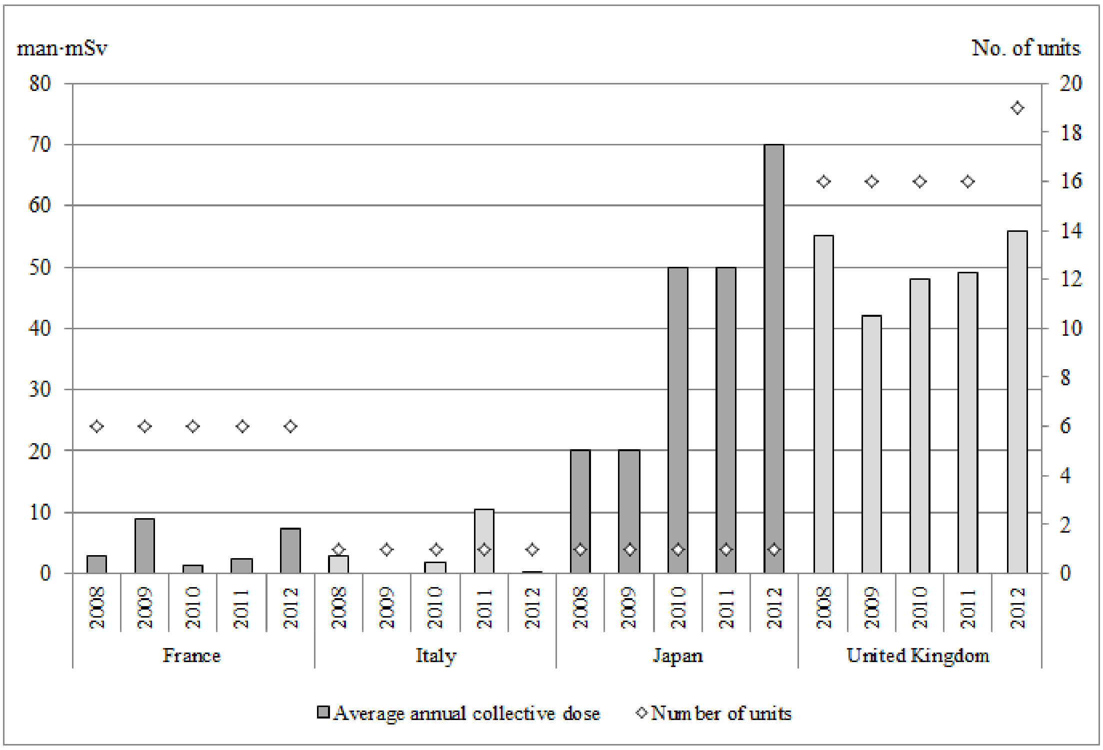


Figure 18. **Average annual collective dose by country from 2008 to 2012 for GCRs**



3. PRINCIPAL EVENTS IN 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 2012. 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 2012 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 for the year 2012

ANNUAL COLLECTIVE DOSE		
OPERATING REACTORS		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
VVER	1	890
REACTORS DEFINITIVELY SHUTDOWN OR IN DECOMMISSIONING		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
VVER	1	No separate data available

Principal events in ISOE participating countries in 2012

Summary of national dosimetric trends

For the year 2012, the dosimetric trend at the Armenian NPP have no 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, non-destructive testings of pipes and other control works during the outage, decontamination works and the works with radioactive wastes. Max individual dose was 17.9 mSv.The collective dose for outside workers was 0.033 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

Number and duration of outages

For the 2012 one outage with 85 (full refueling) days duration was performed.

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

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 Fokushima Daiichi accident will impact on plant design regulatory requirements and site evaluation consideration. The new regulations on site and design requirement are in final approval stage.

Major evolutions

The "Dose reduction program including ALARA culture implementation" for 2012 was established, improvement of old radiation control system is finished. The new radiation control pass system is already in operation.

Component or system replacements

During the outage in 2012, no components or systems were replaced.

Safety-related issues

Some safety related issues still exist 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 and will be done with EU assistance programs.

Unexpected events

For the year 2012 unexpected events were not registered.

New/experimental dose-reduction programmes

The new/experimental dose-reduction programmes were applied for the year 2012.

Organisational evolutions

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

Principal events in ISOE participating countries in 2013

Issues of concern in 2013

In 2013, the medium activity solidified liquid radioactive waste storage issues are to be solved due to radioactive waste strategy development.

Technical plans for major work in 2013

Modernization of Radiation Control System for airborne and liquid releases, finalization of 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 2013.

Improvement of Inspections procedures and special works related 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 for the year 2012

ANNUAL COLLECTIVE DOSE		
OPERATING REACTORS		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
PWR	7	362

Principal events of the year 2012

Events influencing dosimetric trends

Extended outage duration due to the discovering of indications in the Doel 3 and Tihange 2 vessels.

New/experimental dose-reduction programmes

It is too early to identify dosimetry impact of the Zinc injection in the primary circuit of Doel 3. At Doel NPP, implementation of higher water level in the fuel pool before fuel handling has a positive influence on the dosimetry.

Organisational evolutions

As expected, from 1st Jan 2012, introduction of the Optically Stimulated Luminescent (OSL) dosimeters on the site of Tihange, as a replacement of the passive film dosimeters. In case of problems, OSL can be read on site to have a undelayed dose estimation.

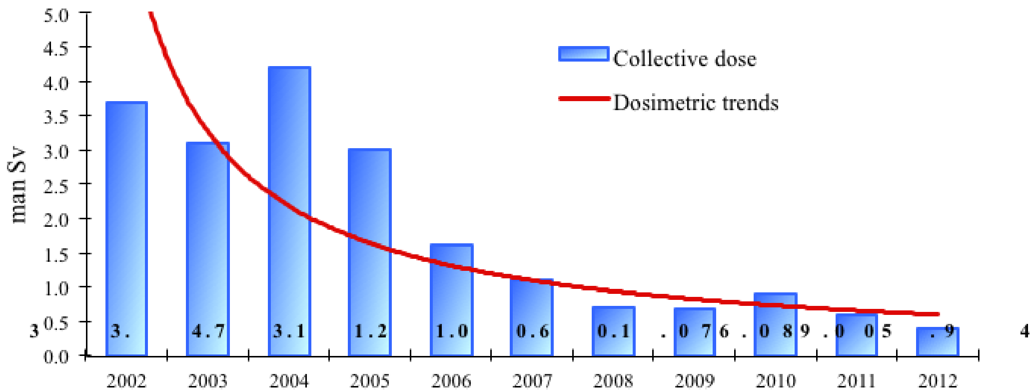
BULGARIA

Dose information for the year 2012

ANNUAL COLLECTIVE DOSE		
OPERATING REACTORS		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
VVER-1000	2	181
REACTORS DEFINITIVELY SHUTDOWN OR IN DECOMMISSIONING		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
VVER-440	4	9.1

Principal events in ISOE participating countries for 2012

Summary of national dosimetric trends



Number and duration of outages

Unit No.	Outage duration - days	Outage information
Unit 5	34 d	Refuelling and maintenance activities
Unit 6	37 d	Refuelling and maintenance activities

Component or system replacements

Replacement of 61 control rods at unit 5
Installation of wide range reactor body temperature control detectors at unit 5
Installation of automatic system for continuous control of coolant activity at unit 5

Organisational evolutions

New external state owned organization - Radwaste Treatment Enterprise of units 3 - 4 established

Principal events in ISOE participating countries for 2013

Technical plans for major work

Refuelling and maintenance at unit 5 and 6

CANADA

Dose information for 2012

ANNUAL COLLECTIVE DOSE		
OPERATING REACTORS		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
CANDU	20	1260

Principal events

Summary of national dosimetric trends

– 25,803. person-mSv for 20 operating units in 2012
– Average annual dose per unit = 1.26 person-Sv in 2012

The total collective effective doses and the average collective dose per unit at operating Canadian nuclear plants increased in 2012 compared to previous years. This result is largely due to the extensive outage programs at Bruce Power and Pickering Nuclear.

The average calculated dose for 2012 includes twenty (20) units. Seventeen units were fully operational and three units returned to service in the fall of 2012 following completion of refurbishment projects: Bruce A Unit 1 returned to service in September 2012; Bruce A Unit 2 returned to service in October 2012; and Point Lepreau returned to service in November 2012. The Dose associated with activities performed at two units in safe storage (Pickering Units 2 and 3) is negligible and therefore not included in the calculated average.

The implementation of the radiation protection at Canadian NPPs met applicable regulatory requirements and doses to workers are maintained below regulatory dose limits.

Distribution of annual effective doses to workers at Canadian NPPs showed that approximately 80 percent of the workers received an annual effective dose below 1 mSv.

Principal Events

Bruce Power

Bruce A Units 1 and 2 refurbishment and restart activities were successfully completed. The project was concluded within the projected dose target. Unit 1 returned to service on September 19, 2012 and Unit 2 returned to service on October 16, 2012.

Bruce A Units 1 & 2 routine operations dose for 2012 was 11 person-mSv. The refurbishment/outage dose was 1,792 person-mSv for a total 2012 dose of 1,803 person-mSv. The internal dose for Bruce A Units 1 & 2 was 196 person-mSv. The external dose was 1,607 person-mSv.

Bruce A Units 3 & 4 routine operations dose for 2012 was 150 person-mSv. The outage dose was 11,124 person-mSv. The internal dose was 367 person-mSv in 2012. The external dose was 10,907 person-mSv. The total dose was 11,274 person-mSv. The large collective dose is due to the large scope of work required for life extension and equipment lifecycle engineering plans at Units 3 and 4.

Bruce B Units 5-8 routine operations dose was 495 person-mSv. The outage dose was 994 person-mSv in 2012. The internal dose was 120 person-mSv. The external dose was 1,369 person-mSv. The total dose was 1,489 person-mSv. Bruce B had one planned outage in 2012 that had a reduced outage scope in comparison with past years. This resulted in Bruce B achieving the lowest collective effective dose when compared with the previous five years.

Darlington Units 1-4

In 2012, Darlington Units 1-4 had routine operations dose of 292 person-mSv. The outage dose (Unit 3) was 1,500 person-mSv. The internal dose for 2012 was 246 person-mSv. The external dose was 1,546 person-mSv. The internal dose was higher than 2011 due to higher-than-expected tritium levels experienced during the outage at Unit 3. Darlington performed better than its year-end target with a total collective dose of 1,792 person-mSv.

Pickering A & B

The routine operations dose for Pickering A Units 1 & 4 was 286 person-mSv in 2012. The outage dose was 3,784 person-mSv. The internal dose was 432 person-mSv. The external dose was 3,638 person-mSv. The total dose was 4,070 person-mSv.

The dose associated with radiological activities performed at Pickering Units 2 & 3 (safe storage) is negligible when compared to collective dose of the operational units. Therefore, this dose is not reported separately but instead included under Pickering A Units 1 & 4.

Pickering B Units 5-8 routine operations dose in 2012 was 571 person-mSv. The outage dose was 3,781 person-mSv. The internal dose was 489 person-mSv. The external dose was 3,863 person-mSv. The total dose was 4,352 person-mSv in 2012.

The observed increase in outage collective doses for Pickering A and B is mainly due to extensive outage programs including modifications executed during planned outages (to improve operations and ensure safe and reliable performance to the end of commercial operation) and some forced outages.

Gentilly-2

In 2012, the routine operations dose at Gentilly-2 was 98 person-mSv. The outage dose was 131 person-mSv. The internal dose in 2012 was 50 person-mSv. The external dose was 179 person-mSv. The total site dose in 2012 was 229 person-mSv. Internal and external doses were the lowest in comparison with previous years due to a reduction in the number and scope of radiological activities performed.

Point Lepreau

The major work activities associated with the refurbishment project were completed in the spring of 2012 and included lower feeder installation, leak testing, and new fuel load. The collective doses received from these major work activities were in good agreement with dose estimates.

The routine operations dose in 2012 at Point Lepreau was 8 person-mSv. The refurbishment/outage dose was 939 person-mSv. The internal dose was 213 person-mSv. The external dose was 734 person-mSv. The total site dose for 2012 was 947 person-mSv.

Conclusion

2012 was an important year for Canadian nuclear plants. The refurbishment projects were successfully completed and units returned to service. Bruce Power site with 8 operational Units is now the largest nuclear site in the world in terms of electrical generation.

CZECH REPUBLIC

Dose information for 2012

Dukovany NPP

Summary of dosimetric trends

There are four units of PWR-440 type 213 in commercial operation since 1985.

The collective effective dose (CED) during the year 2012 was 563 man·mSv. CED was 49 man·mSv and 514 man·mSv for utility and contractors employees, respectively. The total number of exposed workers was 1956 (597 utility employees and 1359 contractors). The average annual collective dose per unit was 141 man·mSv.

The maximum individual effective dose was 1.22 mSv for the utility personnel and 6.97 mSv for contractor employee during outage at Unit 2 when the SG hot collector flange was exchanged especially.

Number and duration of outages

The main contributions to the collective dose were 4 planned outages.

	Outage information	**CED [man·mSv]**
Unit 1	31 days, standard maintenance outage with refueling	84
Unit 2	77 days, standard maintenance outage with refueling including reactor power uprate up to 500 MWe	168
Unit 3	31 days, standard maintenance outage with refueling	83
Unit 4	39 days, standard maintenance outage with refueling	167

Major evolutions

The CED increased slightly in comparison with previous year mainly due to repair works on heterogeneous weld of SG during an outage at Unit 4.

Power uprate at Unit 2 was achieved in Feb-May 2012. Very low values of outages and total effective doses represent results of good primary chemistry water regime, well organized radiation protection structure and strict implementation of ALARA principles during the working activities related to the works with high radiation risk. All CED values are based on electronic personal dosimeters readings.

Unexpected events

There were no unusual or extraordinary radiation events in the year 2012 at Dukovany NPP.

Temelín NPP

Summary of dosimetric trends

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

The collective effective dose (CED) during the year 2012 was 162 man·mSv. CED was 28 man·mSv and 134 man·mSv for utility and contractors employees, respectively. The total number of exposed workers was 1722 (547 utility employees and 1175 contractors). The average annual collective dose per unit was 81 man·mSv.

The maximum individual effective dose 2.23 mSv was received by a contractor while carrying out dismantling and assembly operations on the reactor head during outages.

Number and duration of outages

The main contributions to the values of collective effective dose were 2 planned outages.

	Outage information	**CED [man·mSv]**
Unit 1	49 days, standard maintenance outage with refueling	66
Unit 2	47 days, standard maintenance outage with refueling	63

Major evolutions

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

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

Unexpected events

There were no unusual or extraordinary radiation events in the year 2012 at Temelín NPP.

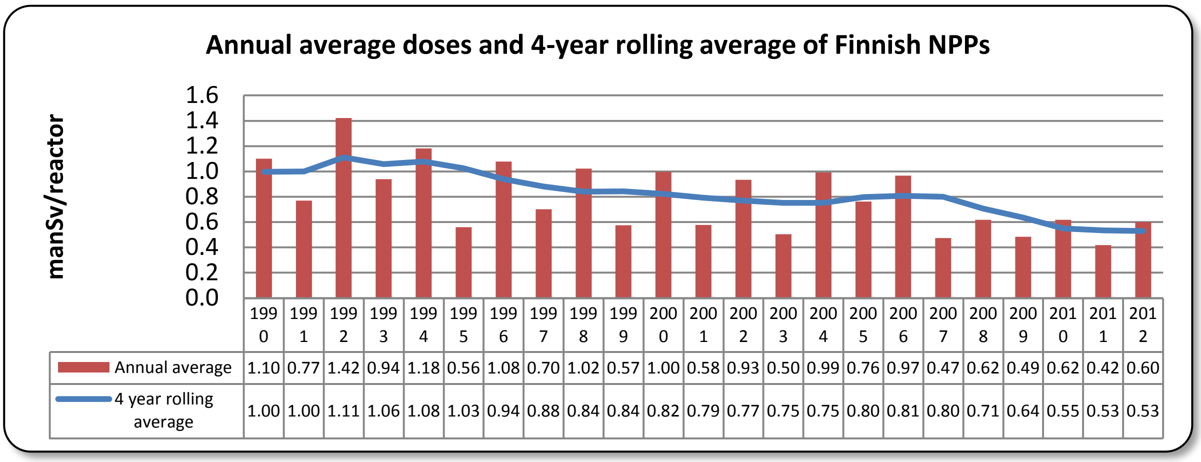
FINLAND

Dose information for the year 2012

ANNUAL COLLECTIVE DOSE		
OPERATING REACTORS		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
VVER	2	841
BWR	2	359
All types	4	600

Summary of national dosimetric trends

Annual collective dose strongly depends on length and type of annual outages. The 2011 collective dose (1677 man·mSv) of Finnish NPP's was the lowest in operating history, mainly due to short outages at three of four reactors. In 2012 there was an extensive inspection outage at Loviisa 1 and a long maintenance outage at Olkiluoto 1, which increased worker exposure compared to 2011. In the long run the 4-year-rolling average of collective doses shows a slightly decreasing trend since the early 1990's.



Principal events of the year 2012

Olkiluoto NPP

The annual outage at Olkiluoto 1 unit started earlier than planned because of some moisture detected in the generator. The maintenance outage took 31 days including refuelling, replacement of the generator, modification of low pressure turbines' discharge sides, modernization of the condensate purification system I&C, a containment leak test and replacing an auxiliary transformer. The collective dose was 428 man·mSv.

At Olkiluoto 2 unit only a short refuelling outage was performed. In addition to refuelling it included mostly inspections and tests. The outage was completed about in 9 days and the collective dose was 139 man·mSv. A fuel leakage was detected during the operating period but it did not cause any significant inconvenience for the outage.

At the end of the year cutting work of old steam dryer was performed at Olkiluoto 2. The collective dose of the work was 9 man·mSv.

Loviisa NPP

At unit 1 an extensive inspection outage was performed. The length was prolonged from planned 39 days to 55 days due to difficulties in primary and secondary circuit pressure tests. Collective dose of Loviisa 1 outage was ca. 1310 man·mSv mainly caused by primary side inspection and maintenance works and related auxiliary tasks (insulation, scaffolding, RP and cleaning). As a large modernisation project the pressure control system of reactor coolant system was renewed during the outage.

At unit 2 the outage was a normal short maintenance outage with a collective dose accumulation of ca. 290 man·mSv.

On both units the collective dose accumulation was the lowest in plant operating history compared to similar outage types.

Source term reduction

After 5 years of studies, testing and approval, one antimony-free mechanical sealing was installed in one of Loviisa 1's six primary coolant pumps. The aim is to replace all antimony-containing sealing during the next two outages. Currently radioactive antimony causes appr. 50 % of doses at both units and after the sealing replacement the dose rates of primary components are expected to decrease by nearly 50 % in the following three years as the antimony is removed from primary coolant.

Report from Authority

Renewal of legislation and regulatory guides is nearing completion and the implementation of new requirements will start in 2013. New guides will be implemented for new NPPs as such.

Olkiluoto 3 is nearing commissioning and operating license phase. Two new units, Olkiluoto 4 and Fennovoima 1, are planned to enter construction license phase by mid-2015 latest. Final repository for spent fuel is currently in construction license phase.

EU level stress tests were initiated in Finland. STUK has reviewed the results. Based on the results it was concluded that no immediate actions are needed at the Finnish NPPs. However, areas where safety can be further enhanced have been identified and there are plans on how to address these areas.

New strategy of STUK for the next years has to take into account governments decreasing budget, in particular on radiation safety research. Because of the direction of the government, STUK is terminating its basic research on radiation effects. The research is being transferred to one of the universities in Finland.

FRANCE

Dose information for the year 2012

ANNUAL COLLECTIVE DOSE		
OPERATING REACTORS		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
PWR	58	670
REACTORS DEFINITIVELY SHUTDOWN OR IN DECOMMISSIONING		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
PWR	1	276
GCR	6	7
HWGCR	1	7
SFR	1	4

PWR: Chooz A ; GCR: Saint-Laurent A; Chinon A; Bugey 1; HWGCR: Brennilis; SFR: Creys-Malville

Collective dose

For 2012, the average collective dose of the French nuclear fleet (58 PWR) is 0.67 man.Sv/unit (2012 annual EDF objective: 0.67 man.Sv/unit). The average collective dose for the 900 MWe 3-loop reactor (900 MWe – 34 reactors) is 0.78 man.Sv/unit and the average collective dose for the 4-loop reactors (1300 MWe and 1450 MWe – 24 reactors) is 0.53 man.Sv/reactor.

Type and number of outages

Type	Number
ASR – short outage	21
VP – standard outage	19
VD – ten-year outage	6
No outage	12
Forced outage	1

Specific activities

Type	Number
SGR	2
RVHR	0

The outage collective dose represents 84% of the total collective dose. The collective dose received when the reactor is operating represents 16% of the total collective dose. The collective dose due to neutron is 0.250 man.Sv 77% of which (0.193 man.Sv) is due to spent fuel transport.

Individual doses

In 2012, no worker has received an individual dose higher than 18 or 16 mSv on the EDF fleet. 76% of the exposed workers have received a cumulated dose in 2012 lower than 1 mSv and 99% of the exposed workers have received less than 10 mSv.

Main 2012 events

The main 2012 events with a dosimetric impact are the following

- RHRS T-piece replacement
  At the instance of the French nuclear safety authority, RHRS T-pieces were replacement on 3 units. The collective doses received during these activities were 0.158 man.Sv at Dampierre 4, 0.125 man.Sv at Chinon B2 and 0.071 man.Sv at Cruas 1.

- Control of the screws of the reactor coolant pump hydraulic units
  At the instance of the French nuclear safety authority, EDF had to perform controls of some specific screws in the hydraulic units of the 4 reactor coolant pump sets of the 1450 MWe reactors. The collective doses received during these activities were 0.207 man.Sv at Civaux 2 and 0.089 at Chooz B2.

- Control of the clamps and corrosion on the guide tubes of the in-core instrumentation system
  During controls at Gravelines 1 in 2011, it appears that clamps containing substances, which are not allowed in French nuclear plants, may cause corrosion on the guide tubes of the in-core instrumentation system. As a consequences, EDF decided to realize controls on all the units and, if necessary, to clean up the corrosion. These activities can could high collective dose due to the fact that they are performed in the reactor pit

3-loop reactors – 900 MWe

In 2012, the 3-loop reactors outage programme was composed of 14 short outages, 11 standard outages, 4 ten-year outages. 2 Steam Generator Replacements were performed. 2 short outages were postponed in 2013 (Bugey 5 and Gravelines 1) and there was no forced outage. Moreover 2 outages of the 2011 programme ended in 2012: 3rd ten-year outage at Fessenheim 2 (collective dose in 2012: 0.516 man.Sv) and 3rd ten-year outage at Gravelines 1 (collective dose in 2012: 0.128 man.Sv). Finally, 1 outage of the 2012 programme ended in 2013 (standard outage and steam generator replacement at Chinon B2).

The lowest collective doses for the various outage types and specific activities were:

- Short outage: 0.237 man.Sv at Saint-Laurent B1,
- Standard outage: 0.408 man.Sv at Chinon B4,
- Ten-year outage: 1.305 man.Sv at Dampierre 2,
- SGR: 0.666 man.Sv at Gravelines 3,

4-loop reactors – 1300 and 1450 MWe

In 2012, the 4-loop reactors outage programme was composed of 7 short outages, 8 standard outages and 2 ten-year outages. 7 reactors had no outage and there was 1 forced outage at Civaux 1 with a collective dose of 0.004 man.Sv). 2 outages of the 2012 programme ended in 2013 (short outage at Cattenom 2 and standard outage at Nogent 2).

The lowest collective doses for the various outage types and specific activities were:

- Short outage: 0.251 man.Sv at Golfech 2,
- Standard outage: 0.582 man.Sv at Penly 2,
- Ten-year outage: 1.005 man.Sv at Golfech 1,

Main radiation protection significant events (ESR)

In 2012, 3 ESR have been classified at the level 1 of the INES scale

- Dampierre NPP
  1 ESR on the unit 1: Skin exposition of a worker over ¼ of the regulatory dose limit (equivalent dose to the skin: 500 mSv/12 rolling months) due to hot spot contamination
  1 ESR on the unit 4: Possible skin exposition of a worker over ¼ of the regulatory dose limit (equivalent dose to the skin: 500 mSv/12 rolling months)

- Blayais NPP
  1 ESR on the unit 4: Exposition of a worker over ¼ of the regulatory dose limit (equivalent dose to the skin: 500 mSv/12 rolling months) following head contamination

Other 2012 radiation protection events

- Blayais NPP:
  Radiography source blocked during a shot. Formally EDF did not declare an ESR following this event. However, the radiography contractor did declare an ESR as a radiography shot incident.
- Chinon NPP:
  The reactor building of the unit 4 was evacuated following the detection of contamination at the +20m level. Internal contamination was detected on workers, but the contamination was lower than the recording level.
- Paluel NPP:
  Internal contamination was detected on workers which were close to the reactor cavity during the installation of the reactor head and cavity decontamination activities.

2013 goals

For 2013, the collective dose objective for the French nuclear fleet is set at 0.74 man.Sv/unit.

For the individual dose, one of the objectives is to reduce by 10% in 3 years the individual dose of the most exposed workers. The other objectives are the following:

- 0 worker with a dose > 18 mSv in 2013,
- Less than 20 workers with a dose > 14 mSv in 2013,
- Less than 340 workers with a dose > 10 mSv in 2013.

Future activities in 2013

Individual dose:

Actions to reduce the individual dose of the most exposed workers: continue action on reactor and steam generator activities; identify actions for radiography and logistic activities.

Collective dose

- Continue the development of the remote monitoring system,
- Test on 5 outages of the CADOR software to optimize the number and location of biological shielding in the reactor building during outages,
- Continue the decontamination of the most polluted units.

French Nuclear Safety Authority (ASN)

For 2012

In 2012, the French Nuclear Safety Authority (ASN) carried out twenty two specific inspections on the subject of radiation protection in NPPs, three of which (Blayais, Civaux and Golfech) were part of an in-depth review of how the three NPPs 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, and that the radiation protection organisation defined and implemented are on the whole satisfactory. ASN does however note that EDF has to enhance its efforts during outages in the coming years to limit the awaited raise of collective and individual dosimetry due to the replacement of large components.

ASN otherwise stresses out a resurgence of events related to the industrial radiography operations, despite the significant efforts made by EDF for several years.

Finally, ASN recalls that as for 2011, EDF needs to improve the quality and the integration of risk analyses, its management of contamination in controlled areas, management of the mobile RP devices, 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.

For 2013

In 2013, ASN conducted, as in 2012, an in-depth inspection of two sites of the same area (Fessenheim and Cattenom) 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.

Some events related to radiation protection of personnel should be mentioned:

- contamination on a worker on Blayais NPP (estimated dose received by the worker on his neck above the regulatory limit for the skin which is 500 mSv by cm² of skin ; event rated at level 2 on the INES scale);
- overexposure of a diver in the spent fuel pool of the Cruas NPP (dose higher than one quarter of the annual regulatory limit ; event rated at level 1 on the INES scale);
- contamination on a worker on Belleville NPP (estimated dose received by the worker on his head higher than one quarter of the annual regulatory limit for the skin ; event rated at level 1 on the INES scale);
- contamination on a worker on Cruas NPP following a finger injury (estimated dose received by the worker on his hand higher than one quarter of the annual regulatory limit for “extremities”; event rated at level 1 on the INES scale).

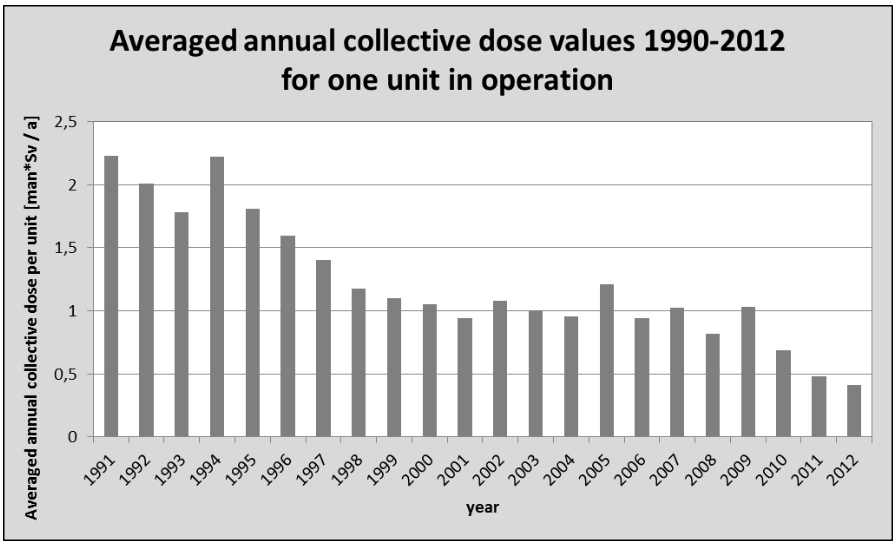
ASN proceeded to inspections to insure that all the necessary measures had been taken following these events.

Finally, since EDF confirmed the likely raise of individual and collective exposures due to the increase of the volume of maintenance work in the coming years, ASN has requested the Advisory Committee for reactors to issue an opinion on the optimisation principle implemented by EDF (end of 2014).

GERMANY

Dose information for the year 2012

ANNUAL COLLECTIVE DOSE		
OPERATING REACTORS		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
PWR	7	230
BWR	2	1070
All types	9	410
REACTORS DEFINITIVELY SHUTDOWN OR IN DECOMMISSIONING		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
PWR	8	20
BWR	4	70
All types	12	50



Summary of national dosimetric trends

Due to the political decisions after the Fukushima accident in 2011 the eight nuclear power plants Unterweser, Biblis A, Biblis B, Neckarwestheim 1, Philippsburg 1, Krümmel, Brunsbüttel and Isar 1 are taken from the net in the middle of the year. For the year 2011 they are still listed as nuclear power plants in operation. But in reality only the nine plants Brokdorf, Emsland, Grafenrheinfeld, Grohnde, Grundremmingen B, Grundremmingen C, Isar 2, Neckarwestheim 2 and Philippsburg 1 had a full year of operation.

The status of the eight plants, which were taken from the net in 2011, is still not clear. They can´t officially be listed as reactors in decommissioning, but in practice they have not been in operation in 2012 and so they are listed in the table above as decommissioning reactors.

In 2012, the average annual collective dose per unit in operation was 0.41 man·Sv and so comparable to the value of 0.48 man·Sv in the year 2011. The trend in the average annual collective dose from 1990 to 2012 is presented in the figure above.

For the decommissioning plants the value of the average annual collective dose is with 0.05 man·Sv even lower.

.HUNGARY

Dose information for the year 2012

ANNUAL COLLECTIVE DOSE		
OPERATING REACTORS		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
VVER	4	587 (with electronic dosimeters) 604 (with film badges)

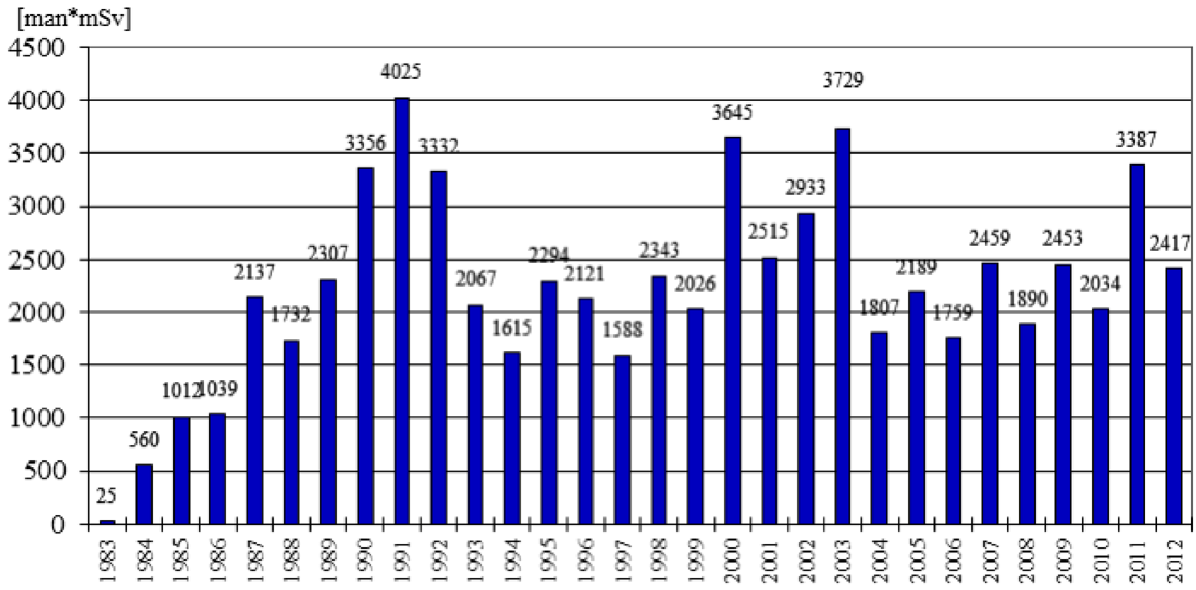
Principal events of the year 2012

Summary of national dosimetric trends

Upon the result of operational dosimetry the collective radiation exposure was 2374 man·mSv for 2012 at Paks NPP (1807 man·mSv with dosimetry work permit and 567 man·mSv without dosimetry work permit). The highest individual radiation exposure was 11.3 mSv, which was well below the dose limit of 50 mSv/year, and our dose constraint of 20 mSv/year.

The collective dose decreased in comparison to the previous year. The lower collective exposures were mainly ascribed to all the outages especially the one “so called” long outages at Unit 2.

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



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

Events influencing dosimetric trends

There was one general overhaul (long maintenance outage) in 2012. The collective dose of outage was 969 man·mSv on Unit 2.

Number and duration of outages

The duration of outages were 32 days on Unit 1, 54 days on Unit 2, 29 days on Unit 3 and 27 days on Unit 4.

ITALY

Dose information for the year 2012

ANNUAL COLLECTIVE DOSE		
REACTORS DEFINITIVELY SHUTDOWN OR IN DECOMMISSIONING		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
PWR	1	3.06 man·mSv (1 unit - Trino NPP)
BWR	2	18.40 man·mSv (1 unit Caorso NPP [7.78 man·mSv] + 1 unit Garigliano NPP [29.01 man·mSv])
GCR	1	0.2 man·mSv (1 unit – Latina NPP)

JAPAN

Dose information for the year 2012

ANNUAL COLLECTIVE DOSE		
OPERATING REACTORS		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
PWR	24	177
BWR*1)	24	290
All types*1)	48	233
REACTORS DEFINITIVELY SHUTDOWN OR IN DECOMMISSIONING		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
BWR*1)	2	41
GCR	1	70
LWCHWR	1	149

*1) BWR and All types do not include Fukushima-daiichi NPP.

Principal events of the year 2012

Outline of national dosimetric trends

The exposure dose per reactor excluding the data of the Fukushima-daiichi nuclear power plant (units 1 - 4 in permanent shutdown and operating reactor unit 5 and 6) decreased substantially as compared with the previous year. The exposure dose for PWR decreased from 960man.mSv/unit of the previous year to 177man.mSv/unit, and exposure dose for BWR decreased from 1050man.mSv/year of the previous year to 290man.mSv/unit. The major factor of reduction is because many nuclear reactors have stopped for a long period of time after the accident of Fukushima-daiichi NPP.

Operating status of nuclear power plants

Almost all reactors stopped operation one by one in FY 2011 for the periodic inspection and did not re-start operation due to the change of regulatory system and regulation standards.

In FY 2012, only three PWRs operated.

From April 1 to May 4: 1 unit (Tomari unit 3)

From May 5 to August 2: no unit operated

From August 3 to August 15: 1 unit (Ohi unit 3)

From August 16 to March 31, 2013: 2 units (Ohi unit 3 & 4)

Exposure dose distribution of workers in Fukushima-daiichi NPP

Exposure dose distributions at Fukushima-daiichi NPP for cumulative dose until March 2013 and for dose during FY 2012 are shown below.

Clasification（mSv）	Cumulative dose (March 2011 - March 2013)			Fiscal year 2012 (April 2012 - March 2013)		
	TEPCO	Contractor	Total	TEPCO	Contractor	Total
Over 250	6	0	6	0	0	0
200 - 250	1	2	3	0	0	0
150 - 200	22	2	24	0	0	0
100 - 150	117	17	134	0	0	0
75 - 100	236	69	305	0	0	0
50 - 75	299	516	815	1	0	1
20 - 50	612	3,504	4,116	62	675	737
10 - 20	494	3,488	3,982	129	2,000	2,129
5 - 10	413	3,208	3,621	266	1,875	2,141
1 - 5	612	6,008	6,620	579	3,326	3,905
1 or less	900	6,418	7,318	586	4,241	4,827
Total	3,712	23,232	26,944	1,623	12,117	13,740
Max.（mSv）	678.80	238.42	678.80	54.10	43.30	54.10
Ave.（mSv）	24.73	10.28	12.27	4.50	5.90	5.74

* TEPCO use integrated value of APD data that measured every time when enter into the area.
These data sometimes fluctuate due to replacing these data to monthly dose data measured by integral dosimeter.

* There has been no significant internal radiation exposure reported since October 2011.

* Internal exposure doses may be revised due to the reconfirmation.

* A TEPCO employee who is exposed to 50 - 75 mSv radiation in FY 2012 is specific worker under high radiation dose.

Regulatory requirements

The Nuclear Regulation Authority launched on September 19, 2012 as a regulatory authority which replaces Nuclear and Industrial Safety Agency. A new safety standard is expected to be established in July 2013. For re-operation of a stopped nuclear reactor, it is necessary to obtain approval by the new safety standards.

THE NETHERLANDS

Dose information for the year 2012

ANNUAL COLLECTIVE DOSE		
OPERATING REACTORS		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
PWR	1	334
REACTORS DEFINITIVELY SHUTDOWN OR IN DECOMMISSIONING		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
BWR	1	0

Principal events of the year 2012

- Yearly Outage: 280 man·mSv; one event with a high pressure injection pump was 38 man·mSv.
- No other significant RP events.

REPUBLIC OF KOREA

Dose information for the year 2012

ANNUAL COLLECTIVE DOSE		
OPERATING REACTORS		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
PWR	19	416.85
PHWR	4	637.72
All types	23	455.26

Principal events of the year 2012

Summary of national dosimetric trends

For the year 2012, 23 NPPs were in operation; 19 PWR units and 4 PHWR units. The average collective dose per unit for the year 2012 was 455.26 man·mSv/unit. The dominant contributors of the collective dose in the year 2012 were the works carried out during the outages, resulting in 86.3% of the total collective dose in 2012. There were 14,715 people involved in radiation works in 23 operating units and the total collective dose was 10,471 man·mSv.

Number and duration of outages

Outages were performed at 13 PWRs and 3 PHWRs. The total duration for the outages was 1,037 days for PWRs and 104 days for PHWRs. Total outage duration was lengthened compared to previous years due to the component replacements and unexpected events.

Component replacements

There were steam generator replacements at Hanul unit 1 in 2012. Hanul unit 1 is a PWR of 950 Mw capacity. 3 steam generators were replaced during the outage, resulting in 670 man·mSv of total collective dose.

(Note: Names of the exisiting nuclear reactors such as Ulchin units and Yonggwang units were changed into new names such as Hanul units and Hanbit units, respectively in May, 2013.)

Unexpected events/incidents

– Hanul unit 3 and 4 started their outages in 2011. Lots of flaws on steam generator U tubes caused by PWSCC were found during ECT. KHNP decided to replace the steam generators, so Hanul unit 4 had to be shutdowned over the whole year of 2012 until the new steam generators were ready for replacement in 2013, while Hanul unit 3 finished its outage and started re-operation after plugging. Steam generators of Hanul unit 3 are also scheduled to be replaced in 2014.
– Indications were found on 6 CEDM penetration tubes of reactor head while conducting Nondestructive test at Hanbit unit 3 during its 14th outage from Oct. 18. 2012. The repair method had not been decided in 2012, so it caused unexpected exposure, performing test and inspections for the determination of repair method. However, the damaged CEDM penetration tubes were repaired and Hanbit unit 3 started re-operation in June 2013.

New reactors on line

There were 23 units in operation in 2012 compared to 21 units in 2011. That means 2 new reactors were on line in 2012. They are Shinkori unit 2 and Shinwolsung unit 1 which are 1000 Mw capacity PWRs. Shinkori unit 2 started its commercial operation on Jul. 20, 2012 and Shinwolsung unit 1 did on Jul. 31, 2012.

New dose-reduction programmes

A trial application of zinc injection to reduce source term has been applied in Hanul unit 1 from 2010 and as the result there was 30% decrease of radiation exposure rate at RCS pipe and steam generator chambers. So KHNP is planning to extend zinc injection to other reactors. Zinc injection will be applied at Kori unit 3, Kori unit 4 and Hanbit unit 4 in 2014.

ROMANIA

Dose information for the year 2012

ANNUAL COLLECTIVE DOSE		
OPERATING REACTORS		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
PHWR	2	459

Principal events of the year 2012

Summary of national dosimetric trends since the last 10 years

Occupational exposure at Cernavoda NPP (2000 – 2012)			
	Internal effective dose (man·mSv)	**External effective dose (man·mSv)**	**Total effective dose (man·mSv)**
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
2012 (2 units)	251	667	918

Events influencing dosimetric trends

Normal operation of the plant (U1 & U2)

During normal operation intervals of Unit 1 there were 3 (two) radiological events that have a significant impact on individual and collective doses: 2 primary heat transport system tritiated heavy water leaks on June 27th due to a broken sight glass and rupture disk, and July 14th, due to a melted ice plug during a pipe replacing activity. The collective internal dose associated to these events was 32 man mSv. On December 3rd, Unit 1 shutdown due to grid disturbance. Repairing activities of Liquid Injection Shutdown System equipments resulting in 10 man mSv collective dose.

At the end of 2012:

- there are 227 employees with individual doses exceeding 1 mSv; 34 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 of the year is 8.11 mSv;
- The contribution of internal dose due to tritium intake is 27.3%.

Planned Outage

A 38 days planned outage was done at Unit#1 between May 4th and June 11th 2012. Activities with major contribution to the collective dose were as follows:

- Horizontal neutron Flux Detectors replacement
- 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 574.6 man mSv (396.9 man mSv external dose and 177.7 man mSv internal dose due to tritium intakes).

Finally this planned outage had a 63% contribution to the collective dose of 2012.

Planned Outages dose history

Year	Unit	Interval	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
2012	1	04.05 – 11.06	396.9	177.7	574.6

Unplanned outages

Unit 1 – July 14 –16: Unit was orderly shutdown in order to replace pipe lines affected by fatigue (3332-4D-7, 3331-1D-18 and 1-3331-3/4D-21) on Primary Heat Transport System, with new ones. (2.53 man mSv external dose and 25 man mSv internal tritium dose for all the activities performed).

Unit 1 – December 3rd – December 6th: forced shutdown due to grid disturbance. Repairing activities of Liquid Injection Shutdown System equipments resulting in 10 om mSv collective dose.

Radiation protection-related issues

After 2011 events at Fukushima –Daichi NPP and the European Commission “Stress test” report recommendations CNE Cernavoda started the implementation of corrective actions for improving plant answer in case of severe accident.

Recommendations that are already fulfilled are related to:

- The suitability of the NPP construction site assessed based on an analysis that takes into account the most severe flood and the most severe earthquake over the last 10000 years;
- NPP design must be able to withstand an earthquake producing at least Peak Ground Acceleration of 0.1g: Cernavoda project could resist at an earthquake with PGA of 0.4g;
- Time available to the operator for the restoration of the safety functions in case of loss of all electrical power is more than one hour (without human intervention);
- A backup Emergency Control Room is available in case the Main Control Room becomes inhabitable.

Recommendations that are in progress:

- Means needed to fight accidents are stored in places adequately protected against external events – they are stored in Unit 3 while the bunker in Unit 5 is under set-up;
- On-site seismic instrumentation – we are assessing the possibilities for improvement of the warning system;
- We intend to ask for an WANO TSM review of the Emergency Operating Procedures that should cover all plant states (full power to shut down);
- Severe Accident Management Guidelines for “full power” state are ready; those for “shut down” are in progress;

- Design changes for passive measures to prevent hydrogen explosions in case of severe accident (Passive Autocatalytic Recombiners) are finished in Unit 1 and in progress in Unit 2 (to be finished during Planned Outage 2013);
- Design changes for Containment Filtered Venting System, to limit the amount of radioactivity released outside the containment in case of an accident, are in progress.

Issues of concern in 2012

The main concerns for 2012 were important works, with high radiological impact, performed during Planned Outage of Unit 1.

Highlights for the year 2013

Issues of concern in 2013

The main concerns for 2013 are activities with high radiological impact, to be performed during a 27 days Planned Outage of Unit 2:

- Fuel channel inspection;
- Fuelling machine bridge components preventive maintenance;
- Piping supports inspection;
- Snubbers replacement;
- Feeder – yoke clearance measurements and correction;
- Inspection for tubing and supports damages in the feeder cabinets;
- Planned outages systematic inspections

RUSSIAN FEDERATION

Dose information for the year 2012

ANNUAL COLLECTIVE DOSE		
OPERATING REACTORS		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
VVER	17	618.1
REACTORS DEFINITIVELY SHUTDOWN OR IN DECOMMISSIONING		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
VVER	2	79.2

Principal events of the year 2012

Summary of national dosimetric trends

In 2012, the total effective annual collective dose of utilities employees and contractors at 17 operating VVER type reactors was 10507.3 man·mSv. This result was practically at the level of 10518.1 man·mSv recorded for the year 2011.

As usual, it was registered a considerable difference between average annual collective doses for the groups of VVER-440 MWe and VVER-1000 MWe reactors. In 2012, the results were as follows:

- 934.5 man·mSv/unit with respect to the group of 6 operating VVER-440 reactors.
- 490.0 man·mSv/unit with respect to the group of 10 operating VVER-1000 reactors (without taking into account the collective dose 4.0 man·mSv of the new Kalinin 4 reactor which was put into commercial operation on 25 September 2012).

Comparative analysis shows that average annual collective doses were relatively constant near 500.0 man·mSv/unit (511.2, 547.8, 490.0 man·mSv/unit in 2010-2012 respectively) for the group of VVER-1000 reactors. Average annual collective doses for the group of VVER-440 reactors changed in more wide range of values: 863.1, 838.7, 934.5 man·mSv/unit for the years 2010-2012 respectively.

Events influencing dosimetric trends

The principal factors influencing on the total collective dose change at Russian VVERs are annual outages durations and amount of repairing and maintenance works.

In comparison to the year 2011, next changes should be taken into consideration for the year 2012:

- Balakovo 1 - collective dose increasing at 92% was caused by major outage in 2012 (standard outage in 2011).
- Balakovo 2 - collective dose decreasing at 59% was caused by standard outage in 2012 (major outage in 2011).
- Balakovo 4 – it was no outage in 2012.
- Kalinin 1 – special radioactive dangerous works inside the SGs on exchange of shutter separators were performed.
- Kalinin 2 – lessons leaned on the use of SGs shutter separators exchange at Kalinin 1 for the same repairing works at two SGs.
- Kalinin 3 – it was no outage in 2012.
- Kola 1 – collective dose increasing at 112% was caused by major outage in 2012 (standard outage in 2011).

- Novovoronezh 3 – 62 days unplanned outage for repairing of reactor vessel head. The total collective dose was 739.9 man·mSv.

Individual doses

In 2012, the annual effective individual doses received by 16 workers of Novovoronezh NPP exceeded control level of 18.0 mSv. This control level was fixed by Concern Rosenergoatom as operational dose constraint starting from 01 January 2011. In this specific case, control level exceeding has been preliminary planned and aimed at collective dose reduction. The main occupational dose limit – 100.0 mSv averaged over defined periods of 5 years, but no more than 50.0 mSv in any single year – was not violated in this situation. All doses were gradually received by persons from the plant maintenance department during repairing of reactor vessel head at Novovoronezh 3. The maximum annual individual dose was 26.6 mSv.

There were no events of exceeding 18.0 mSv of annual individual dose at other plants with VVER type reactors in 2012. The maximum annual effective individual doses were:

- Balakovo – 12.3 mSv.
- Kalinin – 16.0 mSv.
- Kola – 15.7 mSv.
- Rostov – 3.8 mSv.

Planned outages duration and collective doses

Reactor	Duration [days]	Collective dose [man·mSv]
Balakovo 1	99	1407.4
Balakovo 2	36	257.7
Balakovo 3	37	554.7
Balakovo 4	no outage	--
Kalinin 1	79	1072.0
Kalinin 2	49	562.0
Kalinin 3	no outage	--
Kalinin 4	no outage	--
Kola 1	64	890.3
Kola 2	43	412.4
Kola 3	80	893.6
Kola 4	55	309.7
Novovoronezh 3	37	784.4
Novovoronezh 4	36	741.6
Novovoronezh 5	54	409.3
Rostov 1	38	83.4
Rostov 2	40	116.0

Unplanned outages duration and collective doses

Reactor	Duration [days]	Collective dose [man·mSv]
Kalinin 1	6	7.5
Novovoronezh 3	36	739.9
Rostov 1	11	5.3

New reactors on line

Kalinin 4 with VVER-1000 MWe type reactor (project V-320) was put into commercial operation on 25 December 2012.

New dose reduction programmes planning in 2013

- Development of regulation concerning radiation protection management system in Concern Rosenergoatom.
- Development of the manual for providing radiation safety during operation of NPPs.
- Development and validation of the standard method directed at determination of radionuclides in human body in the case of radiation accident.
- Development of the special model for calculation of internal exposure individual doses.
- Development of the software for direct estimation of personal radiation risk coefficients for personal dosimetry of NPP employees.
- Development of the software based on IAEA safe principles and ICRP recommendations for situations of potential exposure.

SLOVAK REPUBLIC

Dose information for the year 2012

ANNUAL COLLECTIVE DOSE		
OPERATING REACTORS		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
VVER	4	164.484
REACTORS DEFINITIVELY SHUTDOWN OR IN DECOMMISSIONING		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
VVER	2	2.124

Principal events of the year 2012

Events influencing dosimetric trends

Bohunice NPP:

The total annual effective dose in Bohunice NPP in 2012 calculated from legal film dosimeters was 372.007 man·mSv (employees 180.486 man·mSv, outside workers 191.521 man·mSv). The maximum individual dose was 5.030 mSv (outside worker). Standard operation and planned outages were without anomalies.

Mochovce NPP:

The total annual effective dose in Mochovce NPP in 2012 evaluated from legal film dosimeters and E50 was 285.928 man·mSv (employees 108.578 man·mSv, outside workers 177.350 man·mSv). The maximum individual dose was 3.810 mSv (employee). Both units were in standard operation. Unit 1 had a standard maintenance outage. Unit 2 had also a standard maintenance outage

JAVYS NPP:

The total annual effective dose in JAVYS NPP in 2012 calculated from legal film dosimeters was 4.247 man·mSv (employees 1.130 man·mSv, outside workers 3.117 man·mSv). The maximum individual dose was 0.691 mSv (outside worker).

Number and duration of outages

Bohunice NPP:

- Unit 3 – 21 days standard maintenance outage. The collective exposure was 99.486 man·mSv from electronic dosimeters.
- Unit 4 – 34 days standard maintenance outage. The collective exposure was 198.050 man·mSv from electronic dosimeters.

Mochovce NPP:

- Unit 1 - 23.2 days standard maintenance outage. The collective exposure was 112.620 man·mSv from electronic dosimeters.
- Unit 2 - 24.9 days standard maintenance outage. The collective exposure was 85.415 man·mSv from electronic dosimeters.

JAVYS NPP:

- Unit 1 – decommissioning
- Unit 2 – decommissioning

New plants on line/plants shut down

Completion of the Mochovce unit 3 and 4 in the year 2012 continued. Main work was performed on secondary and primary circuit. Official delay of unit 3 start-up was announced to year 2014.

Major evolutions

Bohunice NPP:

The plant obtained two important RP regulatory authority decisions:

1. Usage of new Gd fuel enriched by 4.87% 235U,
2. Basic decision for the operation of Bohunice NPP nuclear units and associated radiation risk activities”

Mochovce NPP:

Renewal of the personal dosimetry license and license of reactors operation from radiation protection regulatory body.

SLOVENIA

Dose information for the year 2012

ANNUAL COLLECTIVE DOSE		
OPERATING REACTORS		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
PWR	1	884

Principal events of the year 2012

Summary of national dosimetric trends

The last three years' collective dose average rose from 0.55 to 0.60 man·Sv.

Maximum individual annual dose remains at low level and it was 6.55 mSv, average dose per person was 0.63 mSv.

Events influencing dosimetric trends

The outage collective dose was 0.712 man·Sv. It was a refuelling outage with reactor vessel head replacement.

Number and duration of outages

One planned outage performed in 43.3 days.

Major evolutions and dose-reduction programme

The new reactor vessel head was designed to have impact on reduction of collective doses of future outages.

Technical plans for major work in 2013

Elimination of RTD bypass during outage 2013. Safety upgrade project is going on and it includes installation of passive hydrogen recombines and passive containment filtering system during outage 2013. Autonomous radiation monitoring system has already been installed in the yard at plant perimeter and in the auxiliary building for dose rate measurement using battery powered channels connected by radio link. In addition, some beta/alpha air contamination monitors within the yard were also included within this system.

SPAIN

Dose information for the year 2012

ANNUAL COLLECTIVE DOSE		
OPERATING REACTORS		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man.mSv/unit]**
PWR	6	467.59
BWR	2	252.05
All types	8	413.70
REACTORS DEFINITIVELY SHUTDOWN OR IN DECOMMISSIONING		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man.mSv/unit]**
PWR	1	307.96
GCR	1	0

Principal events of the year 2012

PWRs

Almaraz NPP (2 units)

Events influencing dosimetric trends

- Review and modifiaction of very low dose rate areas called “ALARA ZONES”.
- Continuous optimization of radiation protection procedures and measures.
- Setting dosimetric objectives for specific Jobs.
- Reduction of maximum individual dose objective during outage.

Number and duration of outages

- 20th outage of ALMARAZ Unit 2:
    - Duration 40 days.
    - Colective dose 473.436 man.mSv
    - Maximum individual dose: 4.320 mSv
- 22nd outage of ALMARAZ Unit 1:
    - Duration 59 days.
    - Colective dose 459.826 man.mSv
    - Maximum individual dose: 4.735 mSv

Component or system replacements

- During 20th outage of unit 2 and 22nd outage of unit 1 there have been replaced two reactor coolant pump motors (one per unit).

Safety-related issues

- Elimination of the filter train bypass line in the ventilation system of the spent fuel building.

New/experimental dose-reduction programmes

- Use of Centralized Aspiration Unit´s.
- Modification and upgrade of the cavity purifications system.

Organisational evolutions

- Incorporation of an operational ALARA supervisor.

Ascó NPP (2 units)
Outage information (number and duration)

- Outage of 45 days in Unit 1 with collective dose of 592,72 mSv.p

Vandellòs II NPP
Outage information (number and duration)

- Outage of 49 days of duration. The most relevant activities performed during the outage are the following
  - Inspection of the penetrations of the vessel head
  - Visual inspection of the vessel nozzles through TENNIS robot.
  - Inspection of the primary side of one steam generator
  - Design modification for the elimination of hydraulic seal in the pressurizer safety valves.

Trillo NPP

Nothing interesting during 2012

BWRs
Santa Maria de Garoña NPP
Events influencing dosimetric trends

Date	Event	Mean activity (if it exists)	Collective Dose (man.mSv)
March, 26th to 30th	Unexpected shutdown	Seal replacement recirculation pump B-202-1A	24,981
March 5th to October 26th	Design modification of the new Stand by Gas Treatment System (SBGTS)	--	5,586
May 7th to November 8th	Design modification of the new Independence electrical wiring safety related systems	--	12,066
October 10th to November 12th	SHC maintenance (shutdown reactor cooling system)	Valve MOV-1001-4B replacement	11,319
December 17th to 22nd	Scheduled shutdown	Fuel movement. Reactor discharge	19,605

New/experimental dose-reduction programmes

Programme of monitoring, control and limitation of individual dose. Design of a new performance indicator of individual dose.

Cofrentes NPP

Nothing interesting during 2012.

SWEDEN

Dose information for the year 2012

ANNUAL COLLECTIVE DOSE		
OPERATING REACTORS		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
PWR	3	539.0
BWR	7	670.0
REACTORS DEFINITIVELY SHUTDOWN OR IN DECOMMISSIONING		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
BWR	2	20.0

Principal events of the year 2012

Events influencing dosimetric trends

Barsebäck NPP

Waste storage building will be completed in autumn 2014. Segmentation of internals on both units will be finished and removed in 2015.

Forsmark NPP

A system decontamination (CORD-UV) was performed at Forsmark 2 on two systems: the Cooling System for Cold Shutdown Reactor (321) and the Reactor Water Cleanup System (331). The decontaminations factors after three cycles were 41 for system 321 and 6 for system 331. Forsmark 2 will start trial operation at 3253 MWth in the spring of 2013.

Oskarshamn NPP

During the outage of Oskarshamn 1 repair of the six feed water spargers in the reactor vessel was performed after component decontamination.In Oskarshamn 3 the cutting of internals was finished in February 2012 and the total dose for the work was about 300 man·mSv.

Ringhals NPP

During periodic inspection at Ringhals 1, new cracks were found on the Reactor Vessel Head Sprinkler system. A Mock-up was build for qualification and repair was completed with an exposure of 87 man·mSv.

Conversion to FPHD (Forward Pumped Heat Drain) was performed on one Turbine and will be completed in 2013. Trends in water chemistry and source terms will be carefully followed the upcoming years in order to have full control and be able to make corrective actions.

Two incidents occurred at Ringhals 2 concerning Flux-Map equipment; In-Core cable and detector were not in position “in-Shield”. In one of the incidents, individuals were exposed in a high dose rate (just over 50 mSv/h), with a potential risk for high exposure.

At Ringhals 4 major exchange of check valves in Safety Injection System lead to higher collective dose than planned due to prediction concerning scope of work.

New/experimental dose-reduction programmes

As a part of the SG (Steam Generator) replacement at Ringhals 4 in 2011, it was decided to perform HE-UFC (High Efficiency Ultrasonic Fuel Cleaning) as one measure to reduce source term rebuild and to decrease CRE (Collective Radiation Exposure).

Organisational evolutions

A periodic WANO Peer Review was performed at Ringhals NPP in 2012. The review included the entire site (1 BWR, 3 PWR including Waste-, decontamination- and mechanical plants).

Report from Regulatory Authority

In 2012, the Swedish Radiation Safety Authority (SSM) was reviewed by IAEA´s Integrated Regulatory Review Service (IRRS) with the outcome of 15 good practices, 22 recommendations and 14 suggestions.

The new Director General, who started working in September 2012, has continued the work with updating regulations during 2013. Nineteen of the regulations concerning nuclear facilities are now translated into English and have been published at www.ssm.se. In 2012 SSM received an application for a future possible construction of a new reactor, and this has also trigged SSM to develop new regulations for new reactors to be published in 2015. For this work SSM has recruited several new employees, and further resources would be needed for the review work in case of receiving/should there be a fully detailed sharp application.

The work on reviewing the application of a spent nuclear fuel final repository continues at SSM.

“Periodic safety reviews” for Oskarshamn 1 and Oskarshamn 2 are also in progress.

During 2012 there were intruders at two of the three nuclear power sites. SSM is closely following the nuclear power plants´ efforts to strengthen the outer protective defense barriers.

SWITZERLAND

Dose information for the year 2012

ANNUAL COLLECTIVE DOSE		
OPERATING REACTORS		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·mSv/unit]**
PWR	3	410
BWR	2	1492

Principal events of the year 2012

Events influencing dosimetric trends

Beznau NPP (Unit 1)

The outage took 53 days with a collective dose of 544 man·mSv (planned collective dose target 433 man·mSv). The unforeseeable repair of a hardly feasible crack inside the vessel head by overlay welding generated 82 man·mSv of additional dose. Remote controlled electronic dosemeters at the head of the workers gave valuable information implementing ALARA during the work proceeding. No incorporation was detected above the lower detection limit for quick counter (3000 Bq Co-60). The highest individual dose was 8.4 mSv and lower than the company own dose constraint of 10 mSv.

Beznau NPP (Unit 2)

An unforeseeable outage was performed in order of a leaking main cooling pump. This outage took 23 days and resulted in 55.4 man·mSv. The regular outage was 21 days and brought 55.6 man·mSv.

Mühleberg NPP

The outage of 28 days led to 596 man·mSv. The trend of dose rates on the recirculation pipes shows positive effects on the water chemistry with noble chem and continuous hydrogen injection beside the prevention of stress crack corrosion.

Gösgen NPP

The outage of 20 days resulted in 415 man·mSv. The highest individual dose was 6.5 mSv. No incorporation or permanent contamination of any person was detected. Because of tramp uranium due to old fuel leakages in the years 2007-2010 additional control over iodine aerosols was necessary during opening the primary cooling circuit.

Leibstadt NPP

The outage of 85 days resulted in 1955 man·mSv. The highest individual dose was 11 mSv. No incorporation or permanent contamination of any person was detected. The unforeseeable repair of a crack in the feedwater nozzle by overlay welding generated 74 man·mSv of additional dose.

The welding procedure was exercised intensively on several mock-ups. With teledosimetry the RP officers were able to manage work oversight timely in complex exposure fields.

UNITED KINGDOM

Dose information for the year 2012

ANNUAL COLLECTIVE DOSE		
OPERATING REACTORS		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man.mSv/unit]**
PWR	1	37
GCR (Magnox)	1	19
GCR (AGR)	14	59
REACTORS DEFINITIVELY SHUTDOWN OR IN DECOMMISSIONING		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man.mSv/unit]**
GCR (Magnox)	19*	56

** Oldbury Unit 1 and Wylfa Unit 2 shutdown part way through year.*

Principal events of the year 2012

The Collective Radiation Exposures for the Advanced Gas Cooled Reactors, operated by EDF Energy, were generally low, ranging from 13.2 man.mSv for Heysham 2 to 377.6 man.mSv for Hunterston-B (All UK gas reactor sites have two reactors). The highest collective radiation doses were recorded by the AGRs performing inspection and repairs inside the Reactor Vessel.

Sizewell B, the only PWR, recorded a low annual Collective Radiation Exposure, since the plant did not have a refuelling outage during the year.

Oldbury Reactor 1 (GCR Magnox) shutdown for the final time at the end of February 2012. Both Oldbury Reactors are now in decommissioning. Wylfa Reactor 2 finally shutdown in April 2012. There is now only one Magnox Reactor left operating in UK, Wylfa Unit 1.

Regulatory Issues

At the end of the year the UK regulators, the Office for Nuclear Regulation (ONR) and the Environment Agency (EA) issued a joint statement confirming that they were satisfied that the UK EPR, designed by EDF Energy and Areva, meets regulatory expectations on safety, security and environmental impact.

Additional site-specific consents and approvals will be required from the regulators before this reactor can be built at any UK location and planning permission must be obtained from the Secretary of State for Energy and Climate Change. EDF Energy continue to progress plans to build twin EPR reactor units at Hinkley Point and Sizewell.

During 2012 ONR published a series of reports reviewing the circumstances of the Fukishima nuclear accident, to understand the lessons learned for the UK nuclear industry. These reports draw extensively on separate reviews conducted by the UK nuclear operators. As appropriate the UK nuclear industry has begun to implement appropriate improvements in response to the findings of these reports.

UNITED STATES

Dose information for the year 2012

ANNUAL COLLECTIVE DOSE		
OPERATING REACTORS		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man.mSv]**
PWR	69	560
BWR	35	1200
Total: All types	104	770
REACTORS DEFINITIVELY SHUTDOWN OR IN DECOMMISSIONING		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man.mSv]**
PWR	6*	127
BWR	3*	78

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

Principal events in ISOE participating countries
Summary of national dosimetric trends

The USA PWR and BWR occupational dose averages for 2012 reflected a continued emphasis on dose reduction initiatives at the 104 operating commercial reactors:

Reactor Type	Number of Units	Total Collective Dose	Average Dose per reactor
PWR	69	38,351 person-mSv	0.56 person-Sv/unit
BWR	35	42,003 person-mSv	1.20 person-Sv/unit

The total collective dose for the 104 reactors in 2012 was 80,354 person-mSv. The resulting average collective dose per reactor for USA LWR was 770 person-mSv/unit. Twenty-one individuals received between 20-30 mSv at a site in 2012. Thirteen of those individuals were at the same US site.

US PWRs

The total collective dose for US PWRs in 2012 was 38,351 person-mSv for 69 operating PWR units. The 2012 average collective dose per reactor was 560 person-mSv/PWR unit. The highest annual dose US PWR site was Palisades at 2,451 person-mSv. US PWR units are generally on 18- or 24-month refueling cycles. The US PWR sites that achieved annual site doses of under 100 person-mSv in 2012 were:

- Callaway 45 person-mSv Wolf Creek 78 person-mSv

US BWRs

The total collective dose for US BWRs in 2012 was 42,003 person-mSv for 35 operating BWR units. The 2012 average collective dose per reactor was 1,200 person-mSv/BWR unit. This is primarily due to BWR steam dryer replacements, power up-rates and water chemistry challenges at some US BWR units in 2012.

The highest annual dose US BWR site (3-unit site) was Browns Ferry 1,2,3 at 4,643 person-mSv and Brunswick 1,2 (2-unit site) at 3,698 person-mSv. Most US BWR units are on 24-month refueling cycles.

In calendar year 2012, the collective dose for all light water reactor (LWR) licensees was 80.35 man·Sv. The average annual collective dose per reactor for LWR licensees was 0.77 man·Sv.

New plants on line/plants shut down

Watts Bar 2 is being prepared to commence initial operations in the near future. Southern Company proceeds well on the construction of two new PWRs at the Vogtle site in Georgia. South Carolina Electric & Gas is constructing a new PWR on the Summer site.

Zion Units 1 and 2 located on Lake Michigan north of Chicago continued decommissioning in 2012. The site dose in 2012 was 758.01 person-mSv.

New/experimental dose-reduction programmes

Major initiative at some US plant to fully implement alpha hazard awareness and control programs based on lessons learned from industry events.

Organisational evolutions

Kewaunee site will be shutdown in 2013 due to low natural gas prices in the Wisconsin region creating a difficult economic environment for a single nuclear unit to compete under.

Power uprates are being cancelled or postponed due to low natural gas prices pressure on nuclear units in the US.

4. 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 2012.

4.1 ISOE ALARA Symposia

ISOE International ALARA Symposium

The NATC organized the 2012 ISOE International Symposium, held 8-11 January 2012 at Fort Lauderdale, Florida/US and sponsored by the OECD/NEA and IAEA with the participation of 145 registered participants (including vendors) from 12 countries. The symposium program was structured to include 39 presentations addressing occupational radiation protection in nuclear power plants, implementation of ICRP recommendations with regulatory perspectives, discussion on Fukushima nuclear accident, its possible impact on nuclear industry and lessons learnt. Distinguished papers selected by the participating technical centres included:

- *Underwater Diving Remote Monitoring Implementation,* M. Leasure (Braidwood NPP, USA).
- *Angra 1 & 2 - ALARA Program Successes & Future Initiatives* M. do Amaral (Angra NPP, Brazil.

The NATC Regional US Regional RPM meeting was held on 12-13 January with the attendance from over 65 regulators, RPMs and vendors from 5 countries.

The 2013 ISOE International ALARA Symposia will be organized by ATC.

ISOE Regional ALARA Symposia

European Symposium

The ETC, in collaboration with ČEZ, organized the 2012 ISOE European ALARA Symposium from 20 to 22 June 2012 in Prague (Czech Republic). 171 participants attended the symposium from 18 countries and 15 vendors. Distinguished papers selected by the participating technical centres for presentation at the 2012 ISOE European ALARA Symposium included:

- *Operational Experience of the Replacement of Pressuriser Heaters during a Forced and a Planned Refuelling Outage*, G. Renn and M.Lunn (Sizewell B NPP, UK)
- *Radiation Area Classification and Sizing of the Storage buildings of used-up steam generators - Practical application*, J. Routtier, T. Canal, X. Michoux (EDF CIPN, France)

A poster presentation was also distinguished:

- *Harmonization of Use and Calibration of Radiation Measurement Equipment in the Spanish Nuclear Power Plants,* M. A. de la Rubia and M. Rosales (CSN), A. Félez (UNESA)

The RPM and Regulatory Body meetings were organised on the 19th of June.Two technical visits to Dukovany NPP and Temelin NPP took place on the 22nd of June.

Asian Symposium

The 2012 ISOE Asian ALARA Symposium was held 24-26 September 2012 in Tokyo/Japan with the support Asian and North-American participants of the ISOE. The symposium was organized by the ATC in collaboration with the NATC and was attended by 32 registered participants from four countries. Distinguished papers selected by the participating technical centres included:

- *Los Alamos National Laboratory Developed Technology Proven Effective for Reducing Plant Radiation Levels in Light and Heavy Water Reactors,* Patricia J. Robinson ((n,p) Energy, Inc, USA).

Proceedings and conclusions of the various Symposia are available on the ISOE Network.

4.2 The ISOE Website (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, three phases have been defined: permanently shutdown, safe storage and decommissioning activities.

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;
- Total annual collective dose;
- Average annual collective dose per reactor;
- Rolling average annual collective dose per reactor;
- Average annual collective dose per energy produced;
- Plant unit rankings;
- Total outage collective dose;
- Average outage collective dose per reactor;
- Trends in the number of reactor units;
- 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 2012, the following types of documents were made available:

- Benchmarking reports,
- RP Experience reports,
- RP Management documents,
- Plant information related documents,
- Training documents,
- ISOE 2 questionnaires,
- ISOE 3 reports,
- RP Forum syntheses,
- Source-term management documents,
- Severe Accident Management documents,
- Cavity decontamination 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.

4.3 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 2012 are summarized below.

Benchmarking visits organized by ETC

In 2012, a benchmarking visit to Duke Energy (USA) has been organized by ETC for the French Utility EDF, using ISOE contacts, but no ISOE/ETC resources.

The visit took place from 15th to 19th October 2012. The French team was composed of representatives of EDF and one representative of CEPN. The Corporate office and two NPPs (Catawba & Mc Guire) were visited.

The main topics discussed were:
- Radiation Protection Management at the Corporate Level,
- Performance indicators,
- ALARA,
- RP organisational structure during outage – non outage, and
- Fields operation program.

The synthesis report is available on the ISOE website in the RP Library.

Benchmarking visits organized by NATC

Below given benchmarking visits were conducted by the NATC.

- June 2012: Visit to Temelin NPP, Czech Republic (organised in the framework of the ISOE European Symposium)
- September 2012: Visit to Onagawa NPP, Japan (organised in the framework of the ISOE Asian Symposium)

4.4 ISOE Management

In 2012, 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.

ISOE Management and Programme Activities

As part of the overall operations of the ISOE programme, ongoing technical and management meetings were held throughout 2012, including:

ISOE Meetings	**Date**
ISOE Bureau	Apr. 2012; Nov. 2012
Working Group on Data Analysis (WGDA)	Apr. 2012; Nov. 2012
22nd ISOE Management Board Meeting	Nov. 2012
Expert Group on Water Chemistry and Source-Term Management (EGWC)	Feb. 2012; Oct. 2012
Expert Group on Occupational Radiation Protection in Severe Accident Management and Post-accident Recovery (EG-SAM)	Apr. 2012; Nov. 2012
Joint NEA/CRPPH-ISOE Activities	
Expert Group on Occupational Exposure (EGOE)	Jan. 2012; Oct. 2012

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 2012 and approving the programme of work for 2013. The 2012 mid-year meeting of the ISOE Bureau focused on the status of the ISOE activities for 2012, the status of the renewal of the ISOE Terms and Conditions, planning for the ISOE annual session 2012 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 April and November 2012, 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.

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 in 2011 and met twice in 2012. 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 EG-SAM met twice in 2012. 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 Expert Group on Occupational Exposure (EGOE) was formed by CRPPH at its March 2006 meeting to broadly scope out issues in occupational radiation protection that could have policy and regulatory implications, with instruction to report back to CRPPH on proposed follow-up activities. Recognising the important operational experience residing within the ISOE programme, and the potential benefits to CRPPH and ISOE of collaborative discussions, the CRPPH further instructed the Secretariat to co-ordinate with ISOE on possible involvement in EGOE activities. Requests for nominations to the EGOE were sent to the CRPPH members following the 64^{th} meeting. At its 2006 annual meeting, the ISOE Management Board accepted the invitation to participate in the EGOE scoping exercise, offering participation through members from the utility and regulatory membership, and its further participation was approved at the CRPPH annual meeting (30 May-1 June, 2007)

- ***Elaboration of Case Studies***

The principal work plan of the EGOE was approved at the 65^{th} annual CRPPH meeting, and involved the development of three case studies:

- Occupational radiation protection criteria for designing new NPPs (initial title: Criteria for new build);
- Dose Constraints in Occupational Radiation Protection: Implementation of the Dose Constraints Concept into Radiological Protection Regulations and its use in Operators' Practices;
- Radiological protection policy and operational issues.

Based on the CRPPH approval of the Case Study 1-*Occupational radiation protection criteria for designing new NPPs* at the 68^{th} CRPPH meeting in 2010, the Case study 1 was published in July 2010 as the NEA publication No.6975, and made available to all interested parties.

In addition, the Group finalised its work on Case study No.2-Dose Constraints in Occupational Radiation Protection, and it was approved at the 69th CRPPH meeting in 2011. The Case study 2 was published in October 2011.

In order to complete its mandate, the EGOE began preparing the final cases study which will include a discussion on Policy and Practical Issues in ORP in NPPs. Referring to the 69th CRPPH meeting directions, the EGOE focused on integrated/total risk management and conducted a survey on RP related issues for trans-boundary itinerant workers during the fourth quarter of 2011. The results, including 11 NEA countries input and feedback were evaluated during several meetings of the Group during 2012, and a final report is being developed for review and approval by the CRPPH during its May 2013 meeting. In completing its report, the EGOE will ensure appropriate coordination, on the topic of outside workers, with the IAEA and with the HERCA to ensure complementarily with ongoing work of these organisations.

Annex 1

STATUS OF ISOE PARTICIPATION UNDER THE RENEWED ISOE TERMS AND CONDITIONS (2012-2015)

Note: This annex provides the status of ISOE official participation as of December 2012

Officially Participating Utilities: Operating reactors

Country	**Utility**[4]	**Plant name**	
Republic of Armenia	Armenian Nuclear Power Plan (CJSC)	Medzamor 2	
Belgium	Electrabel (GDF- SUEZ)	Doel 1, 2, 3, 4	Tihange 1, 2, 3
Brazil	Electrobras Eletronuclear S.A.	Angra 1, 2	
Bulgaria	Kozloduy NPP Plc.	Kozloduy 5, 6	
Canada	Bruce Power	Bruce A1, A2, A3, A4	Bruce B5, B6, B7, B8
	Hydro Quebec	Gentilly 2	
	New Brunswick Electric Power Commission	Point Lepreau	
	Ontario Power Generation	Darlington 1, 2, 3, 4	Pickering 1, 4 Pickering 5, 6,7, 8
China	Daya Bay Nuclear Power Operations and Management Co,Ltd.	Daya Bay 1, 2 Ling Ao 1, 2, 3, 4	
	CNNC Nuclear Power Operations Management Co., Ltd.	Qinshan 1	
Czech Republic	CEZ A.S.	Dukovany 1, 2, 3, 4 Temelin 1, 2	
Finland	Fortum Power and Heat Oy	Loviisa 1, 2	
	Teollisuuden Voima Oyj	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
Germany	E.ON Kernkraft GmbH	Brokdorf Grafenrheinfeld Grohnde	Isar 1, 2 Unterweser
	EnBW Kernkraft GmbH	Philippsburg 1, 2	Neckarwestheim 1, 2
	RWE Power AG	Biblis A, B Emsland	Gundremmingen B, C
	Vattenfall Europe Nuclear Energy	Brunsbüttel	Krümmel

[4] Where multiple owners and/or operators are involved, only Leading Undertakings are listed / En cas de plusieurs propriétaires et/ou exploitants, seuls les principaux sont mentionnés

	GmbH		
Hungary	Magyar Villamos Muvek Zrt	Paks 1, 2, 3, 4	
Japan	Chubu Electric Power Co., Inc.	Hamaoka 1, 2, 3, 4, 5	
	Chugoku Electric Power Co. Inc.	Shimane 1, 2	
	Hokkaido Electric Power Co. Inc.	Tomari 1, 2, 3	
	Hokuriku Electric Power Co.	Shika 1,2	
	Japan Atomic Power Co.	Tokai 2	Tsuruga 1, 2
	Kansai Electric Power Co., Inc.	Mihama 1, 2, 3 Ohi 1, 2, 3, 4	Takahama 1, 2, 3, 4
	Kyushu Electric Power Co., Inc.	Genkai 1, 2, 3, 4	Sendai 1, 2
	Shikoku Electric Power Co., Inc.	Ikata 1, 2, 3	
	Tohoku Electric Power Co., Inc.	Onagawa 1, 2, 3	Higashidori 1
	Tokyo Electric Power Co.	Fukushima Daiichi 5, 6 Fukushima Daini 1, 2, 3, 4	Kashiwazaki Kariwa 1, 2, 3, 4, 5, 6, 7
Korea, Republic of	Korean Hydro and Nuclear Power Co. Ltd. (KHNP)	Kori 1, 2, 3, 4 Shin-Kori 1, 2 Shin-Wolsong 1	Ulchin 1, 2, 3, 4, 5, 6 Yonggwang 1, 2, 3, 4, 5, 6 Wolsong 1, 2, 3, 4
Romania	Societatea Nationala Nuclearelectrica	Cernavoda 1, 2	
Slovak Republic	Slovenské Electrárne A.S.	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 1 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	BKW FMB Energie AG	Mühleberg	
	Kernkraftwerk Gösgen-Däniken AG	Gösgen	
	Kernkraftwerk Leibstadt AG	Leibstadt	
	Axpo AG	Beznau 1, 2	
The Netherlands	N.V. EPZ	Borssele	
United Kingdom	EDF Energy	Sizewell B	

Officially Participating Utilities: Definitively shutdown reactors

Country	Utility	Plant name
Bulgaria	Kozloduy NPP Plc.	Kozloduy 1, 2, 3, 4
France	Électricité de France (EDF)	Bugey 1 Chinon A1, A2, A3 Chooz A St. Laurent A1, A2
Italy	SOGIN Spa	Caorso Garigliano Latina Trino
Japan	Japan Atomic Energy Agency	Fugen (LWCHWR)
	Japan Atomic Power Co.	Tokai 1
	Tokyo Electric Power Co.	Fukushima Daiichi 1, 2, 3, 4
Lithuania	Ignalina Nuclear Power Plant	Ignalina 1, 2
Sweden	Barsebäck Kraft AB (BKAB)	Barsebäck 1, 2
United States	Dominion Generation	Kewaunee
	Exelon Nuclear Corporation	Dresden 1 Peach Bottom 1 Zion 1, 2

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	State Nuclear Power Safety Inspectorate (VATESI)
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	ETC
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 2

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

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Annex 3

ISOE MANAGEMENT BOARD AND NATIONAL CO-ORDINATORS (2011-2012)

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	
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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	
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PLETNIOV, Victor	Ignalina NPP
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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
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BREZNIK, Borut	Krsko NPP
JANZEKOVIC, Helena	Slovenian Nuclear Safety Administration
JUG, Nina	Slovenian Radiation Protection Administration
CERNILOGAR RADEZ, Milena	Slovenian Nuclear Safety Administration
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ROSALES CALVO, Maria Luisa	Consejo de Seguridad Nuclear
DE LA RUBIA, Miguel Angel	Consejo de Seguridad Nuclear
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LINDVALL, Carl Göran	Barsebäck NPP
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HENNIGOR, Staffan	Forsmark NPP
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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

Annex 4

ISOE WORKING GROUPS (2012)

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 Nuclear

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 Nuclear
WELLS, Daniel M.	Electric Power Reasearch Institute (EPRI)

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

Chair: MIZUMACHI, Wataru (Japan)

ARMENIA	
PYUSKYULYAN, Konstantin	Armenian Nuclear Power Plant Company
BELGIUM	
THOELEN, Els	Electrabel, DOEL NPP
BRAZIL	
AMARAL,Marcos Antonio	Eletrobrás Termonuclear S.A.
CANADA	Canadian Nuclear Safety Commission (CNSC)
DJEFFAL, Salah	Bruce Power
MCQUEEN, Maureen	Bruce Power
PRITCHARD, Colin	
CZECH REPUBLIC	
FUCHSOVA, Dagmar	State Office for Nuclear safety (SUJB)
HORT, Milan	State Office for Nuclear safety (SUJB)
KOC, Josef	Temelin NPP
FINLAND	
SOVIJARVI, Jukka	Radiation and Nuclear Safety Authority (STUK)
FRANCE	
ABELA, Gonzague	EDF – DIN DQSNR
BELTRAMI, Laure-Anne	CEPN – ISOE ETC
COUASNON, Olivier	Autorité de sûreté nucléaire (ASN) EDF - DPN / UNIE – GPRE
LECOANET, Olivier	CEPN – ISOE ETC
SCHIEBER, Caroline	CEPN – ISOE ETC
GERMANY	
JENTJENS, Lena	Kernkraftwerke/Nuclear Power Plants
KAULARD, Jörg	GRS
SCHMIDT, Claudia	GRS
SLOVAK REPUBLIC	
GRUBEL, Stefan	Slovenské elektrárne, a.s.
SPAIN	
HERRERA, Borja Rosell	Almaraz NPP
LABARTA, Teresa	Consejo de Seguridad Nuclear (CSN)
SWEDEN	
FRITIOFF, Karin	Vattenfall Research & Development AB
SVEDBERG, Torgny	Ringhals AB
SWITZERLAND	
JAHN, Swen-Gunnar	Swiss Federal Nuclear Safety Inspectorate (ENSI)
WOENKHAUS, Jürgen	Beznau NPP
JAPAN	
HAYASHIDA, Yoshihisa	Japan Nuclear Energy Safety Organization (JNES) – ISOE ATC Japan NUS
ITOH, Kunio	Co., Ltd
MIZUMACHI, Wataru	Japan Nuclear Energy Safety Organization (JNES)- ISOE ATC Japan
SUZUKI, Akiko	Nuclear Energy Safety Organization (JNES) – ISOE ATC Japan Nuclear
USUI, Haruo	Energy Safety Organization (JNES)
ROMANIA	
SIMIONOV, Vasile	CNE Cernavoda NPP
RUSSIAN FEDERATION	
GLASUNOV, Vadim	Russian Research Institute for Nuclear Power Plant Operation
UKRAINE	
VITALIEVICH, Zubov Sergei	
UNITED KINGDOM	
RENN, Guy	Sizewell B Power Station
UNITED STATES	
ANDERSON, Ellen	Nuclear Energy Institute (NEI)
BEER, Joe	DC Cook NPP
BROCK, Terry	U.S. Nuclear Regulatory Commission (NRC)
BROWN, Terry J.	DC Cook NPP

HARRIS, Willie	Exelon Nuclear
HIATT, Jerry	Bartlett NPP
HITE, Bob	DC Cook NPP
KOKOSKY, Edwin	Fermi 2
LABURN, Rick	Fermi 2
MILLER, David W.	DC Cook NPP – ISOE NATC
TARZIA, James P.	Radiation Safety & Control Services Inc.
WILEY, Albert Lee	Radiation Emergency Assistance Center Training Site(REAC/TS)

Annex 5

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

2012	No. 19 (July)
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. 36: Dec. 2012	Japanese Dosimetric Results: FY 2011 data and trends
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
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European Technical Centre

No. 56: Dec. 2012	European dosimetric results for 2011
No. 55: Nov. 2012	Man-Sievert Monetary Value Survey (2012 Update)
No. 54: Feb. 2012	European dosimetric results for 2010
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

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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

2012-13: Sept. 2012	2011 CANDU Occupational Dose Benchmarking Charts
2012-12: July 2012	North American Boiling Water Reactor (BWR) 2008 Occupational Dose Benchmarking Charts
2012-11: July 2012	North American Pressurized Water Reactor (PWR) 2008 Occupational Dose Benchmarking Charts
2012-10: July 2012	North American Boiling Water Reactor (BWR) 2007 Occupational Dose Benchmarking Charts
2012-9: July 2012	North American Pressurized Water Reactor (PWR) 2007 Occupational Dose Benchmarking Charts
2012-8: Sept. 2012	North American Boiling Water Reactor (BWR) 2011 Occupational Dose Benchmarking Charts
2012-7: Sept. 2012	North American Pressurized Water Reactor (PWR) 2011 Occupational Dose Benchmarking Charts
2012-6: Sept. 2012	North American Pressurized Water Reactor (PWR) 2011 Occupational Dose Benchmarking Charts
2012-5: July 2012	North American Pressurized Water Reactor (PWR) 2010 Occupational Dose Benchmarking Charts
2012-4: July 2012	North American Boiling Water Reactor (BWR) 2009 Occupational Dose Benchmarking Charts
2012-3: July 2012	North American Pressurized Water Reactor (PWR) 2009 Occupational Dose Benchmarking Charts
2012-2: July 2012	North American Boiling Water Reactor (BWR) 2006 Occupational Dose Benchmarking Charts
2012-1: July 2012	North American Pressurized Water Reactor (PWR) 2006 Occupational Dose Benchmarking Charts
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

Sept. 2012 (Tokyo, Japan)	2012 ISOE Asian ALARA Symposium
Aug. 2010 (Gyeongju, Rep.of Korea)	2010 ISOE Asian ALARA Symposium
Sept. 2009 (Aomori, Japan)	2009 ISOE Asian ALARA Symposium
Nov. 2008 (Tsuruga, Japan)	2008 ISOE International ALARA Symposium
Sept. 2007 (Seoul, 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

June 2012 (Prague, Czech Republic)	2012 ISOE European Regional ALARA Symposium
Nov. 2010 (Cambridge, UK)	2010 ISOE International ALARA Symposium
June 2008 (Turku, Finland)	2008 ISOE European Regional ALARA Symposium
March 2006 (Essen, Germany)	2006 ISOE International ALARA Symposium
March 2004 (Lyon, France)	Fourth ISOE European Workshop on Occupational Exposure Management at Nuclear Power Plants
April 2002 (Portoroz, Slovenia)	Third ISOE European Workshop on Occupational Exposure Management at Nuclear Power Plants
April 2000 (Tarragona, Spain)	Second EC/ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants
Sept. 1998 (Malmö, Sweden)	First EC/ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants

IAEA Technical Centre

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

North American Technical Centre

Jan. 2012 (Ft. Lauderdale, FL, USA)	2012 ISOE International ALARA Symposium
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