ISOE

INFORMATION SYSTEM ON OCCUPATIONAL EXPOSURE

Ninth Annual Report

OCCUPATIONAL EXPOSURES AT NUCLEAR POWER PLANTS

1999

AEN NEA

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Pursuant to Article 1 of the Convention signed in Paris on 14th December 1960, and which came into force on 30th September 1961, the Organisation for Economic Co-operation and Development (OECD) shall promote policies designed:

- to achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;
- to contribute to sound economic expansion in Member as well as non-member countries in the process of economic development; and
- to contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

The original Member countries of the OECD are Austria, Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The following countries became Members subsequently through accession at the dates indicated hereafter: Japan (28th April 1964), Finland (28th January 1969), Australia (7th June 1971), New Zealand (29th May 1973), Mexico (18th May 1994), the Czech Republic (21st December 1995), Hungary (7th May 1996), Poland (22nd November 1996) and the Republic of Korea (12th December 1996). The Commission of the European Communities takes part in the work of the OECD (Article 13 of the OECD Convention).

NUCLEAR ENERGY AGENCY

The OECD Nuclear Energy Agency (NEA) was established on 1st February 1958 under the name of the OEEC European Nuclear Energy Agency. It received its present designation on 20th April 1972, when Japan became its first non-European full Member. NEA membership today consists of 27 OECD Member countries: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, the Netherlands, Norway, Portugal, Republic of Korea, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The Commission of the European Communities 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 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 been steadily decreasing for over a decade. Regulatory pressures, particularly after the issuance of ICRP Publication 60 in 1990, technological advances, improved plant designs, and improved water chemistry and plant operational procedures have contributed to this downward trend. However, with the ageing of the world's nuclear power plants the task of maintaining occupational exposures at low levels has become increasingly difficult. In addition, economic pressures have led plant operation managers to streamline refuelling and maintenance operations as much as possible, thus adding scheduling and budgetary pressure to the task of reducing operational exposures.

In response to these pressures, radiation protection personnel have found that occupational exposures will be reduced by properly planning, preparing, implementing, and reviewing jobs, while applying work management techniques such that the exposures become "as low as reasonably achievable"(ALARA). To facilitate this global approach to work through the exchange of techniques and experiences in occupational exposure reduction, the Nuclear Energy Agency (NEA) of the Organisation for Economic Co-operation and Development (OECD) launched the Information System on Occupational Exposure (ISOE) on 1 January 1992 after a two-year pilot programme. Participation in ISOE includes representatives from both utilities (public and private) and from national regulatory authorities. Since 1993, the International Atomic Energy Agency (IAEA) co-sponsors the ISOE Programme, thus allowing the participation of utilities and authorities from non-NEA member countries. For the past several years, the NEA and the IAEA have formed a Joint Secretariat in order to make the most of the strengths of both organisations for the benefit of the ISOE Programme.

The ISOE Programme includes two parts. First, occupational exposure data and experience are collected periodically from all participants to form the ISOE Databases. Due to the varied nature of the data collected, three distinct but linked databases are used for data storage, retrieval and analysis. Second, in creating the network necessary for data collection, close contacts have been established among utilities and authorities from all over the world, thus creating an ISOE Network for the direct exchange of operational experience. This dual system of databases and communications network joins utilities and regulatory agencies throughout the world, providing occupational exposure data for analyses of dose trends, technique comparisons, cost-benefit and other analyses promoting the application of the ALARA principle.

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EXECUTIVE SUMMARY

The ISOE Programme Ninth Annual Report 1999, as it is given here, represents the status of the ISOE Programme at the end of December 1999.

As of the end of 1999, occupational exposure data from a total of 429 reactors (380operating and 49 in cold-shutdown or some stage of decommissioning) from 26 countries representing 77 utilities are included in the ISOE 1 database. In addition, regulatory authorities from 23 countries participate in the ISOE Programme. During 1999, two non-NEA countries, Bulgaria and Pakistan, joined the ISOE Programme with their regulatory authorities. The participation of 380 operating commercial nuclear reactors in the ISOE programme represents 88% of the World's operating commercial nuclear reactors (total of 433).

In 1999, the occupational exposure, in general, followed the downward trend already observed in the last twelve years from 1986 to 1998 or stayed at the already achieved low level. In most of ISOE participating countries, 1999 saw a reduction of the average collective dose per unit. The average collective dose per unit for PWRs slightly increased from 0.98 man·Sv in 1998 to 1.01 man Sv in 1999, for BWRs from 1.74 man·Sv in 1998 to 1.79 man·Sv in 1999 and for CANDU reactors from 0.59 man·Sv in 1998 to 0.85 man·Sv in 1999. For GCR the dose decreased from 0.21 man·Sv in 1998 to 0.15 man·Sv in 1999. In 1999, the average collective dose per reactor for LWGRs (RBMK), represented in the database by two units in Lithuania and one unit in Ukraine, slightly increased from 7.53 man·Sv in 1998 to 8.08 man·Sv in 1999, a value higher than for all other types of reactors.

The average collective dose per reactor for shutdown reactors saw a reduction over the years 1988 to 1999. However, the reactors represented in these figures are of different type and size, and are, in general, at different phases of their decommissioning programmes. For these reasons, and because these figures are based on a limited number of shutdown reactors, it is impossible to draw definitive conclusions.

In 1999, the Technical Centres published a number of ISOE information sheets in order to exchange experience between ISOE participants. To further promote the preparation and distribution of such information sheets, this Annual Report contains short abstracts of recent interesting information sheets such as the replacement of reactor internals and full system decontamination of a Japanese BWR and the experience with the first annual inspection outage of a Japanese ABWR. In addition, a short summary on permanent shielding in a drywell is presented.

The regular meeting of a VVER and RBMK working group under the auspices of the IAEA facilitates exchange of information and experience between operators of VVER and RBMK reactors.

In February 1999, the International ALARA Symposium took place in Orlando Florida, followed by a National ALARA Symposium in February 2000 at the same place and the second EC/ISOE Workshop on Occupational Exposure at Nuclear Power Plants in Tarragona Spain in April 2000. The common objective of these workshops was to communicate experience in ALARA implementation and occupational exposure issues, and to share lessons learned. The international and broad participation in these workshops shows the interest in ALARA and occupational exposure issues.

A new type of ISOE publication, the ISOE Plant Dossier, is available since 1999 and provides each plant with a specific set of detailed information on this plant allowing to compare data with other plants, e. g. of the same sister unit group.

An extended chapter summarises recent developments and principal events in ISOE participating countries.

Finally, the ISOE Programme made significant progress during 1999, particularly in terms of data analysis and output. Details of this progress as well as the programme of work for 2000 are provided in Chapter 3.

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

Since the inception of the ISOE Programme in 1992, the number of actively participating commercial nuclear power plants has continued to increase. At the same time, the depth to which participating units supply the various occupational exposure details to the database has also grown. The result of this growth is that the ISOE database system is the most complete commercial nuclear power plant occupational exposure database in the world.

As of the end of 1999, occupational exposure data from a total of 380 operating commercial nuclear reactors and 49 commercial nuclear reactors in cold-shutdown or some stage of decommissioning are included in the ISOE 1 database. These units represent 77 utilities from 26 countries. In addition, regulatory authorities from 23 countries participate in the ISOE Programme. Annex 2 provides a complete list of the units, utilities and authorities participating in the programme and included in the database. Table 1 below summarises participation by country, type of reactor and reactor status.

The participation of 380 operating commercial nuclear reactors in the ISOE programme represents 88% of the World's operating commercial nuclear reactors (total of 433). These numbers are illustrated in a pie chart on this page.

During 1999, two non-NEA countries, Bulgaria and Pakistan, joined the ISOE Programme with their regulatory authorities.

Operating Nuclear Power Plants

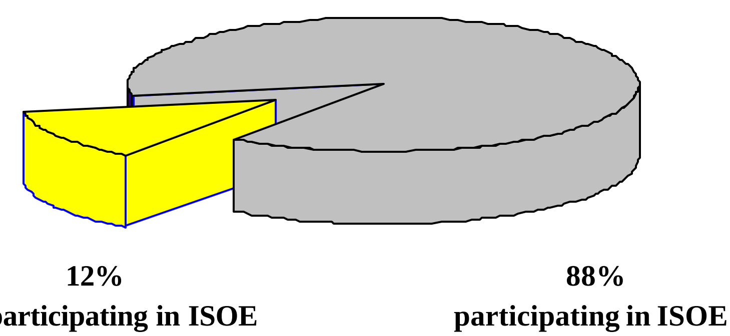


Table 1

Participation Summary

Operating Reactors Participating in ISOE						
Country	**PWR**	**BWR**	**PHWR**	**GCR**	**LWGR**	**Total**
Armenia	1	–	–	–	–	1
Belgium	7	–	–	–	–	7
Brazil	1	–	–	–	–	1
Canada	–	–	21	–	–	21
China	3	–	–	–	–	3
Czech Republic	4	–	–	–	–	4
Finland	2	2	–	–	–	4
France	57	–	–	–	–	57
Germany	14	6	–	–	–	20
Hungary	4	–	–	–	–	4
Japan	23	28	–	–	–	51
Korea	11	–	4	–	–	15
Lithuania	–	–	–	–	2	2
Mexico	–	2	–	–	–	2
Netherlands	1	–	–	–	–	1
Romania	–	–	1	–	–	1
Slovakia	4	–	–	–	–	4
Slovenia	1	–	–	–	–	1
South Africa	2	–	–	–	–	2
Spain	7	2	–	–	–	9
Sweden	3	9	–	–	–	12
Switzerland	3	2	–	–	–	5
Ukraine	13	–	–	–	1	14
United Kingdom	1	–	–	–	–	1
United States	27	16	–	–	–	43
Total	**189**	**67**	**26**	**–**	**3**	**285**

Operating Reactors Not Participating in ISOE, but Included in the ISOE Database						
Country	**PWR**	**BWR**	**HWR**	**GCR**	**LWGR**	**Total**
United Kingdom	–	–	–	34	–	34
United States	42	19	–	–	–	61
Total	**42**	**19**	**–**	**34**	**–**	**95**

Total number of Operating Reactors Included in the ISOE Database						
	PWR	**BWR**	**HWR**	**GCR**	**LWGR**	**Total**
Total	**231**	**86**	**26**	**34**	**3**	**380**

Table 1 (continued)

Definitively Shutdown Reactors Participating in ISOE					
Country	**PWR**	**BWR**	**HWR**	**GCR**	**Total**
France	1	–	–	6	7
Germany	–	1	–	1	2
Italy	1	2	–	1	4
Japan	–	–	–	1	1
Netherlands	–	1	–	–	1
Spain	–	–	–	1	1
United States	4	3	–	1	8
Total	**6**	**7**	**–**	**11**	**24**

Definitively Shutdown Reactors Not Participating in ISOE but Included in the ISOE Database					
Country	**PWR**	**BWR**	**HWR**	**GCR**	**Total**
Canada	–	–	2	–	2
Germany	6	3	–	–	9
United Kingdom	–	–	–	6	6
United States	6	2	–	–	8
Total	**12**	**5**	**2**	**6**	**25**

Total Number of Definitively Shutdown Reactors Included in the ISOE Database					
	PWR	**BWR**	**HWR**	**GCR**	**Total**
Total	**18**	**12**	**2**	**17**	**49**

Number of utilities officially participating: 77
Number of countries officially participating: 26
Number of authorities officially participating: 23

2. THE EVOLUTION OF COLLECTIVE DOSE IN ISOE MEMBER COUNTRIES

One of the most important aspects of the ISOE Programme is the tracking of annual occupational exposure trends. Using the ISOE 1 database, which contains annual occupational exposure data supplied by all Participating Utilities, various exposure trends can be displayed by country, by reactor type, or by other criteria such as sister-unit grouping.

2.1 Occupational Exposure Trends in Operating Reactors

In most ISOE participating countries, the average dose per unit for PWRs could be slightly reduced, in 1999, or stayed fairly constant. As can be seen in section 2.10, part of this reduction is due to the implementation of work management principles and the reduction in outage durations.

In 1999, the average annual doses for BWRs saw a reduction for most of the countries. These reductions are in part due to the positive effect of major plant modification works performed in previous years, and the result of extensive ALARA and work management programmes. An increase in average annual dose can be observed in Japan and Spain. The Laguna Verde nuclear power plant in Mexico could reduce the annual average dose from 4.77 man·Sv in 1998 to 3.68 man·Sv in 1999.

It should be noted that although there is a general downward trend the collective dose always shows certain yearly fluctuations. This is due to variations in outage scheduling, changes of cycle length, amount of work and backfitting in the plants.

Table 2 summarises the average annual exposure trends for participating countries over the past three years. Figures 1 to 4 show this tabular data in a bar-chart format, for 1999 only, ranked from highest to lowest average dose. Please note that due to the complex parameters driving the collective doses and the varieties of the contributing plants, these figures do not allow to derive any conclusions on the quality of radiation protection performance in the countries addressed. Figures 5 and 6 show the trends in average collective dose per reactor for the years 1988 to 1999 by reactor type.

Table 2

Evolution of Average Annual Dose per Unit, by Country and Reactor Type, from 1997-1999 (man·Sv)

	PWR			BWR			CANDU		
	1997	**1998**	**1999**	**1997**	**1998**	**1999**	**1997**	**1998**	**1999**
Armenia	3.41	1.51	1.58						
Belgium	0.39	0.70	0.40						
Brazil	2.61	1.26	0.16						
Canada							0.59	0.52	0.85
China	0.67	0.71	0.55						
Czech Republic	0.38	0.34	0.28						
Finland	0.57	1.04	0.68	0.83	1.03	0.47			
France	1.42	1.20	1.17						
Germany	1.43	1.01	1.23	1.33	1.56	0.81			
Hungary	0.49	0.76	0.53						
Japan	1.01	0.96	1.02	2.05	1.78	2.14			
Korea	0.88	1.04	0.84				0.62	1.00	0.85
Mexico				2.25	4.77	3.68			
Netherlands	2.83	0.68	0.30						
Romania							0.25	0.26	0.46
Slovakia	0.77	0.98	0.59						
Slovenia	0.99	1.25	1.65						
South Africa	1.24	0.65	0.86						
Spain	1.35	0.55	0.71	2.39	0.53	2.45			
Sweden	0.64	0.59	0.44	2.82	1.55	1.12			
Switzerland	0.48	0.46	0.77	1.45	1.19	1.10			
Ukraine	2.05	1.89	1.37						
United Kingdom	0.50	0.04	0.66						
United States	1.32	0.90	1.05	2.05	1.90	1.83			

	GCR			LWGR		
	1997	**1998**	**1999**	**1997**	**1998**	**1999**
Japan	0.24					
Lithuania				9.25	7.53	6.39
Ukraine						11.47
United Kingdom	0.23	0.21	0.15*			

* This is the average annual dose for 14 AGR in United Kingdom.

Figure 1

1999 PWR Average collective dose per reactor by country

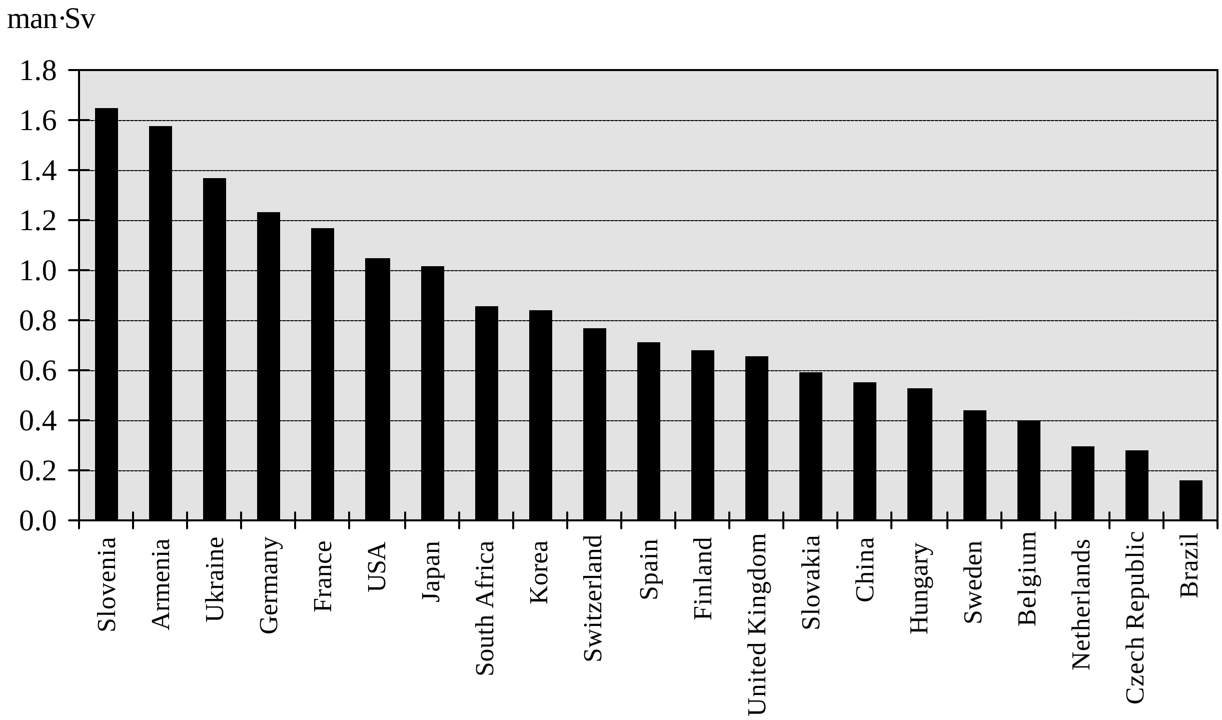


Figure 2

1999 BWR Average collective dose per reactor by country

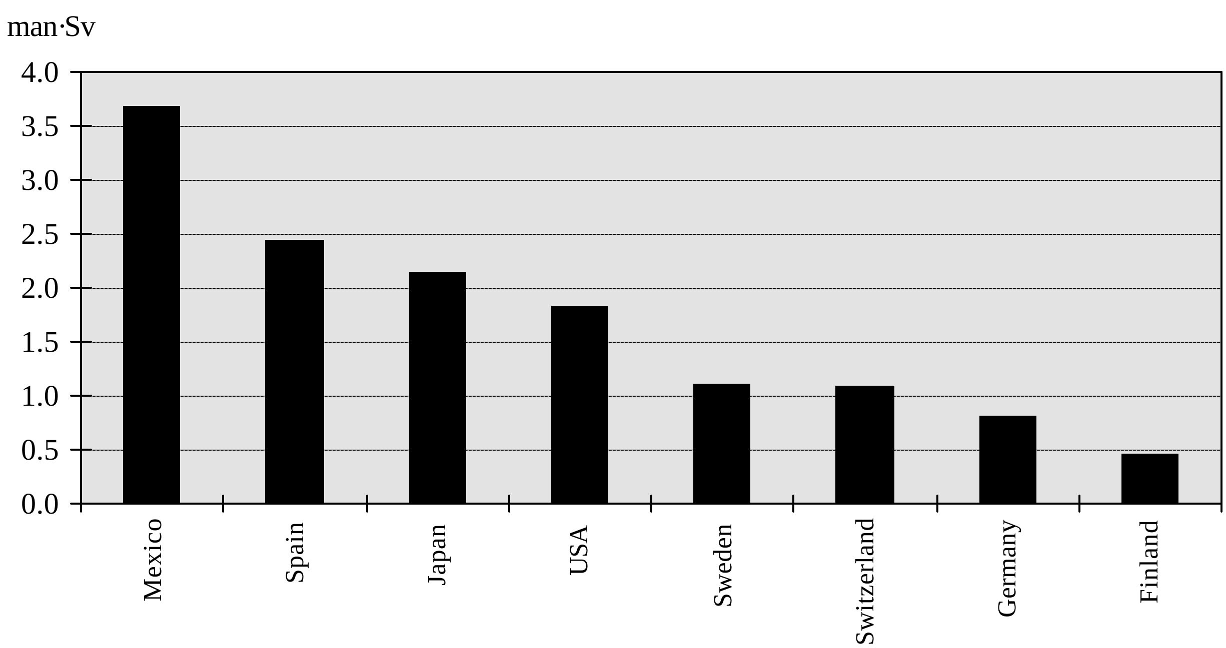


Figure 3

1999 CANDU Average collective dose per reactor by country

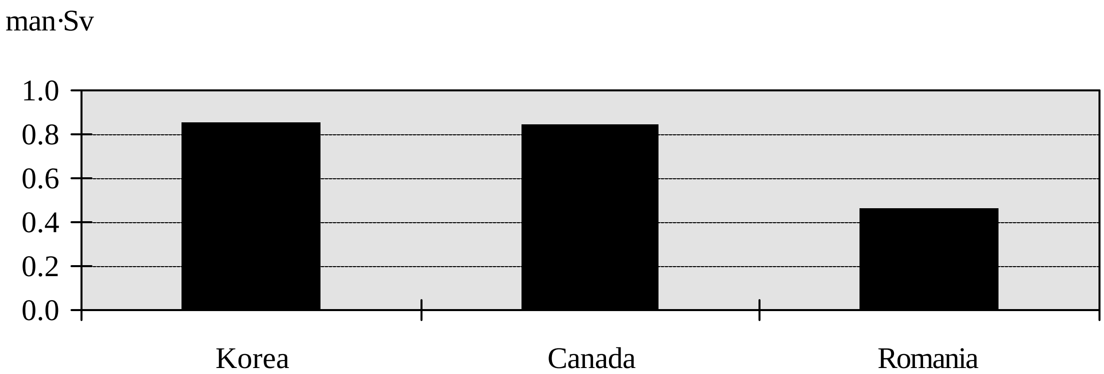


Figure 4

1999 Average collective dose per reactor type

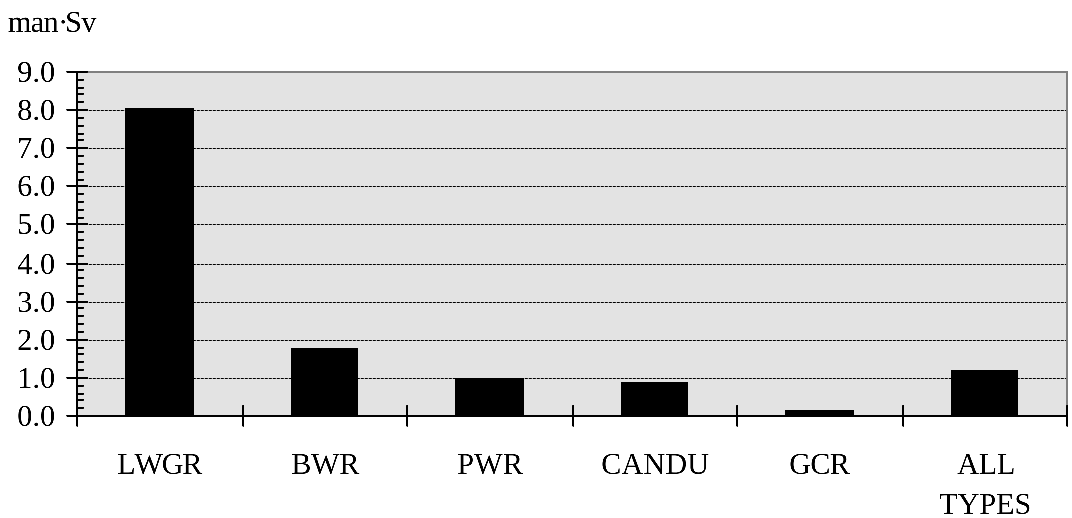


Figure 5

Average collective dose per reactor for operating reactors included in ISOE by reactor type

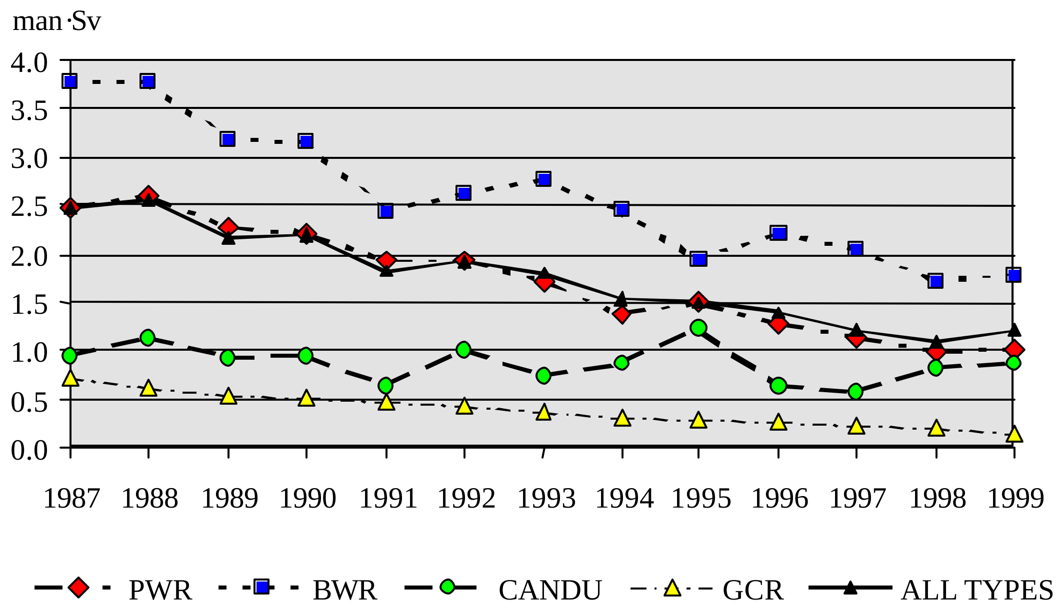
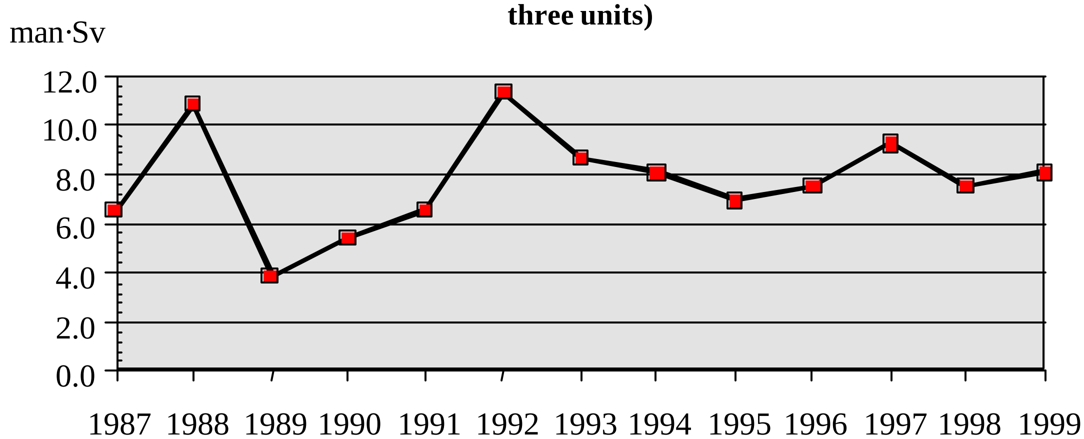


Figure 6

Average collective dose per reactor for operating LWGRs included in ISOE (Number of reactors: 1987-1998 two units, since 1999 three units)



2.2 Occupational Exposure Trends in Reactors in Cold Shutdown or in Decommissioning

The average collective dose per reactor for shutdown reactors saw a reduction over the years 1987 to 1999. However, the reactors represented in these figures are of different type and size, and are, in general, at different phases of their decommissioning programmes. For these reasons, and because these figures are based on a limited number of shutdown reactors, it is impossible to draw definitive conclusions.

Table 3 shows the average annual dose per unit by country and type of reactor for the years 1997 to 1999. Figures 7 to 10 summarise the average collective dose per reactor for shutdown reactors and the number of shutdown reactors for the years 1987 to 1999 for PWRs, BWRs, GCRs and for all types.

Table 3

Average Annual Dose per Unit by Country and Reactor Type for the Years 1997-1999

PWR						
	1997		**1998**		**1999**	
	No.	man·mSv	No.	man·mSv	No.	man·mSv
France	1	112	1	120	1	91
Germany			6	96	6	74
Italy	1	1	1	1	1	19
United States	5	236	6	520	9	366

BWR						
	1997		**1998**		**1999**	
	No.	man·mSv	No.	man·mSv	No.	man·mSv
Germany	1	461	4	386	4	326
Italy	2	50	2	56	2	53
Netherlands	1	168	1	158	1	217
United States	2	90	3	357	4	252

GCR						
	1997		**1998**		**1999**	
	No.	man·mSv	No.	man·mSv	No.	man·mSv
France	6	49	6	81	6	40
Germany			1	44	1	30
Italy	1	43	1	43	1	42
Japan			1	130	1	170
United Kingdom	6	77	6	78	no data available	

Figure 7

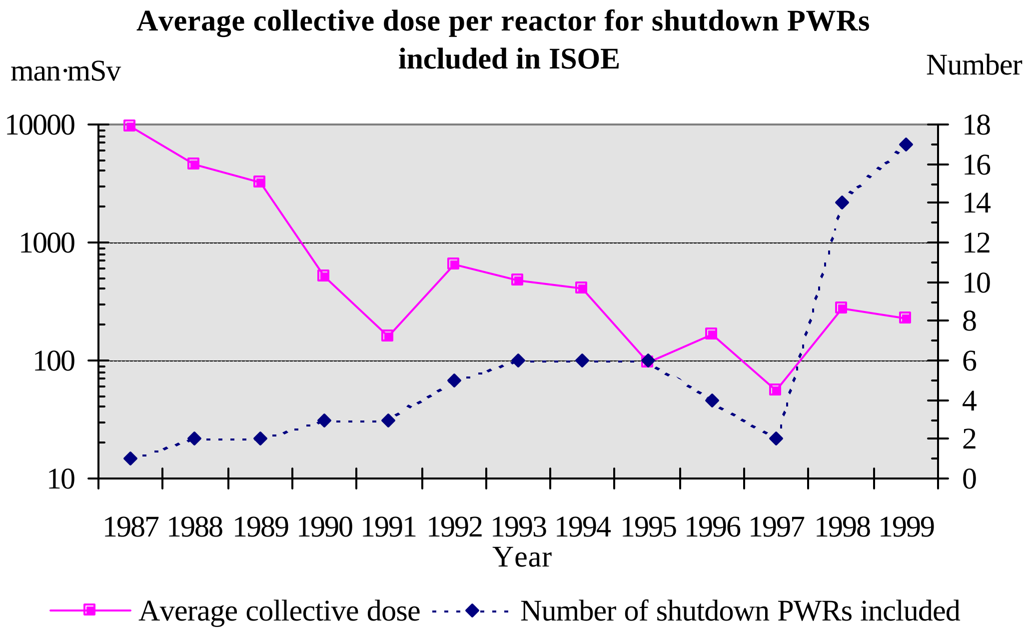


Figure 8

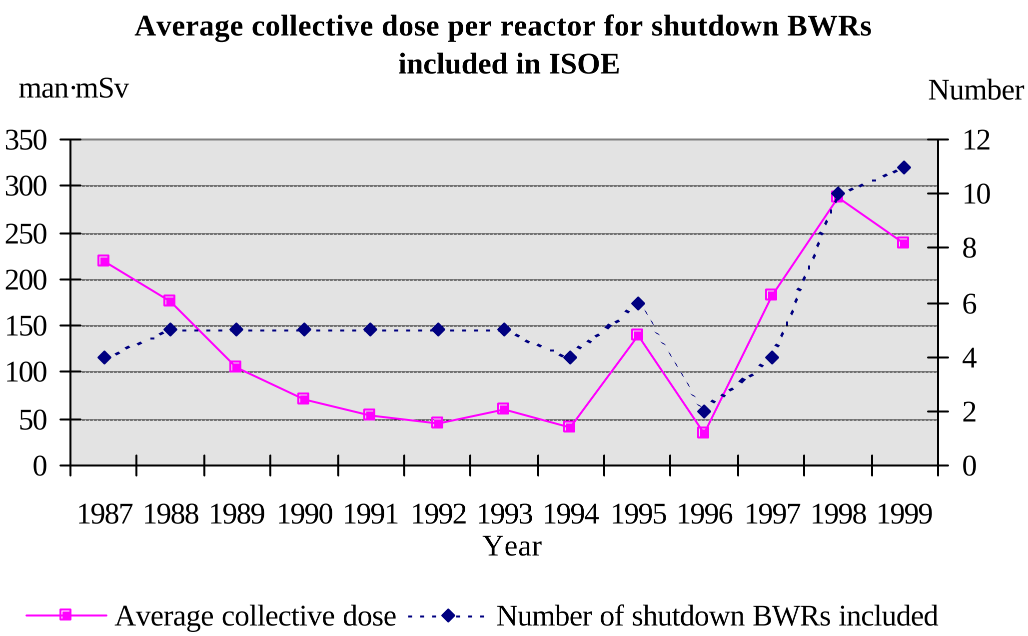


Figure 9

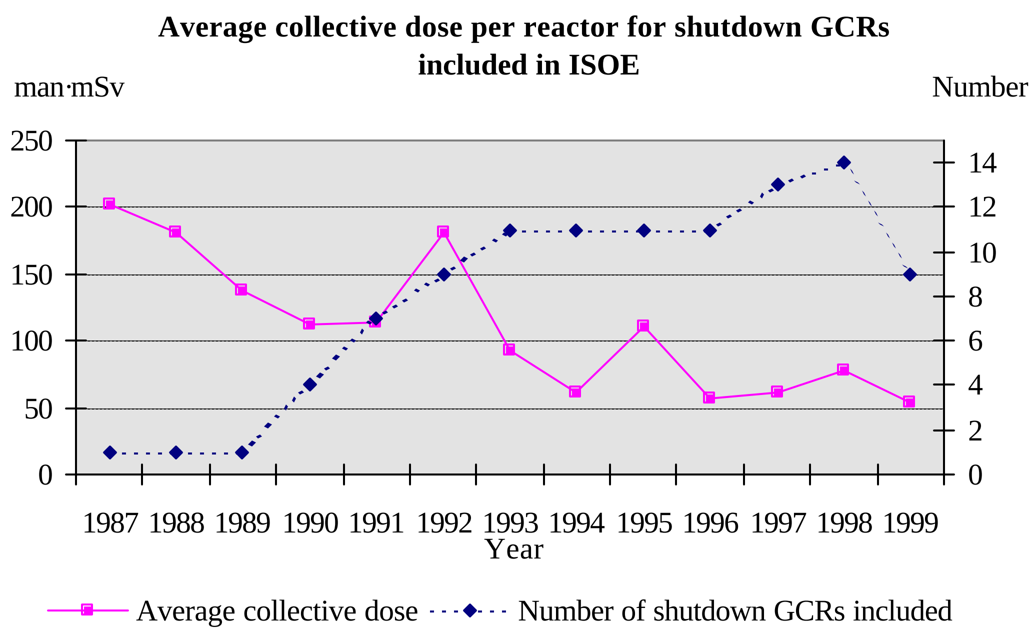
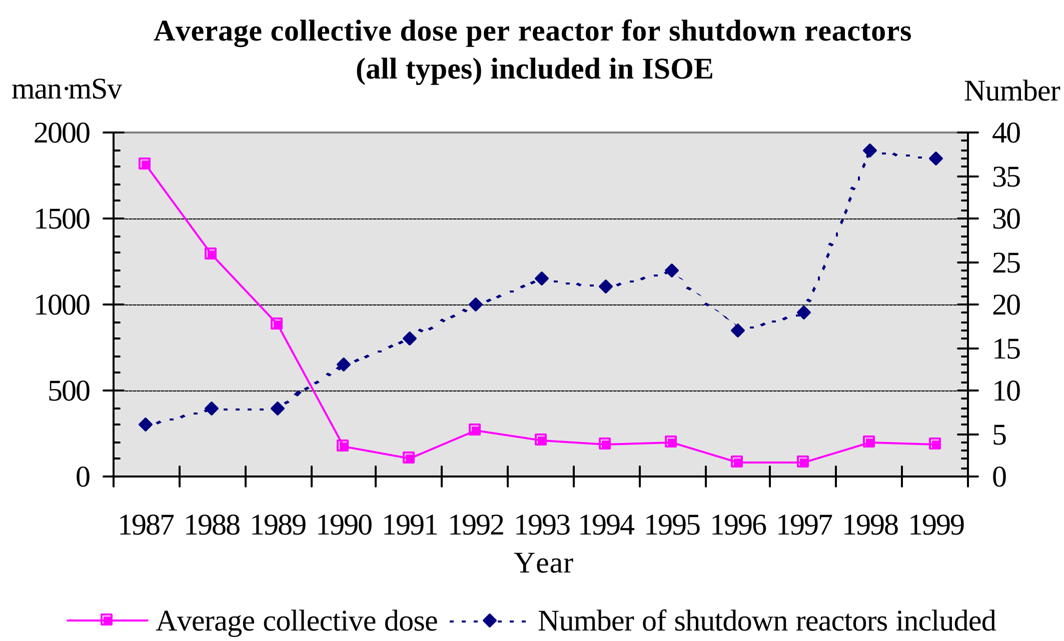


Figure 10



2.3 Replacement of Reactor Internals and Full System Decontamination of a Japanese BWR

Since 1990, BWR plants reported world wide on shroud cracking caused by stress corrosion. In 1994, stress corrosion cracking was found across the weld line of the shroud of the Japanese reactor Fukushima Daiichi 2. An intensive research and development programme had been carried out in Japan to establish countermeasures for the core shroud cracking. A shroud replacement process was developed and first applied at the unit 3 of Fukushima Daiichi, a 784 MW BWR.

The major components, which were replaced together with the shroud, were the top guide, the core plate, the feed water spargers, the core spray spargers, the jet pumps, the differential pressure detector / stand-by liquid control piping, and the in-core monitor guide tubes, as well as the various piping and nozzle safe ends connected to them. The cutting process of the existing shroud and other components inside the reactor was basically done under water using Electric Discharge Machining remotely. The welding was performed automatically in air.

The outage, including the core internals replacement, was initially expected to last 300 days, however lasted actually 423 days.

Measures Taken to Reduce Radiation Exposure

It was expected that the shroud replacement process would involve many operations inside the reactor pressure vessel, such as the installation and fine-tuning of equipment. The reduction of the dose rate prior to the replacement work was seen as a necessary measure to reduce occupational exposure. Therefore, it was decided to perform a full system decontamination of the reactor pressure vessel and the reactor re-circulation system by applying the CORD/UV process (Chemical Oxidation Reduction Decontamination/Ultra Violet light). Due to this process, the average decontamination factor reached the value 43 at the bottom of the reactor vessel, and 46 at the surface of the reactor re-circulation loops. These results were higher than the target value of 20.

In addition, mechanical cleaning methods and installation of various shielding were applied to lower further the dose rate inside the reactor pressure vessel. After mechanical cleaning, the dose rate at the bottom of the reactor vessel was 0.03 mSv/h under water, with shielding the dose rate in air was 0.2 mSv/h.

The total effective dose for the replacement of the shroud and other equipment was 11.5 man·Sv which was lower than the estimated value of 12.6 man·Sv due to the high effectiveness of the above mentioned radiation reduction measures.

A more detailed description of the “Replacement of reactor internals and Full System Decontamination of a Japanese BWR” is available as ISOE Asian Technical Centre Information Sheet No. 9.

2.4 Experience of 1st Annual Inspection Outage in a Japanese ABWR

The Japanese reactor Kashiwazaki-Kariwa unit 6, the world’s first advanced boiling water reactor (ABWR), performed it’s first annual inspection outage from November 1997 to January 1998 after a stable operation of 378 days. This first outage included numerous inspections and testing, which lasted only 61 days including 6 days of Christmas and New Year holidays.

The total effective dose during the inspection outage was 0.3 man·Sv.

A more detailed description of the “Experience of 1st Annual Inspection Outage in an ABWR” is available as ISOE Asian Technical Centre Information Sheet No. 10.

2.5 Permanent Shielding in a Drywell

Pilgrim Station is a 670-megawatt GE BWR 3 with a Mark 1 containment. The plant is located on the shore of Cape Cod Bay in Plymouth, Massachusetts. Historically, the Pilgrim Plant has been a high source term BWR. In spite of this, its annual occupational dose has been below average with: 60-70% of the dose received by plant workers is from the drywell.

Permanent Shielding Plan Developed:

Prior to 1996, 160-200 mSv each refuelling outage was spent installing 20-30 tons of temporary lead shielding in all areas. In 1996, a plan was developed to reduce occupational exposure by installing permanent shielding in the drywell of the plant. Justification for this approach was based on:

- 100 mSv temporary shielding installation cost per refuelling outage;
- High occupancy times in the drywell;
- Personnel safety concerns with repetitive temporary shielding installation in the drywell;
- Emergent work and forced outages – shielding already installed.

The plan called for the installation of lead blanket curtains in the drywell because curtains could be fit into tight work areas. Curtains or shadow shielding could be installed in vertical configurations from drywell internal structures that could be more easily qualified than direct shielding on pipe. Also, the drywell represented the most difficult site for large scope temporary shielding installation. Finally, shielding hung from structures allowed increased direct loading of temporary shielding on pipes.

With the success of the initial permanent shielding installation project, plans are underway to install additional permanent shielding at Pilgrim.

The installation of permanent shielding at Pilgrim has been proven to be an effective tool to reduce site occupational exposure without compromising plant safety.

2.6 Standardisation of Dose Rate Measurements in VVER Reactors

An IAEA Regional Technical Co-operation Project on Improving Occupational Radiation Protection in Nuclear Power Plants in Central and Eastern Europe and in Republics of the former Soviet Union was launched in 1997, having as one of its principal objectives to facilitate information exchange between Health Physicists in VVER and RBMK nuclear power plants. In this forum a Working Group on Standardisation of dose rate measurements in VVER reactors presented its first report in November 1998 when an agreement on a scheme for measurements was also reached. In November 1999 information from all VVER reactors was for the first time collected and the presentation caused the members of the Working Group, and especially those who registered very low dose rates, to go back and investigate what may have had a significant impact on the dose rate. It is expected that following a meeting to be held in October 2000 more information and analyses can be presented.

2.7 Summary of the 1999 and 2000 ALARA Symposia in Orlando, Florida, United States

1999 International ALARA Symposium Highlights

The 1999 International ALARA Symposium was held on 31 January – 3 February 1999 in Orlando, Florida, USA under the endorsement of the OECD/NEA and the IAEA. The purpose of this technical symposium was to promote the global exchange of occupational dose reduction information for the nuclear fuel cycle. The theme of the symposium was "Soaring into the Next Millennium" to achieve world class dose reduction performance.

A total of 140 individuals from 12 countries attended the symposium including Austria, Canada, China, Czech Republic, France, Luxembourg, Mexico, Netherlands, Slovenia, Spain, United Kingdom and United States. The Exhibition Hall consisted of 26 vendors from the France, Germany and USA.

The symposium included 47 oral presentations discussing dose reduction achievements and lessons learned from 12 countries. A half-day continuing education course on applied ALARA tools was conducted on 31 January 1999. Dr. John W. Baum, Head, Brookhaven ALARA Center (retired), was honored at the symposium for outstanding global leadership for the past 25 years in occupational dose reduction. Indian Point 3, New York Power Authority, was recognised as the 1998 World Class ALARA Performer at the symposium.

Highlights of the Technical Sessions:

The Plenary Session featured presentations from Dr. John Baum on the accomplishments of the Brookhaven ALARA Center, Dr. John Waddington, Director-General, Atomic Energy Control Board, on the Canadian perspective on ALARA and Dr. Don Cool, Director, US NRC, on risk based performance protection programs.

A European panel of judges selected the following best symposium papers:

1. "Laguna Verde Dose Reduction Program," Sergio Zorrilla, Mexico
2. "Remote Radiological Monitoring with the CARE System," Richard Warnock, San Onofre, USA.
3. "Higher Than Expected Dose Rates for Refueling Outage," Fletcher Wilson, Catawba Station, USA.

The authors of the Best Papers were invited to present their papers at the 2000 European ALARA Workshop in Tarragona, Spain.

Participants at the 1999 International ALARA Symposium were particularly interested in the Best Papers from the 1998 Malmo, Sweden European Symposium: Hot Spot Clean-up Programmes at PWRs, EDF-France and Use of Electronic Dosimeters, Magnox Electric-United Kingdom.

The paper on occupational dose reduction opportunities by applying risk assessment to operations and maintenance activities, such as in-service inspections, was well received by the symposium attendees. Risk informed in-service inspection schedules enhance the effectiveness of examining piping components by concentrating valuable inspection resources on high-safety significant locations. This results in reduced inspection frequency while maintaining regulatory compliance and overall plant safety.

2000 North American ALARA Symposium Highlights

The 2000 North American ALARA Symposium was held on 23-26 January 2000 in Orlando, Florida, USA. Over 170 individuals attended the meeting as participants and vendors from 8 countries including Canada, Finland, Great Britain, Romania, Slovenia, South Africa, Spain, and USA. The North American Technical Centre organised the third ALARA Symposium held in North America. The North American Technical Centre supported other industry group meetings held at the same hotel before and after the symposium including Nuclear Energy Institute's Benchmarking Workshop (210 attendees, 19-22 January), and PWR ALARA and Radiation Protection Committee (75 attendees, 27-28 January).

The symposium included 34 oral presentations during the 3 days of technical sessions. Two half-day continuing education courses on applied ALARA tools and techniques were conducted on January 23 prior to the symposium. A preliminary meeting for the new NEA Expert Group on Best Practices of Radiation Protection Managers was also held prior to the symposium. Registrants were able to evaluate new ALARA tools and services in the Exhibition Hall composed of booths from 28 vendors. IAEA supported participants from central and eastern European countries as well as South Africa.

The next 2001 International ALARA Symposium be held February 3-7, 2001 in Anaheim, California.

2.8 Summary of the 2nd EC/ISOE Workshop on Occupational Exposure Management in Nuclear Power Plants, Tarragona, Spain April 2000

The European Technical Centre co-organised with the European Commission the second EC/ISOE Workshop on Occupational Exposure at Nuclear Power Plants in April 2000, in Tarragona, Spain. 160 participants from 23 countries, mainly European but also from America and Asia, attended the Workshop. The IAEA supported participants from Central and Eastern European countries as well as from China, Korea and Pakistan. Two thirds of the participants were senior health physicists from Nuclear Power Plants (NPPs) and Nuclear Research Centres, the last third was equally composed of representatives of national regulatory bodies and contractors. This workshop allowed 32 oral presentations and 15 posters presentations to be provided, in addition 8 vendors presented their products in booths. One of the most appreciated item, by all participants, was the half-day spent in small groups' discussions. The success of this Workshop is largely due to the important organisational support from the Vandellos 2 and Asco utility and ENRESA (the Spanish body in charge of dismantling installations). The translation from French, German and Spanish to English, which has been financially supported by Framatome (the French Vendor), allowed a wide participation from radiological protection professionals from the plants.

The impact of deregulation and free market on radiological protection of the workers has been addressed both during the introductory session (by the Spanish and Swedish regulatory bodies) and within all small group discussions. All participants confirmed that, up to now, deregulation has not had any negative impact on the protection of workers; however some pointed out that this was a new and quite difficult challenge for the industry. A presentation from the French utility described a new type of contractual relationships between a plant and group of contractors' firms allowing these last to pool resources in the areas of Nuclear Safety and radiological protection. As a conclusion it was recommended: ***"To consider new "Radiation Protection" management techniques to avoid the potential negative impacts of deregulation on exposures, while keeping radiation protection independent from operation and maintenance of the plant".***

A topical session concerned the evolution of radiological protection for the dismantling of installations. After a recall of the main conclusions from the first European ALARA Network (EAN) Workshop on that topic (Saclay 1997), several experiences from Spain, France, Germany and the United Kingdom were presented. Most of them focussed on procedures and techniques set up to manage risks. One major conclusion was that "there is a need to improve feedback in decommissioning both on operations performed and on incidents that have occurred". The ISOE system was then considered as a potential support to facilitate this improvement. Another recommendation from the EAN workshop has been endorsed by the participants : ***"To adopt a uniform system***

of control in (and outside) Europe to demonstrate that an acceptable level if risk has been achieved when material arising from decommissioning are cleared".

The implementation of the ALARA principle during large tasks was addressed by Chinese, Dutch and Swiss lectures. In general, speaking this second EC/ISOE international Workshop was mainly devoted to feedback experience from the plants and lessons learned on ALARA implementation and occupational exposure issues. The reduction of dose rates through Zinc injection was demonstrated, even if improvements have still to be expected, both for PWR and BWR through German and Swedish experiences. The Swedish paper from the Barsebäck NPP was awarded.

During the discussions and the lectures a need for harmonisation was pointed out both in terms of practices (decontamination of personnel clothing's, foreign workers management…) and in regulations (release criteria).

The workshop participants also recommended: ***"To maintain in the system of radiological protection the concept of collective dose which is a very useful management tool, efficient as a performance indicator and indispensable as an optimisation tool".***

There was an agreement that the use of the collective dose has to be complemented by the use of other indicators such as:

- the individual dose distribution,
- the number of exposed man-hours,
- and, as suggested in a Spanish paper, some ratios such as the daily collective dose during an outage divided by the exposed man-hours.

Finally, the Workshop was a good opportunity to reinforce the links with overseas health physicists when listening to the awarded papers from the 1999 ISOE international symposium of Orlando (United States of America). Moreover three speakers were awarded at Tarragona and are invited to make their presentations in 2001 at the ISOE international ALARA symposium in the United States of America. The awarded presentations came from Barsebäck (Sweden) on "the reduction of dose rates through Zinc injection", from Sizewell (UK) concerning "health physics problems of power operation with failed fuel" and from Framatome (France) concerning "the management of foreign workers in different countries".

The next ISOE European Workshop will take place in 2002 in Slovenia.

2.9 ISOE Nuclear Power Plant Dossier

A new type of ISOE publication is available since 1999: the ISOE Plant Dossier. The main objective is to provide each plant with a specific folder allowing that plant to perform some benchmarking with the other plants of their sister unit groups.

The ISOE Plant Dossier consists of two separate folders. The first dossier contains information related to a specific plant:

- graphs with collective doses where the evolution of each unit of the plant is compared with those of sister unit group:
  - total annual collective dose;
  - collective dose for each of the 18 outage jobs in the database;
  - collective dose for each of the 12 occupational categories;
- list of ISOE 3 Reports;
- ISOE Information Sheets;
- Incident Reporting ISOE Information Sheets;
- other information provided by the ISOE System.

The second one contains more generic documentation on the ISOE System:

- the organisation of the ISOE System (ISOE structure and ISOE information flow);
- the list of participants;
- the programme of work for the current year;
- the classification of nuclear power plants: sister unit groups;
- the ISOE Terms and Conditions.

For the moment, such ISOE Plant Dossiers have been set-up and distributed in Spain and several countries have shown their interest for that product. The data allowing to generate such Dossier are supplied on request by the European Technical Centre, either to a National co-ordinator or to a nuclear power plant as Excel files. It is also possible for each participant to select the sister unit group or the sets of reactor units to which he/she would like to compare his own units.

In the future, several pushbuttons will be available in the MADRAS Application in order to extract the data for a specific plant unit.

2.10 Principal Events of 1999 in ISOE Participating Countries

As with any “raw data”, the information presented in section 2.1 and 2.2 above is only a graphical presentation of average numerical results from the year 1999. Such information serves to identify broad trends and to help to highlight specific areas where further study might reveal interesting detailed experiences or lessons. To help to enhance this numerical data, this section provides a short list of important events which took place during 1999 and which may have influenced the occupational exposure trends. These are presented by country.

ARMENIA

Summary of National Dosimetric Trends

Dosimetric control of the Armenian NPP personnel is performed by means of film dosimeters and thermoluminescent integrating dosimeters. However, while performing special maintenance works during outages, the personnel wear also electronic dosimeters with software provision.

Events Influencing Dosimetric Trends

In 1999, two outages were performed. The first outage (10 – 24 April 1999) included the dismantling and changing of defective nozzles of measurement levels of 2SG-5 and 2SG-6, the plugging by welds plugs of 2SG-5 tubes and the removal of a defect special water purification system. During this outage the maximum individual dose was 7.0 mSv and the collective dose was 0.03 man·Sv.

Duration of the second outage was approximately 3 months; from the beginning of September to the beginning of December shutdown of Unit – 2 was performed in order to carry out PPM and usual refuelling. The planned exposure doses were agreed with the regulatory body. The exposure doses were planned in advance for the following works:

- Transport-technological operations on the reactor, reactor revision and maintenance;
- Steam Generators revision and maintenance;
- Maintenance and revision of the main circulation circuit equipment;
- Maintenance and revision of pressurizer;
- Maintenance and revision of the Special Water Purification-1(SWP) system;
- Decontamination works;
- Works on metal control;
- General works;
- Miscellaneous works.

During the second outage the maximum individual dose was 20 mSv (Occupational annual dose limit is 50 mSv), and the collective dose was 0.74 man·Sv.

In 1999, the maximum individual dose at the Armenian NPP was 29.0 mSv, the collective dose 1.57 man·Sv.

Some safety-related problems exist due to lack of sufficient qualified maintenance personnel, and it's natural that implementation of the ALARA approaches in such cases is not always achievable.

The Armenian NPP develops programmes on the reduction of the personnel exposure doses, which includes organisational and technical issues of the following type;

- Programmes of work performance which are dangerous from the point of view of radiation;
- Materials and methodical instructions according to the main ALARA approaches
- Technical arrangements, such as use of mobile ventilation facilities, which provide local removals of radioactive aerosols during the operations connected with cutting, welding and decontamination in the NPP controlled zone; Introduction water investigation system of cladding with the help of under water camera.

A number of regulatory issues should be solved.

The development of legal and regulatory documents on Radiation Safety according to recommendations from the ICRP and the International Basic Safety Standards has been started, which should be finished in 2001. Their implementation will require the licensee to limit the annual occupational exposure to 20 mSv, which will require implementation of additional protective measures.

BELGIUM

1999:

Summary of National Dosimetric Trends

Trends from one year to another are very difficult to draw, because of the different cycle length of the units: Doel have yearly cycles and Tihange have 18 months cycles. In 1998 all the seven units made their outages; one of them made a SG replacement, and in 1999, only four of them had outages, and one performed a reactor vessel head replacement.

Events Influencing Dosimetric Trends

Replacement of the reactor vessel's head of Tihange 1, during the month of September. This replacement was made with a total collective dose of 274.26 man·mSv. The initial foresight was 286 man·mSv.

Number and Duration of Outages

In 1999, the Nuclear Power Plant Doel 1 had an outage which lasted 22 days, Doel 2: 23 days, Doel 3 18 days and Doel 4 26 days. Unit 1 of Tihange power plant performed its 1999 outage within 31 days including the replacement of the reactor vessel head. Tihange 2 and 3 have fuel cycles of 18 months, and did not have outages in 1999.

Major Evolutions

Some collective doses decreases with the strict application of ALARA preparation. As an example, in Doel units 1&2 (twin units) from 1997 till 1999, the total dose was decreasing from 900 man·mSv to 732 man·mSv, due to ALARA campaigns and awareness raising actions.

Component or System Replacements

Replacement of the reactor vessel head of Tihange 1 and the replacement of the rotor of one primary coolant pump on Doel 1.

Unexpected Events

A cold shutdown in Tihange 3, for *in-situ* repair of a pressuriser safety valve resulted in a collective dose of 14.13 man·mSv.

Two shutdowns for plugging of leaking steam generator tubes were made in Doel 2 with respectively 34.88 and 29.44 man·mSv collective doses.

2000

Issues of Concern

Only Tihange 1 will not have any outage during that year. All other six units will have one.

Collective Doses in Belgium for the Year 1999

Doel 1	354.0 man·mSv	Tihange 1	1058.4 man·mSv
Doel 2	378.0 man·mSv	Tihange 2	59.5 man·mSv
Doel 3	508.1 man·mSv	Tihange 3	81.0 man·mSv
Doel 4	369.0 man·mSv		

CANADA

On a national basis, Canada's CANDU reactors are ageing, which continues a trend towards requirements for increased maintenance, and therefore increased dose. Mitigating measures such as source term reduction must continue to be introduced to counteract the trend towards increased dose.

Pt. Lepreau Generating Station

Pt. Lepreau had a significant unexpected event – more boiler tubes needed to be assessed for thinning, and the wrong type of replacement tubes was installed initially in the outage. They had to be cut out and the proper tubes put in.

The 1999 outage ran from May 8 to July 31.

1999 Total Dose	**1.356 man·Sv**
Outage Dose	***1.223 man·Sv***
Steam generator tube inspection and plugging	500 man·mSv
PHT feeder inspection	100 man·mSv
SLARette	90 man·mSv

For 2000, in terms of "organisational evolution", all Pt. Lepreau staff are attending Vision and Interpersonal Skills training to develop a unified mindset.

The annual outage starts in mid-August.

Gentilly-2

1999 annual outage was extended from 42 days to 109 days due to the fact that one of the workforce Unions was negotiating a new work contract and members were not doing overtime work.

Gentilly experienced leak problems with the new Antimony-free Heat Transport System pump seals (installed in the 1998 outage). It was necessary to put back some of the old seals containing Antimony. Following that action in 1999, ^{122}Sb and ^{124}Sb reappeared during the 2000 annual outage.

1999 Total Dose	
Total:	1.938 man·Sv
External:	1.616 man·Sv
Internal:	0.322 man·Sv
Outage Doses	
Total:	1.708 man·Sv
External:	1.488 man·Sv
Internal:	0.220 man·Sv

Major external doses during the 1999 outage were received on Feeders Seismic Support Inspection (10%); Steam generator primary side cleaning (38%) and Fuelling machine activities such as gearbox and SLARETTE (10%).

Targets in 2000:

2000 Total Dose	
Total:	1.32 man·Sv
Outage Doses	
Total:	1.12 man·Sv
External:	1.00 man·Sv
Internal:	0.12 man·Sv

Ontario Hydro/Ontario Power Generation

On April 1, 1999, Ontario Hydro split into several companies, including Ontario Power Generation (OPG). OPG owns and operates the generating stations, including nuclear stations, formerly held by Ontario Hydro.

In 1999, OPG had twelve (12) operating nuclear reactors, consisting of Bruce 5-8 , Pickering 5-8 , and Darlington 1-4, plus 8 laid-up reactors (Bruce 1-4 and Pickering 1-4). The Bruce 1-4 and Pickering 1-4 reactors were laid-up pending performance improvements at the other stations. A plan is in place to begin returning the Pickering 1-4 units to service, if approvals are received, over 2001-2002. Return to service of the Bruce 1-4 units was to be evaluated in the future by OPG.

In 1999 it became apparent that due to opening of electricity market to competition, Ontario Hydro would be required to sell some of its generating assets. A process started to find potential buyers for some plant.

The emphasis for 1999 was to continue work to bring the operating reactors up to a state of nuclear excellence (top quartile *vs* US plants). Large amounts of maintenance work have been performed, with the result of relatively high doses compared to recent years.

From the radiation protection perspective in 1999, there were four major initiatives.

First, the implementation of a $23 Million (Canadian) Contamination Control project expected to be complete by the end of 2000. The project will provide a program that effectively controls contamination at the source and prevents contamination spread. This will be accomplished using installation of standardised equipment, standardised procedures including use of catch containment devices, a contamination control training program, and performance indicators.

Second, the implementation of a complete teledosimetry/remote video-monitoring program, starting at Pickering. It is projected that this system could be utilised to prevent 100 mSv per standard maintenance outage. Plans for 2000 include similar systems at Bruce 5-8 and Darlington.

Third, an increase in the emphasis on oversight of radiation protection by Radiation Protection staff, and an increase in the amount of serviced radiation protection that will be available. The Radiation Protection organisation was doubled in size, allowing for radiation safety technicians on shift, and providing more in-field services and staff mentoring, as well as greater involvement in the radiation work planning processes.

Finally, the Radiation Protection staff went through a reorganisation. All Radiation Protection functions began reporting to a senior vice-president, who reports directly to the Chief Nuclear Officer. Previously, there were station and Head Office Radiation Safety Sections who reported to different Managers, different VPs, a senior VP, and then the Chief Nuclear Officer. This change was implemented due to concern over the loss of respect for radiation and the loss of control of contamination apparent from internal and external audits. It was concluded that the radiation safety program focus needed to be raised to a much higher level.

In 2000, some of the major initiatives will include greater involvement of new ALARA staff in all aspects of radioactive work. There are improvement plans in areas such as source term reduction, hot spot identification and removal, and improvements in temporary shielding.

CZECH REPUBLIC

The 15 Years Analysis of Results of Personal Monitoring in NPP Dukovany

Average Annual Individual Effective Dose

The annual average Individual Effective Dose (IED) during the whole time of NPP operation falls into interval 0.5-0.8 mSv for all workers (utility employees and contractors as well). From 1994 we can observe conversion of ratio of IED of employees to IED of contractors. This is caused mostly by formation of many small firms established by the utility employees offering the services to NPP and then working as contractors.

Taking advantage from the Central Registry of Occupational Exposure maintained by State Office for Nuclear Safety where the workers are classified by their profession, we can compare the average annual IED for selected professions, where the progress of IED appears more interesting.

In 1992 year the special repair works in steam generator rooms during the outages started (reconstruction upper feedwater steam generator distribution system) and continue up to now. Before the start of these repair works the decontamination of steam generator room is performed. Evaluating doses we can follow the significant decrease of annual average IED for workers performed decontamination and for them covered the reconstruction. This is caused mostly by the better and better skill of the workers and partially by the better effectiveness of works (more effective decontamination process, better knowledge of work).

Higher Individual Effective Doses

From 1991 to 1999, in only 52 cases the individual effective dose exceeded 10 mSv and only 6 workers received doses over 20 mSv. In most cases there were contracted workers performed activities during standard maintenance outages at all four units (insulation works, etc).

Concerning the internal contamination – one interesting case of internal contamination with a mixture of radionuclides occurred in 1998 year. The cleaning of drained boron recycling and storage tank was planned during the outage. Cleaning works were performed by 5 workers of small specialised maintenance company. Even the workplace was prepared for cleaning in harmony with the programme of radiation protection assurance, due to high temperature in cleaned place, there was high dustiness of background during the cleaning works. The surface and internal contamination of workers was found after the end of works. Committed effective dose less than 0.5 mSv was estimated for 4 workers and higher than 7 mSv for 1 worker. Repeated whole body counting and bioassay analyses however led finally to the estimation of Committed Effective Dose 1.5 mSv for that worker.

Collective Effective Dose

The value of annual Collective Effective Dose (CDE) during the operation time varies from 1 to 1.9 man·Sv. From 1999 the methodology of calculation of collective effective dose changed in connection with the change of recording level from 0.05 to 0.1 mSv. This was done in correspondence with the methods used for calculation of collective dose by WANO and others.

CHINA

1999:

The average collective dose per unit for the year 1999 was 552 man·mSv: 324.18 man·mSv or 0.44 man·Sv/TWh for Qinshan NPP; 680.32 man·mSv for Daya Bay 1 and 652.7 man·mSv for Daya Bay 2. For Qinshan NPP the average collective dose was 367.05 man·mSv in 1997 and 792.33 man·mSv in 1998. The outage length developed from 55 days in 1997, 171 days in 1998 to 258 days in 1999. The reactor lower internals were replaced, from 21 March 1999 to 18 June 1999, 90 days.

New/Experimental Dose-reduction Program

Temporary Shielding and Preset Shielding

During the reactor lower internals recovery service, in order to provide additional shielding water, the water level of the cavity was raised by a minimum of 800 mm from 12.150 m to 12.950 m during the process of inverting the lower internals. The inverting process were carried out using an up-ender frame which had shielding of 4 inches (101.6 mm) of iron on the top and 3 inches (78.2 mm) on three sides to shield the part of the lower internals where the energy absorber was located. Temporarily shielding was also used around the reactor vessel head.

Clean-up Refuelling Water

During the reactor lower internals recovery service, a temp orary underwater vacuum pump and filter system was set up to purify the debris arise from underwater Electro-discharge Machine (EDM) cutting. Meanwhile the refuelling pool purification system was kept on operating to reduce the dose-rate of the cavity area.

Use of Cameras and Long-handle Ttools

During the reactor lower internals recovery service, inspection and repair activities were carried out using surface cameras and long-handle tools to the extent practicable. Diver was used for some of these activities and he was required to be offset a safe distance from the activated materials using water as shielding.

Very Low Dose-rate Standby Area Established

During outage, radiation survey maps of the work area in containment were used to define areas of low exposure and all personnel were instructed to use these areas when not required to be actively involved in activity. Ropes and barriers were used to identify high-dose areas during each step of the work.

Use of Mock-ups and Training

All personnel had received ALARA training pertinent to their job. Mock-ups were extensively used to test procedures and minimise time in radiation fields.

Continuing ALARA Communications

During the reactor lower internals recovery service, each job step received an ALARA review taking into account the radiation fields at that time and lessons learned from previous steps. Each meeting to discuss the work progress (e.g. at shift turnover) has an ALARA agenda item.

In the event that radiation levels were significantly different that predicted, or if an unusual number of contaminations occurred, the job would be halted and corrective actions taken. If necessary the job step might need to be re-engineered.

The dose-rate on the deck +18m was up to 6mSv/h, obviously higher than 1.3 mSv/h on +13 m refuelling machine level due to gamma scatter effort when the core barrel upending to certain position. The RP technician requested the chain pull workers to change working place to save the dose and actually saved about 40 man·mSv from this effort.

2000:

A model task to strengthen occupational radiation protection will be established and implemented in Qinshan with the support of IAEA.

In the coming year, one of the major works is the overhaul of the reactor coolant pumps (RCP) during the 5^{th} refuelling outage. The radiation protection training and ALARA campaign will be strengthened by revising Radiation Protection Guide handbook and adopting overseas ALARA good practices before the end of year 2000.

FINLAND

In 1999, the maintenance outages carried out at Finnish NPPs were short. One reason for the short outages is good planning of work schedule.

At Olkiluoto 1 unit the outage lasted 8 days and was the shortest in the history of Olkiluoto outages. The received collective radiation dose was 0.35 man·Sv. At Olkiluoto 2 unit the outage lasted 10 days and was the shortest in the history of this unit. The received collective dose was 0.38 man·Sv. One of the most extensive jobs carried out in both outages was the repairing of the cracks in a steam separator. A group of divers came from USA to carry out this underwater work. The highest collective and individual doses were incurred during this work. One diver received a dose of 15.4 mSv.

The refuelling and maintenance outages at Loviisa NPP units were also short. At Loviisa 1 unit the outage lasted 20 days and the collective dose was 0.75 man·Sv. The most extensive works carried out during the outage were the replacement of a feed water distribution pipe in one of the steam generators, the replacement of the cables in the steam generator room and the annealing of the internal material surveillance samples of the reactor. After the annealing, the material samples were put back to the reactor. The goal is to follow the service life of the pressure vessel after the annealing. At Loviisa 2 unit the maintenance outage lasted 19 days and the collective dose was 0.51 man·Sv. The highest occupational dose was received related to the replacement of the electric and automation cables. The highest individual dose, 16 mSv, was also received during this work.

In the beginning of 1999 the Radiation Act and Decree was revised in Finland due to the adoption of the European Union BSS directive. Radiation workers were have to be categorised into two groups, A and B. The medical check of workers belonging to the A category is to be held annually when it was done earlier every three years. This new categorisation has made a lot of work in Finnish NPPs and the procedure is not yet finalised.

All four reactors in Finland were commissioned in the end of 1970’s. Both plants implemented extensive modernisation projects in 1998. At the same time the power levels were increased. Modernisation is made also in radiation protection. The most challenging future tasks concern the upgrading of installed radiation monitor systems.

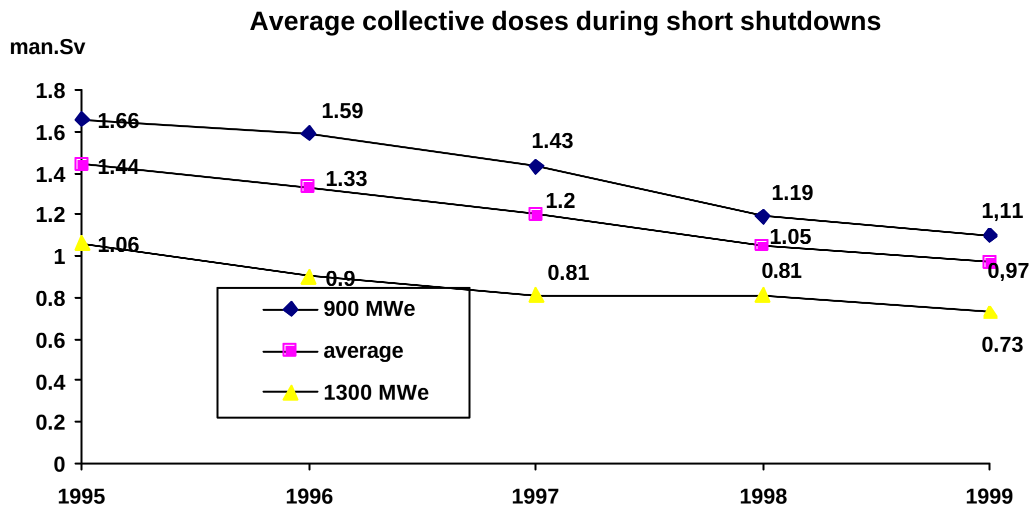
FRANCE

Summary of National Dosimetric Trends

Collective Doses

EDF operates 58 pressurised water reactors (PWRs) distributed over 19 sites (34 reactors of 900 MWe, 20 reactors of 1 300 MWe, 4 reactors of 1 450 MWe, including one still in the commissioning phase).

The average collective dose per reactor received by all the exposed workers decreased by 5%, dropping from 1.2 man·Sv in 1998 to 1.17 man·Sv in 1999. This value is already lower than the objective set up for the year 2000, that is, 1.2 man·Sv. It is the result of ongoing efforts committed by the Company to optimise doses and, particularly, for large-scale maintenance operations.



For the 900 MWe level, the collective dose reduction seems to be marking time, while, on the 1 300 MWe level, the collective dose has considerably decreased. This drop may be explained not only by the concerted efforts made to reduce doses on hazardous work sites, but also by the willingness to reduce the amount of operations performed in a controlled area. The generalisation of simple refuelling shutdowns (ASR), the lengthening of the fuel's cycles on the 1 300 MWe level, as well as the implementation of a reliability oriented maintenance policy have allowed acting in this manner.

Individual Doses

The average annual value for individual exposure (for exposed workers having received a dose strictly greater than zero) remained stable: it was 2.35 mSv in 1999 (2.32 mSv in 1998). This stability is explained by the fact that there were fewer exposed workers in 1999 (27 340) as compared to 1998 (28 392), that is, a reduction of 1 052 (4%). Therefore, the average dose did not change even though the collective dose decreased.

The number of workers having received an annual dose greater than 20 mSv were reduced to a very low level in 1999. Eight people exceeded this value in 1999 compared to 17 in 1998 and 193 in 1997. Except for the two individuals who clearly exceeded this value (the Tricastin incident at 340 mSv and the Dampierre incident at 30 mSv), the six other people did not exceed 21 mSv.

Events Influencing Dosimetric Trends

The global results conceal, however, a net disparity between the 900 MWe units, whose collective dosimetry is stagnating (1.41 man·Sv in 1999 and 1.37 man·Sv in 1998), and the 1 300 MWe units (0.73 man·Sv in 1999; 0.92 man·Sv in 1998) whose collective dosimetry continues to progress.

This progress is primarily due to

- the application of the ALARA policy, which has been notably integrated into optimisation of dosimetric referential for the most dose generating jobs (approximately 70% of the collective dose);
- the launching of actions with respect to service provider firms (sponsorship, setting of dosimetric objectives in job contracts, etc.);
- the revising of the maintenance policy, which is targeted at reducing the volume of maintenance operations. It is supported by the generalisation of “Simple Refuelling Shutdowns (24 in 1999) and the optimisation of preventive maintenance (Reliability oriented Maintenance Optimisation).

The extension of the fuel cycle (going from a refuelling of 1/4 of a core every 10-12 months to a refuelling of 1/3 of a core every 18-20 months) on the 1 300 MWe energy rated levels also contributes in reducing the shutdown periods and consequently in reducing the collective and individual doses.

Unexpected Events

On March 11, 1999, a technician of the Tricastin nuclear power plant received a 340 mSv dose when he entered the reactor pit (controlled area classified "red") even though the power plant was shutdown for maintenance. Because this incident exceeded the regulatory limit of 50 mSv/year set for workers, it was classified level 2 on the INES scale.

GERMANY

The occupational exposure in German nuclear power plants, in general, was low and – compared to 1998 – often could be reduced even more. The reason for this result can be seen in the following positive factors:

- Continuous optimisation of radiation protection procedures and measures;
- Reduction of outage duration times; and
- Reduction of dose-intensive back fitting and maintenance works.

In some plants new measures (Zinc-Injection) for the reduction of dose rates in controlled zones, mainly caused by ^{60}Co, have been introduced. The results up to now show that positive trends can be expected for the future also for those PWRs, which did not replace material containing cobalt.

Following the new EU-Guideline, the amendment of the German Radiation Protection Ordinance (RPO) has been nearly completed. Therefore, the VGB-Working Group “Practical Radiation Protection“ has started a working programme to interpret the regulations of the new RPO in order to assure that it can be transferred effectively into practice on the basis of consistent understanding.

HUNGARY

In 1999, the annual collective dose for Paks NPP, based on legal dosimetry (using film badges), was 2 122 man·mSv including plant staff and contractors. The average collective dose per unit (Paks NPP operates four units) was 530 man·mSv.

The maximum annual individual dose was 13.1 mSv. There was no internal radiation exposure reaching or exceeding the 0.15 mSv committed effective dose.

As in previous years, the outages of the units in 1999 contributed the major part to the collective dose, 90% of the collective dose was due to works carried out during the outages. Unit 2, 3 and 4 had short outages (26-35 days), while on Unit 1 a long outage (64 days) was completed in 1999.

The realisation of the earlier decided safety upgrading program continued in 1999, however, due to their character these activities resulted in less collective doses compared to 1998. Within the works performed during the safety upgrading, the refurbishment of the reactor protection system on Unit 1 has to be highlighted, as well as the preparation of reactor protection system refurbishment on Unit 2 and 3 which all together resulted 215 man·mSv collective dose according to operational dosimetry control.

JAPAN

Fiscal Year 1998

Summary of National Dosimetric Trends

The Fiscal Year 1998 has resulted in a little reduction from the previous year for both BWRs and PWRs. The average annual collective dose per unit is 1.38 man·Sv, 1.78 man·Sv and 0.96 man·Sv, for all operating units, BWRs and PWRs, respectively.

In FY1998, the main improvement works having significant collective dose during planed outage were as follows.

BWRs

- replacement of a shroud and other reactor internals (8.5man·Sv for 2 units)
- replacement of PLR pipe lines (2.3 man·Sv)

PWRs

- replacement work of check valves in the safety injection system (0.5 man·Sv)
- replacement work of small diameter piping (0.4 man·Sv)

Periodical inspections were completed at 22 BWR units and 15 PWR units. The average duration for periodical inspection are 111 days for BWRs and 93 days for PWRs.

The Tokai P.S. (GCR) ended its commercial operation on 31 March 1998.

Fiscal Year 1999

Summary of National Dosimetric Trends

The Fiscal Year 1999 has resulted in a little increase in dosimetry from the previous year for both BWRs and PWRs. The average annual collective dose per unit is 1.64 man·Sv, 2.14 man·Sv, and 1.02 man·Sv for all operating units, BWRs and PWRs, respectively.

In FY 1999, the major improvement works having significant collective dose during the planned outage were as follows:

BWRs

- replacement of a shroud and other reactor internals (4.9 man·Sv for 2 units);
- replacement of PLR pipe lines (6.5man·Sv for 3 units);
- Laser desensitisation treatment of jet pump riser pipes (2.9man·Sv for 1 unit).

PWRs

- replacement of steam generators (2 man·Sv for 1 unit).

Periodical inspections were completed at 24 BWR units and 22 PWR units. The average duration for periodical inspection was 89 days for BWRs and 66 days for PWRs. The shortest outage lasted 36 days.

Unexpected Event

On September 30, a critical accident took place at the conversion test facility of JCO.Co in Tokai-mura. The accident happened during the process of fuel manufacturing for Experimental FBR (Joyo). Three workers were exposed to a large amount of neutron and gamma radiation (16-20 Gy, 6-10 Gy, 1-4.5 Gy). As a result, 2 workers died of overexposure after the long intensive medical treatment. Evacuation of residents within 350meters and sheltering of the population of 310 000 within 10 kilometres were recommended.

For the Year Following the Report:

Japan is preparing for the adoption of the ICRP publication 60 in the regulatory framework, from the beginning of FY 2001.

Plans for Major Work in the Coming Year:

It is planed to replace a shroud and other reactor internals at 2 BWRs in FY 2000. Steam Generator replacements are scheduled at one PWR in FY 2000 and for another PWR in FY 2001.

LITHUANIA

The average annual collective dose per unit and per reactor type for the year 1999 for the Ignalina nuclear power plant LWGR (RBMK 2 Units), was 6.39 man·Sv.

The total number of workers under individual dosimetric control was 4 145. Analysis of dose budgets has shown that the actual values were significantly lower than planned. Occupational exposure at the Ignalina NPP is decreasing: 9.25 man·Sv in 1997, 7.53 man·Sv in 1998 and 6.39 man·Sv in 1999. The observed reduction of the collective dose can be explained by using work management programmes and ALARA implementation, programmes of safety improvements at the NPP and equipment modernisation works.

In 1999 there were two outages performed at the Ignalina NPP: the outage of Unit No. 1 was 74 days, the outage of Unit No. 2 was 64 days and the collective dose was 3.451 man·Sv for Unit 1 and 5.789 man·Sv for Unit 2. The total collective effective dose in 1999 was 12.79 man·Sv, 10.33 man·Sv for plant personnel and 2.46 man·Sv for outside workers, portioned as: normal operation - 20.0%, outage of Unit No. 1 – 30.8%, outage of Unit No. 2 – 49.2%.

The maximal individual effective dose was 31.89 mSv for plant personnel and 33.3 mSv for outside workers. A total of 101 workers and 22 outside workers reached individual doses above the dose limit (20 mSv).

It was considered to wash the outline of the main circulation circuit without any chemical reagents, to perform the washdown of the blind zones of the group distribution header from the corrosion products. Such measures have significantly reduced the gamma dose rates at premises of controlled zone of the Ignalina NPP.

In 1999, the assessment of internal exposure for 705 workers from the ‘critical group’ (selection of workers was made taking into account the working conditions in the controlled zone of INPP during the outages) was carried out. There was no internal overexposure of the plant personnel detected in 1999.

For the year 2000, the Ignalina NPP will continue its efforts to implement the ALARA programme through technical actions. Also the maximum individual dose should be below 20 mSv.

Regarding occupational exposure, the regulatory body (the Radiation Protection Centre, RPC) intends for the year 2000:

- to approve the dose budget for the coming year, including outage periods;
- to establish new regulations related to general requirements for radiation protection and safety at the NPP;
- to improve constantly the form and contents of performed inspection activities at the plant;
- to continue the assessment of occupational exposure due to internal exposure of plant workers;

- to evaluate trends of the occupational exposure of outside workers and to analyze their reasons.

MEXICO

1999

Collective Dose

Unit 1 total	6.20 man·Sv
Normal operations	1.34 man·Sv
7th refuelling outage	4.86 man·Sv
Unit 2 Normal operations	1.13 man·Sv
Average Unit 1 and Unit 2	**3.66 man·Sv/Unit**

Main Events Influencing Dosimetric Trends /Results

- Steam leaks repair, both units (14% U1, 11% U2 percentages of Normal Operations total collective dose).
- Condensate demineralisers prefilters substitution in both Units (8.4% U1, 11.9% U2 percentages of Normal Operations Collective Dose).
- Unit 1 Seventh Refuelling Outage (August 8 through September 27, 1999):
  - Substitution of the motors of the recirculation pumps. For this job, the whole recirculation pumps had to be taken out the drywell. So, significant associated jobs were the removal of interferences (supports, valves, snubbers, piping and instrumentation) that impeded the extraction of these pumps from the drywell, as well as the replacement of such components once the pumps were returned to their locations.
  - Regulatory ten-year in-service inspection inside the primary containment, and in particular the inspections related to the recirculation nozzles.
  - Thermal insulation removal and replacement for the jobs above mentioned.
  - Preventive / corrective maintenance of about 700 valves in Turbine Building in order to reduce steam leaks in normal operations.
- Although zinc injection had been implemented since the previous year (1998) and the effects had started to be evident, radiation fields inside the drywell still remain high due to presence of Co-60 and Iron inside the reactor vessel and lines related to the primary coolant.

Major Evolutions

Power upgrade in both units to 105% of the original rate. The current rate is 684 MWe per unit.

Component or Systems Replacement

During Unit 1 seventh refuelling outage, as stated above, the motors of the recirculation pumps were substituted. This was the major task of the outage, and one of the biggest challenges we have ever had.

Dose Reduction Program Evolution

The LV dose reduction program, based on source reduction, continues. The injection of depleted Zn, which started at the beginning of this cycle, proved to be very helpful in Unit 1: the recontamination rate of the systems that were chemically decontaminated the previous outage was of about just 20%. The expected recontamination rate with no Zn injection had been estimated in about 75%.

For Unit 2, however, by the end of 1999, the injection of Zn had not yet proven to have any measurable effect. This is very probably due to the fact that the concentration of Iron in feedwater could not be controlled to less than 2ppb in this Unit after the Zn injection startup, as well as because the significant amount of crud accumulated in the reactor vessel and on fuel elements during the first four years of operations. This situation made it necessary to contemplate the possibility of a physical removal of crud from the reactor vessel during the Fourth Unit-2 refuelling outage in March 2000, as well as implementing control measures on the sources of Iron in excess.

2000

Technical Aspects

- The ineffective role of Zn injection in Unit 2 described above lead to a set of remedial actions to be implemented during the Fourth Refuelling Outage of this unit:
- To make a new chemical decontamination of the Recirculation loops, as well as portions of RHR and RWCU systems.
- To remove a substantial percentage of crud from the reactor vessel through vacuuming and submerged filters.
- To restart the injection of zinc.
- To control the main contribution of Iron to the feedwater by placing a stainless steel liner on the main steam reheaters internal surfaces.

In order to neutralise the expected increase on dose rates as a consequence of a forthcoming hydrogen injection to protect reactor internals of both Units from intergranular stress corrosion cracking (probably in 2001), concurrent noble metal injections have been considered in the plans.

For year 2000 the collective dose of LVNPP is expected to continue its decreasing trend, and by the end of the year it's been calculated to account around 3 man·Sv/Yr-Unit. This is around 62% of the collective dose obtained in 1998, and 81% of 1999.

Regulatory Aspects

The Mexican regulatory body released a draft proposal regarding a new national regulation based on ICRP – 60. Our current regulations are based on ICRP-26 and the U.S. 10 CFR20 & 50.

NETHERLANDS

In the Netherlands, there is one reactor in operation, the Borssele Nuclear Power Plant. The Dodewaard reactor is definitely shut down since 1997.

The Borssele Nuclear Power Plant (KCB) is a PWR with two loops and an electrical power generation of 465 MW. The reactor is in operation since 1973.

In 1999, the annual collective dose for KCB was 295 mSv, including the shutdown dosis of 188 mSv. The shutdown period lasted 15 days and is the shortest outage since start of operation. The annual collective dose for the Dodewaard reactor was 217 mSv in 1999.

ROMANIA

SNN-CNE Prod Cernavoda operates a single unit Nuclear Power Plant of CANDU-600 type. The year of 1999 is the third full year of commercial operation.

For this year the station collective dose was 456 man·mSv (including both external & internal doses), distributed over 354 exposed individuals i.e. those receiving reportable doses.

The highest individual dose was 9.6 mSv and the average individual dose for exposed workers was 1.3 mSv. Approximately 60% of exposed individuals received doses less than 1 mSv and further on less than 3% received doses above 5 mSv. No individual received doses above 10 mSv.

In comparison to previous years, with respect to maximum individual doses, number of exposed workers and number of individuals receiving doses above 5 mSv, the figures are similar.

Station collective dose was higher than previous years, mainly due to more extensive work during the planned outage and a three day unplanned outage for leak search and repair. The mentioned outages had a contribution to the annual collective dose of 356 man·mSv and 35 man mSv, respectively.

The main activities having significant impact on collective dose during the planned outage were as follows:

- first fuel channel inspection – 43.2 man·mSv;
- steam generator inspection – 19.2 man·mSv;
- maintenance of channel temperature monitoring devices – 18.9 man·mSv;
- work in feeder cabinets (swagelock replacement, tubing inspection) – 96.2 man·mSv.

For the following year, the main projects refer to:

- review of Radiation Program in order to increase efficiency;
- establish a comprehensive job dose assessment program;
- upgrading and extension of exit contamination monitors.

SLOVAKIA

National Trends in Occupational Doses in Nuclear Installations

In 1999 nearly 6000 workers were monitored in nuclear industry of the Slovak Republic (including outside workers). Total collective dose was 4 man·Sv. The maximum individual dose was 15.6 mSv. In operating units there was the average collective dose per unit in operation 0.597 man·Sv. The main contributions to the total collective dose in nuclear installations of Slovakia were caused by planned outages on each operating unit, by the safety improvement reconstruction of NPP V1 in Bohunice and by the decommissioning of NPP A1. Please note that these data include already the occupational exposure data from Mochovce nuclear power plant, although this plant joined the ISOE programme in beginning 2000.

There was no accident and no overexposure in nuclear installations of Slovakia in 1999. There was no worker exposed in excess of 20 mSv.

Nuclear Power Plant Bohunice (4 Units)

Total collective effective dose in NPP Bohunice in 1999 was 2.343 man·Sv (employees 1.262 man·Sv and outside workers 1.081 man·Sv). The maximum individual dose was 15.49 mSv.

Events Influencing Dosimetric Trends in 1999

The planned outages on each unit and reconstruction works at Units 1 and 2 were the main events that contributed to the total collective dose at Bohunice NPP. The sum of the collective doses during the outages presents 85% of the total annual collective dose in 1999.

Unit 1	43 days standard maintenance outage with refuelling combined with reconstruction works. Total collective dose during outage was 497.89 man mSv; the collective dose from the reconstruction works presents approx. 44% of the total collective dose during outage.
Unit 2	90 days major maintenance outage with refuelling combined with reconstruction. Total collective dose during outage was 842.13 man·mSv; the dose from reconstruction works presents approx. 22% of the total collective dose during outage.
Unit 3	76 days major maintenance outage. Total collective dose during outage was 406.56 man·mSv.
Unit 4	46 days standard maintenance outage. Total collective dose during outage was 239.60 man·mSv.

Major Evolutions

Component and system replacement:

Reconstruction works at Unit 1 and Unit 2. The goal of the reconstruction is the improvement of the nuclear safety of reactors units. The reconstruction work was focused mainly on the emergency core cooling system reconstruction, spray system reconstruction, improvement of the hermetic zone resistance, ventilation systems and the anti-seismic measures.

Unexpected events:

Exposure of one worker during the transport of an internal part (protecting tube system) of the reactor – effective dose of 10.07 mSv.

Expected Principal Events for the Year 2000

Plans for major work in the coming year:

Unit 1	144 days outage for refuelling with reconstruction
Unit 2	43 days standard maintenance outage
Unit 3	78 days standard maintenance outage with the inspection of internal parts of reactor
Unit 4	46 days standard maintenance outage

Technical issues of concern from radiation protection point of view:

Radiation instrumentation – renewing of whole body counter, exchanging of portal monitors at the exits from radiation controlled areas and installation of new electronic personal dosimetry

Decommissioning of Nuclear Power Plants and Management of Radioactive Waste Bohunice

This nuclear installation (company) is responsible for decommissioning of NPP A1 in Bohunice (Gas cooled, heavy water moderated reactor) and for treatment, conditioning and disposal of radioactive waste. Total collective dose 1.000 man·Sv (employees 0.545 man·Sv, outside workers 0.455 man·Sv). Maximum individual effective dose 16.57 mSv.

Events Iinfluencing Dosimetric Trends in 1999

Main contribution to the collective dose

- Spent fuel preparation for transport to Russian Federation.
- Radioactive waste treatment.

Expected Major Work in 2000

- Trial operation of the radioactive waste conditioning facility in Bohunice.
- Commissioning of the near surface waste repository in Mochovce, and
- Decontamination of the reactor hall and the spent fuel storage of the NPP A1.

SLOVENIA

Radiological performance indicators of Krsko nuclear power plant for the year 1999 were:

Collective radiation exposure was 1.65 man·Sv (per electrical output 0.35 man mSv/GWh). Maximum individual dose was 11.95 mSv and average individual dose 1.68 mSv.

Refuelling Outage (61 days):

Planned refuelling outage was extensive, considering the activities at the primary side. The works were steam generator sleeving and plugging, maintenance of the valves requiring empty coolant loops, in-service inspection of reactor coolant pump, welding of the clamping to be prepared for steam generator replacement, installations for the inadequate core cooling monitoring and testing of the component's snubbers.

Major Evolution:

The project of modernisation of Krsko nuclear power plant includes steam generators replacement and reactor power upgrades in year 2000.

New regulation concerning the radiation protection of workers will be issued by year 2002.

SOUTH AFRICA

Summary of National Dosimetric Trends for the Year 1999

During the year, 1756 people were occupationally exposed at Koeberg Nuclear Power Station. The total collective dose for the workforce was 1726.4 mSv versus a target of 2 Sv. The annual average dose for the occupationally exposed work force was 0.98 mSv. The highest individual dose was 20.35 mSv.

Events Influencing Dosimetric Trends

Koeberg Nuclear Power Station successfully completed two refuelling outages during 1999 which contributed 83,6% of the collective dose for 1999. The refuelling outage on Unit 1 and Unit 2 contributed 657.54 man·mSv and 786.91 man·mSv to the collective dose respectively. The duration of these outages were 31 days at Unit 1 and 41 days at Unit 2.

Component or System Replacements

Koeberg Nuclear Power Station replaced the first large heat exchanger used to remove the residual heat from the primary system during shutdown. The collective dose for this task was 24.73 man·mSv.

Koeberg Nuclear Power Station replaced most of the concrete liners in the floor-drain channels which houses liquid effluent piping. The collective dose for this task was 48.47 man·mSv.

Organisational Evolutions

A Corporate Custodian has been appointed to provide direction and rules for the radiation protection programmes in Eskom. The Corporate Custodian also interface with the regulatory authorities on all radiation protection related matters.

For the Year 2000

The Spent Fuel Pool storage facilities will be modified during 2000-2001 to accommodate more fuel. This task may result in an estimated collective dose of 30-40 man·mSv.

Eskom and the National Nuclear Regulator are having discussions on a process-based licence for Koeberg Nuclear Power Station.

Dose assessments have been conducted for all major tasks. The dose target for 2000 at Koeberg Nuclear Power Station is set at 1090 man·mSv.

SPAIN

In 1999, the average dose per unit is 0.71 man·Sv for PWR and 2.45 man·Sv for BWR. To compare these values with those of the previous years it has to be taken into account the number of units with outage in those years.

	PWR			BWR		
Year	Outages	Collective doses (man·Sv)	3 year rolling average	Outages	Collective doses (man·Sv)	3 year rolling average
1996	4	1.47		2	3.36	
1997	5	1.35		1	2.39	
1998	4	0.55	1.12	0	0.53	2.09
1999	5	0.71	0.87	1	2.45	1.79

For PWR, we consider 20% more exposure due to normal operation for the plants and some more for the two plants (150 man·mSv each) which didn't have refueling this year.

As it can be seen, in PWR the downward trend that started last year (after steam generator replacement) continues, although there has been a slight increase because one more unit had outage than in 1998 and because of a higher dose than expected in one of the plants. For BWR, this trend also continues, having two outages with only 2 man·Sv compared to 1996 values with also two outages of 3.36 man Sv.

The outage duration and doses have been the following:

NPP	Type	Duration (days)	Coll. Doses (man·Sv)	Comments
J. Cabrera	PWR		0.686	
Almaraz I	PWR	41	1.283	Antimonium contamination in primary coolant
Almaraz II	PWR	–	–	No outage
Ascó I	PWR	–	–	No outage
Ascó II	PWR	32	10726	Power increase to 104%
Vandellos II	PWR	51	1.092	Power increase to 104%. Tenth cycle inspection.
Trillo	PWR	69	0.362	Pressurizer spray lines modifications.
S.M Garoña	BWR	39	2.226	Decontamination of recirculation loops and condensate system modification.
Cofrentes	BWR	27	1.787	Important mechanical modifications.

It is important to point out that two to the units have been upgraded to 104% in this year.

The most interesting incident related to collective dose occurred in Almaraz NPP outage. In this outage, after cooling the primary circuit high levels of radiation in contact were detected in several points of this system. The outage works were halted and the causes of this high level investigated. This causes were high level of antimonium 122 and 124 in the primary coolant due to leaks in one of the two in-core neutron sources, because of a defect in the source cladding. The primary coolant was treated with the demineralizers to reduce the antimonium concentration to the levels recommended by INPO. The outage works then continued re-estimating the expected collective dose from 0,78 man· Sv to 1,73 man·Sv. The final collective dose has been 1,28 man·Sv. An extensive program to re-evaluate works related to the RC, the CVCS, the RHR systems was done, modifying the work conditions in relation to the source term in the areas.

On February the Regulatory Body (CSN) approved a new Safety Guide about Practical implementation of the Optimisation of Radiation Protection in Spanish NPP (GS 1.12). This Guide describes the general criteria of the ALARA organisations in NPP. As a consequence, a review of the evolution of the ALARA organisations has been undertaken by UNESA. The conclusion is that there have been no mayor changes since 1996 when they were officially set up, ad that all of them meet the general criteria established in the new Safety Guide.

Working in decommissioning Nuclear Power Plant Vandellos I (GCR) are going on with the so called "hot cell" where fuel irradiated elements were handling, and where a great problem of alpha contamination exists.

SWEDEN

Summary of National Dosimetric Trends

After the extensive modernisation period during the last decade of the older Swedish BWRs the dosimetric trend is significantly decreasing to a reasonably low level. The average collective doses for BWRs for 1999 was as low as 1.03 man·Sv. Analogue collective doses for the Swedish PWRs was 0.433 man·Sv.

For the country in total the collective dose was 10.6 man·Sv, corresponding to 12 reactors with a total energy production of 72.2 TWh.

Events Influencing Dosimetric Trends

The major contributor to the downgrade dosimetric trend is in major related to the modernisation of older BWR reactor. But also an effect's of the change in health physics philosophy taking place in the mid 90's, more relaying on education/training and self-management by the individual worker.

New Plants on Line/plants Shutdown

Barsebäck unit 1 was shutdown for final at the last day of November, this as a result of a political decision. Final decommissioning of the plant is not yet scheduled.

Unexpected Events

A common unexpected problem on all the ABB reactors of 2nd generation was cracks discovered in some of the mount brackets for the core-spray system inside the shroud head. This problem did not lead directly to an increase in doses but prolonged, in general, the outage period by 60-90 days.

Plans for Major Work in the Coming Year

Unit 1 and 2 at Forsmark are preparing to change the shroud and core grid next year. A work similar to the one did at Oskarshamn unit 1 in 1998, which lead to a very moderate collective dose of 0.2 man·Sv.

SWITZERLAND

Dosimetric Trends (1998 Data are Shown in brackets)

The 3 840 (3 578) occupationally exposed persons concerned here – 4 NPP sites, 5 power reactors – accumulated 1999 4.50 (3.75) man·Sv effective dose. The maximum registered individual effective dose amounted to 14.9 mSv. No individual effective dose above 20 mSv has been registered since 1994. The mean individual doses varied between 0.9 and 1.5 mSv being generally somewhat higher for plant personnel compared to contract personnel.

Events Influencing Dosimetric Trends

The annual dose for 1999 is dominated by the steam generator replacement at KKB 2 (0.64 man·Sv). Other aspects that helped to reduce the dose load:

- Further reduction of the recirculation loop dose rate at KKM (Muehleberg) respectively at the primary loop of KKB 1 / 2 (Beznau 1, 2);
- Generally very good fuel behaviour in all Swiss plants in 1999.

All plants except KKB 2 (steam generator replacement, additional duration of 1.5 months) had a normal refuelling/inspection outage of roughly one month duration.

No new plants are being built or planned in Switzerland, as the constitutional 10 years moratorium is still valid.

Major evolutions

KKL (Leibstadt) realised in 1999 a 9% of the permitted 14.7% power increase. Although a slightly overproportional influence of the power increase on plant dose rate mainly due to ^{16}N has been observed, no significant increase of dose rate in the surroundings could be detected.

KKB (Beznau) replaced the steam generators at unit 2. Furthermore 4 spare adapter plugs at the reactor vessel head have been replaced.

KKM (Muehleberg) replaced the brass tubes of the second condenser in preparation of an anticipated noble metal coating and hydrogen injection in the year 2000.

ALARA committees have been established at three Swiss NPP sites. Most dose reductions shown are of the evolutionary “lessons learned” type.

Issues for 2000

Issues of concern

The economical liberalisation of the electric power market is partially reflected in personnel reduction programmes increasing the individual work load. In addition, contractors are involved in nuclear power plant work to a lesser degree and sometimes less experienced companies get the contract. These developments have to be closely monitored by the authority.

Technical Issues

As a lead site, KKB will go back from 18 month cycles to a so-called hybrid cycle (one full inspection/refuelling outage followed by a refuelling outage only). KKM (Muehleberg) and KKL (Leibstadt) will follow with similar schemes.

Regulatory Issues

Reorganisation of the Swiss authority in order to achieve a process oriented work scheme with fully certified quality management tools has come a long way and substantial implementation work will be done during 2000.

UKRAINE

Summary of National Dosimetric Trends

For the last five years the level of occupational exposure at nuclear power plants in Ukraine has had stable tendency to decrease. For example, annual collective dose for the personnel of NPPs decreased by 35% in 1999 in comparison with 1995, and by 9% – in comparison with 1998.

Number and duration of outages at NPPs don't differ from ordinary. It is possible to mark that there was enlarged volume of repair works at Chernobyl 3 in 1999. That increased the annual collective dose for personnel by 5% in comparison with the last year.

In 1999, there were no new units commissioned or units shut down.

Unexpected Events

In July 1999, at Chernobyl 3, two workers from the metal laboratory received a high dose (83.2 mSv and 97.7 mSv respectively) due to loss of control of an ionisation source through a failure in a gamma ray projector type "Amertest".

New Dose – Reduction Programmes

A new Radiation Safety Standard Ukraine (NRSU-97) came into action in 1998. The Law of Ukraine "About protection of the man against ionizing radiation" was adopted on 24.02.98. According to the Law and NRSU-97 the main legislative dose limit in occupational exposure category A is 20 mSv per year for newly commissioned plants and 50 mSv per year for operating ones. In that case they must be gradually changed to the limit 20 mSv (the time of the transitive period is established by the authority bodies).

With the purpose of the performance of new dose limit in 1999 Ministry of Energy of Ukraine developed "Program of transition of nuclear power utilities of Ukraine to the NRSU-97 requirement's performance", which was approved by regulatory authorities. There are technical and organisational measures aimed at decrease of the individual and collective dose of occupational exposure.

Applicability of the Programme

- Definition of conformity of radiation safety condition to the requirements of NRSU-97.
- Definition of the basic direction of the transition activity.
- Establishment of duration of the transitive period.
- The Program determines the basic directions of activity.
- Revision of the standards (job instruction, maintenance regulation) at an utility level.
- Revision of methodological foundations.
- Elaboration of measures aimed at reduction of personnel exposure doses.

The transition to the new regulating base with more severe criteria demands such complex of measures, as:

- Elaboration of complements and changes of the radiation protection instruction.
- Additional training of the personnel responsible for the works, which are dangerous from the point of view of radiation exposure.
- Organisation of the new individual dose control workplaces (automation of the calculations and analysis of exposure doses by means of computer network).

- Development and installation of additional biological protection at constant workplace with high irradiation level.
- Purchase and launching of the complex for remote technical survey of the equipment with high irradiation level.

For the Year Following the Report

In 2000 National Nuclear Energy Generating Company "Energoatom" which includes all Ukrainian NPPs is planning to outfit each plant with modern electronic personnel dosimetry system produced by MGP Instruments (France). The organisational evolutions on the implementation of the ALARA principle are not effective any more. Further reduction the dose of occupational exposure is impossible without usage of the above-mentioned system.

UNITED KINGDOM

Summary of National Dosimetric Trends

The Health & Safety Executive (HSE) established a Central Index of Dose Information (CIDI) in 1987 which is managed by the National Radiological Protection Board. Dose statistics for 1998 have recently been published.

Table 1***: Contribution of reactor operation and maintenance to the national occupational dose burden.*** **Notional Dose data are from CIDI and refer to ICRP Category A Workers only**

Year	UK Occupational Collective Dose (man·Sv)	Reactor Operations		Reactor Maintenance	
		Collective Dose (man·Sv)	% of UK total	Collective Dose (man·Sv)	% of UK total
1997	47.07	4.09	8.69	5.57	11.83
1998	32.02	3.98	12.43	4.87	15.21

From Table 1, it can been seen that the collective dose from all occupational exposures in the UK during 1998 was reduced by 32% compared to 1997. The collective dose from reactor operation and maintenance also fell over the same period. However, despite the reduction in actual collective dose, the relative contribution of nuclear power sectors to the overall national dose burden increased during 1998.

Table 2: **Collective Dose During 1999 by Reactor Type**

Unit Type	Net Output 1999 (TWh)	Collective Dose (man·mSv)		
		Total	Per GWh	Per reactor
PWR	8.2	664	0.081	664
AGR	56.3	2076	0.037	148
Magnox	–	–	–	–

The current UK nuclear generating capacity is provided by 1 PWR, 14 AGR and 20 Magnox units. The PWR and AGR units are operated by British Energy and the Magnox units by BNFL Magnox Generation. Six Magnox reactors at three sites are currently being decommissioned. Bradwell Magnox Station and Sizewell A Magnox Station are due to close in 2 and 4 years time respectively. Only one PWR is in operation (at Sizewell B) and no more reactors are currently planned. Table 2 summarises the dose burden at each type of reactor. It should be noted that only 4 AGR reactors had an outage in 1999.

Events Influencing Dosimetric Trends

Sizewell B's collective dose for the whole of 1999 was 664.00 man·mSv, the mean individual dose being 0.45 mSv. During 1999, Sizewell B had one planned refuelling outage (RF03) and two short forced outages. The collective dose for RF03 was 634.78 man·mSv accounting for 96% of the annual collective dose. The mean individual dose during RF03 was 0.55 mSv and the maximum individual dose was 6.14 mSv. There were 112 personal contamination events, although 75% of these were below the reportable threshold (4Bq/cm^2 averaged over 300cm^2) under the company radiological safety rules.

Major Evolutions

During RF03 there were a number of significant events that prolonged the outage. At the start of RF03 an INES Level 1 incident occurred when 10m^3 of primary coolant was lost into the containment sumps. In addition to the Site Incident (failure of an RHR relief valve trevitest), problems associated with an accumulator weld repair severely disrupted the critical path. Overall, RF03 was extended by 27 days and as a result, the planned dose budget of 550 man·mSv was exceeded by 15% due to these events.

Dungeness B (AGR) has been in a prolonged outage due to extensive boiler superheater inspections and repairs.

Issues for 2000

- The EURATOM Basic Safety Standards Directive was incorporated into UK law by the enactment of the Ionising Radiation Regulations 1999 on the 1st of January 2000.
- REPPIR (emergency preparedness & public information) regulations are expected to be enacted in 2001.
- The forthcoming Utilities Bill and more proactive regulation of the energy market means that nuclear generation is under intense pressure to become more competitive.

Plans for Major Work in the Coming Year

Sizewell B has RF04 planned for 32 days in September 2000. The Health and Safety Executive have granted approval to a Dosimetry Service, operated by BNFL (Magnox Generation), to provide a service based on the use of electronic dosemeters for legal dose measurements. The dosemeter being used by the service is the Siemens 1.2D EMC enhanced and measures the operational quantities Hp(10) and Hp(0.07). There is currently one client using the EPD for the personal dose measurements, Oldbury Power Station with approximately 300 staff routinely issued with the dosemeter. Other UK power station sites are expected to become clients during 2000-2001.

UNITED STATES

The United States Nuclear Regulatory Commission designated the Information System on Occupational Exposure (ISOE) as an official database in 1999. Hence, the US joins Switzerland, Germany and Sweden in recognising the value of using the international occupational dose database for oversight and performance monitoring of nuclear power plants. This achievement recognises a significant achievement in the North American Technical Centre ISOE program milestones.

US Nuclear Power Plant Highlights for 1999:

Approval of plant life extension applications was granted for Calvert Cliffs Nuclear Power Station located in Lusby, Maryland. Calvert Cliffs, Units 1 & 2 received site operating license extensions from the US Nuclear Regulatory Commission for an additional 20 years per unit of operation (2036 & 2038, respectively). Baltimore Gas & Electric Company was the first North American nuclear utility to achieve approval of a plant life extension application from the regulatory body.

A significant milestone was achieved with the return to successful full-power operations of several US units after completion of 2-3 year extended maintenance outages (e.g., Clinton Power Station in April 1999, and D.C. Cook, Unit 1, in June 2000). US operating nuclear power plant capacity factor increased to 88.5% in 1999: up from 84.3% in 1998. With the inclusion of units under extended shutdowns, the US nuclear power plant capacity factor increased to 86.8% in 1999: up from 79.5% in 1998. The electrical output of US nuclear power plants increased to 727.9 billion of kWh in 1999: up from 673.7 billion of kWh in 1998.

Consolidation of US nuclear plants into fewer companies continued, with strong management focus on safety and efficiency of plant operations. For example, purchases of TMI-1 and Clinton Power Stations were initiated by Amergen (PECo Energy & British Energy); Entergy negotiated the purchase of Pilgrim, Indiana Point 3, and Fitzpatrick.

US Country Highlights Related to Plant Radiation Protection Programs in 1999 include:

1. successful results of noble metal chemical additions at several US BWRs;
2. injection of depleted zinc at US PWRs in addition to BWRs;
3. reduction in the number of radiation protection technicians required for refuelling outage job coverage by expansion of the installation of remote monitoring systems (video cameras/cell phones/teledosimetry connected to a central monitoring station);
4. achievement of shorter refuelling outages and the resulting reduction of outage and annual occupational dose;
5. completion of a pilot plant risk-informed and performance-based monitoring system by the US Nuclear Regulatory Commission in 1999: followed by full implementation at all US plants on 2 April 2000;
6. impacts of de-regulated business environment affecting Radiation Protection Managers as reflected in staff reductions, budgetary cuts, reduced training allowances, and increased internal performance monitoring;
7. in-service inspection schedule extensions applications received approval by the US Nuclear Regulatory Commission resulting in significant annual dose savings and cost reductions, while maintaining levels of plant safety.

Increase in US Utility ISOE Membership

Participation in the ISOE program by US pressurised water reactors and boiling water reactors continued to expand in 1999 which broadened North American utility and regulatory support of the North American Technical Centre's ISOE programme. First Energy Company joined the ISOE program in December 1999. The nuclear units owned by First Energy Company include Beaver Valley Units 1 & 2, Davis Besse Unit 1 and Perry Unit 1. It is of interest to note that Davis Besse has been one of the top 5 lowest annual dose units in the US for the past 10 years.

US ISOE participant interests focused on the dose and cost reduction opportunities available to individual plants based on regulatory relief granted for extension of the frequency of in-service inspections. ALARA training and international ALARA information exchange afforded by the 1999 International ALARA Symposium and the 2000 North American ALARA Symposium were successful due in part to the strong support by IAEA, European, Asian and North American ISOE utility and regulatory members.

US Occupational Dose Trends

Trends in US radiation protection programmes at nuclear power plants in 1999 were identified by a review of US PWR and BWR ALARA Committee discussions, industry meetings and requests for NATC studies from utility and regulatory participants. US nuclear industry trends influencing the conduct of radiation protection programs included:

1. Longer operational cycles, e.g. TMI-1 set a PWR Record of over 720 days of continuous operation: Byron started a 520 day continuous operation cycle.

2. Shorter refuelling outages, e.g. Quad Cities Unit 2 a 28 day refuelling outage and 1.50 man·Sv outage dose.

Trends identified within US radiation protection organisations included:

1. Careful management of shutdown chemistry at US PWRs especially following steam generator replacement.
2. More self-assessment occurring within radiation protection departments to ensure adequacy of program implementation.
3. Fewer qualified contract health physics technicians available for refuelling outages. Reduction of senior health physics professionals available to nuclear utilities due to retirements. Some nuclear utilities are implementing "over-hire" programs to address the need of maintaining an adequate supply of qualified professionals to support plant operations (including plant life extension initiatives). Resource sharing among utilities is increasing, also to address personnel constraints during refuelling outages.
4. Greater use of Remote Monitoring Systems, e.g., video cameras, telemetry of electronic dosimetry data. Such systems have resulted in a reduction in the number of contract health physics technicians needed to be hired for refuelling outage support.
5. Most of the US radiation work force is now included in a national dose and security clearance tracking system (PADS).
6. Greater use of incineration as compared to direct burial for low level radwaste.
7. Risk-informed inspection criteria being developed as a result of 2-year regulatory and industry initiative to improve regulatory inspections.
8. Initiation of Noble Metal treatment at US BWRs (Duane Arnold, Peach Bottom, Unit 2 & 3, Quad Cities, Unit 1).
9. Participation of 15 US nuclear utilities, 55 reactor units and approximately 75 000 workers in the 17-countries occupational dose epidemiology study entitled: "Collaborative Study of Cancer Risk Among Radiation Workers in the Nuclear Industry."
10. Implementation of decommissioning activities at Trojan, Big Rock Point and San Onofre, Unit 1.

US PWR and BWR Country Occupational Dose Averages:

The US PWR and BWR country occupational dose averages for 1999 are summarised below:

Reactor Type	Number of Units	Total Collective Dose [man·Sv]	Collective Dose Per Reactor [man·Sv]
PWR	69	7231	1.05
BWR	35	6390	1.83

US PWR country occupational dose averages for 1999 were similar to the European dose averages for the same period:

Region	**PWR** [man·Sv]	**BWR** [man·Sv]
Europe	1.03 (excluding VVER)	1.09
USA	1.05	1.83

For US BWRs, the 1999 occupational dose average was higher than the European dose averages by 0.74 man·Sv.

Summary

US Radiation Protection Programs are experiencing changes in their mode of operation based on the US electric industry moving towards a deregulated business environment. As a result, a marked improvement in nuclear power plant availability and a decrease in outage duration have been achieved at many US nuclear power plants in the 1999-2000 period.

More focus has been placed on operational reliability and efficiency, while at the same time a risk-based performance monitoring system has been implemented countrywide.

3. THE ISOE PROGRAMME OF WORK

3.1 Achievements of the ISOE Programme in 1999

Status of Participation

As of the end of 1999, occupational exposure data from a total of 380 operating commercial nuclear reactors and 49 commercial nuclear reactors in cold-shutdown or some stage of decommissioning are included in the ISOE database. These units represent 77 utilities from 26 countries. In addition, regulatory authorities from 23 countries participate in the ISOE Programme. The participation of 380 operating commercial nuclear reactors in the ISOE programme represents 88% of the World's operating commercial nuclear reactors (total of 433).

Data Analysis and Output

One of the most important aspects of the ISOE Programme is the data analysis, such as the tracking of annual occupational exposure trends. Using the ISOE database, which contains annual occupational exposure data supplied by all Participating Utilities, various exposure trends can be displayed by country, by reactor type, or by other criteria such as sister-unit grouping.

Collection of ISOE 1 and ISOE 2 Data

The ISOE 1 data for 1998 was collected and the updated ISOE 1 database, together with MADRAS version 2.0, was distributed to all participants in June 1999.

The questionnaire on ISOE 2 indicators was distributed to participating countries to complete the questionnaire for one PWR and one BWR as a test. Completed questionnaires were received from Brazil, China, Czech Republic, Finland, France, Germany, Mexico, Slovenia, Slovakia and South Africa. The ISOE Steering Group adopted a proposal regarding the implementation of ISOE 2 indicators.

Integrating ISOE 1 Data and ISOE 2 Data into one Database

The integration of ISOE 1 data and ISOE 2 data into one database will be done after the completion of the new input module for ISOE 1 and ISOE 2 data.

Further Promotion of the ISOE 3 Database

The European Technical Centre prepared a short summary of data currently contained in the ISOE 3 database. The NEA Secretariat will prepare an ISOE Information Sheet on the status.

ISOE Technical Publications

The following publications were released in 1999:

- The ISOE Annual Report 1997 was published and distributed in June 1999.
- The ISOE Annual Report 1998 was published and distributed in October 1999.

The following Information sheets were published during 1999:

Asian Technical Centre	
No. 9, October 1999	Replacement of Reactor Internals and Full System Decontamination at a Japanese BWR
No. 10, November1999	Experience of 1st Annual Inspection Outage in an ABWR
No. 11, October 1999	Japanese Dosimetric Results: FY 1998 Data and Trends
No. 12, October 1999	Japanese Occupational Exposure during Periodical Inspection at LWRs ended in FY 1998
European Technical Centre	
No. 20, April 1999	Preliminary European Dosimetric Results 1998
Incident Reporting Information Sheet No. 1, May 1999	Exposure Incident at Tricastin Nuclear Power Plant (France), 11 March 1999 **(restricted distribution)**
IAEA Technical Centre	
No. 2, April 1999	IAEA Publications on occupational radiation protection
No. 3, April 1999	IAEA technical co-operation projects on improving occupational radiation protection in nuclear power plants
No. 4, April 1999	Workshop on implementation and management of the ALARA principle in nuclear power plant operations, IAEA, Vienna 22 – 23 April 1998

Software Development

The quality assurance procedure on the new version of the ISOE 1 database was performed and completed by the European Technical Centre in co-operation with the North American Technical Centre.

The new version of the ISOE 1 database and MADRAS Version 2.0 was distributed together with the 1998 data to the Technical Centres and to all Participants in June 1999. A second mailing of the ISOE database, including missing data, was completed in September 1999.

Development of a new combined ISOE 1 and ISOE 2 data questionnaire in a Microsoft ACCESS environment

The European Technical Centre prepared in close co-operation with the North American Technical Centre the "Specification of new input module under ACCESS for ISOE 1 and ISOE 2 database" and the ISOE Working Group on Software Development approved it. The ETC prepared the software design description and developed the software. The new input module was distributed in summer 2000.

Organisational Structure

Modified ISOE Terms and Conditions

The Terms and Conditions had been modified in order to reflect that the OECD/NEA and the IAEA form a Joint Secretariat. These modified Terms and Conditions were approved by the ISOE Steering Group followed by the renewal of participation of the members of the ISOE Programme. With the renewal of participation in ISOE, the adopted ISOE Terms and Conditions will be valid for a period of four years, ending 31 December 2003.

Organisation and co-ordination of ISOE Web information at the Joint Secretariat and at the four ISOE Technical Centres

The joint NEA/IAEA Secretariat updated the ISOE Web information on the NEA web site. The ISOE Web information includes latest data, links to the Technical Centres and ISOE publications, such as the ISOE Annual Report and ISOE Information Sheets, which can be downloaded.

3.2 Proposed Programme of Work for 2000

The Information System on Occupational Exposure will continue working on the following ongoing tasks:

Status of Participation and of the ISOE Databases

Increase the number of Utilities and Authorities participating in the ISOE Programme.

Data Collection and Management

- Review of the ISOE 3 database current content and information management. Development of a new structure.
- Collection of ISOE 1 data using the new ISOE data input module.
- Collection of ISOE 2 data, once the input model has been developed.
- Provision, on request, of Excel files with specific data to National co-ordinators in order to help them to prepare the national ISOE nuclear power plant dossier.
- Review of information in ISOE D and reconsideration of the questionnaire content. Introduction of the new ISOE D questionnaire in the new ISOE data input module, in 2001

Documents and Reports

ISOE Annual Report 1999 – Objective to publish the report in August 2000

Technical Reports:

Report on “Radiation Protection Manager: Best Practices at Nuclear Power Plants”. This technical report is proposed to address the following topics:

- Radiation protection organisation at nuclear power plants.
- Radiation Protection Manager’s responsibilities.
- Radiation protection during normal operation.
- Regulator compliance experience with risk informed regulation and other regulatory initiatives.
- Radiation protection during refuelling outage.
- On-line maintenance experience.
- Radiation Protection Manager interface with the public and local community leaders.
- Radiation protection response to abnormal events.

- Radiation protection management of emergency response programme.
- Dose Optimisation: Internal vs. external exposure and the use of personal protective equipment.
- Recommended actions for Radiation Protection Managers preparing for future plant decommissioning.

The preparation of this report will take about 2 years and will be published in the year 2001.

Information Sheets:

Yearly Analyses

- Asian dose control status (ATC).
- Preliminary European Dosimetric Results for the year 1999 (general distribution) (ETC).
- Information on exposure data collected for 1999 (IAEATC).

Special Analyses

- Job/dose analysis (ATC).
- European Annual Outage Doses (general distribution) (ETC).
- Radiological protection actions for insulators in Nuclear Power Plants (restricted distribution) (ETC).
- Steam Generator Replacement update (general distribution) (ETC).
- Scaffolding and Servicing people doses analyses (ETC together with NEA Secretariat).
- Experience implementing risk informed regulations (NATC).
- Control rod drive maintenance dose trends at BWR (NATC).
- Shutdown cooling after steam generator replacements at PWRs (NATC).
- Dose trends with motor operated valves at CANDU plants (NATC).
- Dose Constraints: What, How, When (NEA Secretariat).
- Decommissioning trends.

International ISOE Workshop on Occupational Exposure in Nuclear Power Plants

- Organisation of the 2000 International ISOE ALARA Symposium, 4-7 April 2000, Tarragona (Spain).
- Organisation of the 2000 North American Regional ALARA Symposium, 23-27 January 2000, Orlando, Florida (USA).

Software Development

- Finalisation and distribution of the new ISOE 1 data questionnaire in a Microsoft ACCESS environment translated to different languages with the help of national co-ordinators, before the 1999 data collection.
- Definition of tabular structure for implementation of the new ISOE 2 data in the ISOE database.
- Development of the ISOE 2 input model.
- Integration of ISOE 1 and ISOE 2 data into one database (ISOEDAT).
- Modification of the data collection and retrieval software under Japanese environment to accommodate to the change in ISOE 1/2 database structure approved by the Steering Committee.
- Suggest and develop software to implement ISOE 3 data.

Web Pages

Regular update of the co-ordinated ISOE Web information at the NEA web site by the Joint Secretariat in collaboration with the ISOE Technical Centres.

The accessible web pages are:

ATC	http://www.nupec.or.jp/isoe/

ETC	http://isoe.cepn.asso.fr
IAEATC	http://www.iaea.org/ns/rasanet/programme/radiationsafety/radiationprotection/isoe/techcentreact.htm
NATC	http://hps.ne.uiuc.edu
NEA	http://www.nea.fr/html/jointptoj/isoe.html

Further Topics of Interest in Operational Radiation Protection

In addition to being a focal point for data collection and analysis, the ISOE Programme is also a broad and powerful network for direct communications between radiation protection experts at utilities and regulatory authorities alike. Discussions of ongoing issues of concern, as well as the identification and discussion of issues which may affect operational radiation protection in the near and/or mid-term future, are central parts of the ISOE Programme. Some of the issues, which were of concern during 1999, are listed here:

- Radiological engineering good practices.
- Source term reduction techniques manual.
- Official Dosimetry: Electronic vs TLD; Active vs Passive.
- Optimisation and training in RP.
- External companies responsibilities in optimisation.
- Deregulation and optimisation.

ANNEX 1

LIST OF ISOE PUBLICATIONS

Reports

1. *ISOE – Nuclear Power Plant Occupational Exposures in OECD Countries: 1969-1991*, OECD, 1993.

2. *ISOE – Nuclear Power Plant Occupational Exposures in OECD Countries: 1969-1992*, OECD, 1994.

3. ISOE – *Third Annual Report: Occupational Exposures at Nuclear Power Plants: 1969-1993*, OECD, 1995.

4. *ISOE – Fourth Annual Report: Occupational Exposures at Nuclear Power Plants: 1969-1994*, OECD, 1996.

5. *ISOE – Fifth Annual Report: Occupational Exposures at Nuclear Power Plants: 1969-1995*, OECD, 1997.

6. *ISOE – Sixth Annual Report: Occupational Exposures at Nuclear Power Plants: 1969-1996*, OECD, 1998.

7. *Work Management in the Nuclear Power Industry*, OECD, 1997 (also available in Chinese, German, Russian and Spanish).

8. *ISOE – Seventh Annual Report of the ISOE Programme: Occupational Exposures at Nuclear Power Plants: 1997*, OECD, 1999.

9. *ISOE – Eighth Annual Report of the ISOE Programme: Occupational Exposures at Nuclear Power Plants: 1998*, OECD, 1999.

ISOE Information Sheets

Asian Technical Centre	
No. 1, October 1995	Japanese Dosimetric Results: FY 1994 data
No. 2, October 1995	Japanese Occupational Exposure during Periodical Inspection at LWRs ended in FY 1994
No. 3, July 1996	Japanese Dosimetric Results: FY 1995 data
No. 4, July 1996	Japanese Occupational Exposure During Periodical Inspection at LWRs ended in FY 1995
No. 5, September 1997	Japanese Dosimetric Results: FY 1996 data
No. 6, September 1997	Japanese Occupational Exposure during Periodical Inspection at LWRs ended in FY 1996
No. 7, October 1998	Japanese Dosimetric Results: FY 1997 data
No. 8, October 1998	Japanese Occupational Exposure During Periodical Inspection at LWRs Ended in FY 1997
No. 9, October 1999	Replacement of Reactor Internals and Full System Decontamination at a Japanese BWR
No. 10, November 1999	Experience of 1^{st} Annual Inspection Outage in an ABWR
No. 11, October 1999	Japanese Dosimetric Results: FY 1998 Data and Trends
No. 12, October 1999	Japanese Occupational Exposure During Periodical Inspection at LWRs Ended in FY 1998
European Technical Centre	
No. 1, April 1994	Occupational Exposure and Steam Generator Replacement
No. 2, May 1994	The influence of Reactor Age and Installed Power on Collective Dose: 1992 data
No. 3, June 1994	First European Dosimetric Results: 1993 data
No. 4, June 1995	Preliminary European Dosimetric Results for 1994
No. 6, April 1996	Overview of the first three Full System Decontamination
No. 7, June 1996	Preliminary European Dosimetric Results for 1995
No. 9, December 1996	Reactor Vessel Closure Head Replacement
No. 10, June 1997	Preliminary European Dosimetric Results for 1996
No. 11, September 1997	Annual Individual Doses Distributions: Data Available and Statistical Biases
No. 12, September 1997	Occupational Exposure and Reactor Vessel Annealing
No. 14, July 1998	PWR Collective Dose per Job 1994-1995-1996 Data (restricted distribution)
No. 15, September 1998	PWR Collective Dose per Job 1994-1995-1996 Data (general distribution)
No. 16, July 1998	Preliminary European Dosimetric Results for 1997 (general distribution)
No. 17, December 1998	Occupational Exposure and Steam Generator Replacements, update (general distribution)
No. 18, September 1998	The Use of the Man-Sievert Monetary Value in 1997 (general distribution)
No. 19, October 1998	ISOE 3 data base – New ISOE 3 Questionnaires received (since September 1998) (restricted distribution)
No. 20, April 1999	Preliminary European Dosimetric Results 1998

IAEA Technical Centre	
No. 1, October 1995	ISOE Expert meeting
No. 2, April 1999	IAEA Publications on occupational radiation protection
No. 3, April 1999	IAEA Technical Co-operation Projects on Improving Occupational Radiation Protection in Nuclear Power Plants
No. 4, April 1999	IAEA Workshop on Implementation and Management of the ALARA Principle in Nuclear Power Plant Operations, Vienna 22-23 April 1998
North American Technical Centre	
No. 1, July 1996	Swedish Approaches to Radiation Protection at Nuclear Power Plants: NATC site visit report by Peter Knapp

ISOE Topical Session Reports

First ISOE Topical Session: December 1994	• Fuel Failure • Steam Generator Replacement
Second ISOE Topical Session: November 1995	• Electronic Dosimetry • Chemical Decontamination
Third ISOE Topical Session: November 1996	• Primary Water Chemistry and its Affect on Dosimetry • ALARA Training and Tools

ISOE International Workshop Proceedings

North American Technical Centre	
March 1997, Orlando, Florida, USA	First International ALARA Symposium
January 1999, Orlando, Florida, USA	Second International ALARA Symposium
January 2000, Orlando, Florida, USA	North-American National ALARA Symposium
European Technical Centre	
September 1998, Malmo, Sweden	First EC/ISOE 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

ANNEX 2

ISOE PARTICIPATION AS OF DECEMBER 1999

Operating Reactors

Country	Utility	Plant Name
Armenia	Armenian (Medzamor) NPP	Armenia 2
Belgium	Electrabel	Doel 1, 2, 3, 4 Tihange 1, 2, 3
Brazil	Electronuclear A/S	Angra 1
Canada	Ontario Hydro/Ontario Power Generation Hydro Quebec New Brunswick Electric Power Company	Bruce A1, A2, A3, A4, Bruce B5, B6, B7, B8 Pickering A1, A2, A3, A4 Pickering B5, B6, B7, B8 Darlington 1, 2, 3, 4 Gentilly 2 Point Lepreau
China	Guangdong Nuclear Power Joint Venture Co., Ltd Qin Shan Nuclear Power Co	Guangdong 1, 2 Qin Shan 1
Czech Republic	CEZ	Dukovany 1, 2, 3, 4
Finland	Fortum Power and Heat Oy Teollisuuden Voima Oy	Loviisa 1, 2 Olkiluoto 1, 2
France	Électricité de France	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 Cruas 1, 2, 3, 4 Dampierre 1, 2, 3, 4 Fessenheim 1, 2 Flamanville 1, 2 Golfech 1, 2 Gravelines 1, 2, 3, 4, 5, 6 Nogent 1, 2 Paluel 1, 2, 3, 4 Penly 1, 2 Saint-Alban 1, 2 Saint Laurent B1, B2 Tricastin 1, 2, 3, 4

Country	Utility	Plant Name
Germany	Energie-Versorgung Schwaben AG (EVS)	Obrigheim
	Badenwerk AG (BW)/EVS	Philippsburg 1, 2
	Bayernwerk AG (BAG)	Grafenrheinfeld
	BAG/Isar-Amperwerk AG (IAW)	Isar 1
	Ostbayrische Energieversorgungs-AG Stadtwerke München (BAG/IAW/OBAG/SWM)	Isar 2
	PreussenElektra AG (PE)	Unterweser Brokdorf Stade
	Neckarwerke AG, TWS Stuttgart	Gemeinschschafts – Kernkraftwerk Neckar, Neckarwestheim (GKN) 1, 2
	Hamburgische Elektrizitäts-Werke AG (HEW)	Brunsbüttel
	HEW and PE	Krümmel
	RWE Energie AG	Biblis A, B Mülheim-Kärlich
	Kernkraftwerke Gundremmingen Betriebsgesellschaft mbH (KGB)	Gundremmingen B, C
	Vereinigte Elektrizitätswerke Westfalen AG (VEW)	Emsland
	Gemeinschaftskernkraftwerk Grohnde GMBH	Grohnde
Hungary	Magyar Vilamos Muvek Rt	Paks 1, 2, 3, 4
Japan	Hokkaido Electric Power Co.	Tomari 1, 2
	Touhoku Electric Power Co.	Onagawa 1, 2
	Tokyo Electric Power Co.	Fukushima Daiichi 1,2,3,4, 5,6 Fukushima Daini 1,2,3,4 Kashiwazaki Kariwa 1,2,3,4,5,6,7
	Chubu Electric Power Co.	Hamaoka 1, 2, 3, 4
	Hokuriku Electric Power Co.	Shika
	Kansai Electric Power Co.	Mihama 1, 2, 3 Takahama 1, 2, 3, 4 Ohi 1, 2, 3, 4
	Chugoku Electric Power Co.	Shimane 1, 2
	Shikoku Electric Power Co.	Ikata 1, 2, 3
	Kyushu Electric Power Co.	Genkai 1, 2, 3, 4 Sendai 1, 2

Country	Utility	Plant Name
Japan (cont.)	Japan Atomic Power Co. Japan Nuclear Cycle Development Institute (JNC)	Tokai 2 Tsuruga 1, 2 Fugen ATR
Korea	Korean Electric Power Corp.	Wolsong 1, 2, 3, 4 Kori 1, 2, 3, 4 Ulchin 1, 2, 3 Yonggwang 1, 2, 3, 4
Lithuania	Ignalina State Nuclear Power Plant	Ignalina 1, 2
Mexico	Comisiòn Federal de Electricidad	Laguna Verde 1, 2
Netherlands	N.V. EPZ	Borssele
Romania	Societatea Nationala Nuclearelectrica	Cernavoda 1
Slovakia	Jaslovské Bohunice NPP	Bohunice 1, 2, 3, 4
Slovenia	Krsko Nuclear Power Plant	Krsko 1
South Africa	ESKOM	Koeberg 1, 2
Spain	UNESA	Almaraz 1, 2 Asco 1, 2 Cofrentes Santa Maria de Garona Trillo Vandellos 2 Jose Cabrera
Sweden	Barsebäck Kraft AB Forsmarks Kraftgrupp AB OKG AB Vattenfall AB	Barsebäck 1, 2 Forsmark 1, 2, 3 Oskarshamn 1, 2, 3 Ringhals 1, 2, 3, 4
Switzerland	Kernkraftwerk Leibstadt AG (KKL) Forces Motrices Bernoises (FMB) Nordostschweizerische Kraftwerke AG (NOK) Kernkraftwerk Gosgen-Daniken (KGD)	Leibstadt Muhleberg Beznau 1, 2 Gosgen

Country	Utility	Plant Name
Ukraine	Department of Nuclear Energy of the Ministry of Energy	Chernobyl 3 Khmelnitski 1 Rovno1,2,3 South Ukraine 1,2,3 Zaporozhe 1,2,3,4,5,6
United Kingdom	Nuclear Electric	Sizewell B
United States	American Electric Power	D.C. Cook 1, 2
	Arizona Public Service Co.	Palo Verde 1, 2, 3
	Baltimore Gas & Electric Co.	Calvert Cliffs 1, 2
	Boston Edison Company	Pilgrim 1
	Carolina Power and Light Co.	H. B. Robinson 2
	Commonwealth Edison Co.	Braidwood 1, 2 Byron 1, 2 Dresden 2, 3 LaSalle County 1, 2 Quad Cities 1, 2
	Consumers Energy	Palisades 1
	FirstEnergy Corporation	Beaver Valley 1,2 Davis Besse 1 Perry 1
	GPU Nuclear Corporation	TMI 1 Oyster Creek 1
	Illinois Power Co.	Clinton 1
	New York Power Authority	Indian Point 3
	Pacific Gas and Electric Company	Diablo Canyon 1, 2
	PECO Nuclear	Limerick 1, 2 Peach Bottom 2, 3
	PPL Corporation	Susquehanna 1, 2
	South Carolina Electric Co.	Virgil C. Summer 1
	Southern California Edison Co.	San Onofre 2, 3
	TXU Electric	Comanche Peak 1, 2
	Wisconsin Electric Power Co	Point Beach 1, 2

PARTICIPATING UTILITIES
Definitively Shutdown Reactors

Country	Utility	Plant Name
France	Électricité de France	Bugey 1 Chinon A1, A2, A3 Chooz A St. Laurent A1, A2
Germany	PreussenElektra AG (PE) Arbeitsgemeinschaft Versuchsreaktor AVR	Würgassen Jülich
Italy	Ente Nazionale per l'Energia Elettrica	Caorso Garigliano Latina (GCR) Trino
Japan	Japan Atomic Power Co.	Tokai 1
Netherlands	NCGKN	Dodewaard
Spain	UNESA	Vandellos 1
United States	Southern California Edison Co. GPU Nuclear Corporation Commonwealth Edison Co. Pacific Gas and Electric Company PECO Nuclear Consumers Power Company	San Onofre 1 TMI 2 Dresden 1 Zion 1, 2 Humboldt Bay 1 Peach Bottom 1 Big Rock Point 1

PARTICIPATING REGULATORY AUTHORITIES

Country	Authority
Armenia	Armenian Nuclear Regulatory Authority (ANRA)
Belgium	Service de la sécurité technique des installations nucléaires
Bulgaria	Committee on the Use of Atomic Energy for Peaceful Purposes
Canada	Canadian Nuclear Safety Commission
China	China National Nuclear Corporation (CNNC)
Czech Republic	State Office for Nuclear Safety
Finland	Säteilyturvakeskus (STUK)
France	Ministère du travail, et des affaires sociales, Represented by the Office de Protection contre les Rayonnements Ionisants (OPRI)
Germany	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit
Italy	Agenzia Nazionale per la Protezione dell'Ambiente (ANPA)
Japan	Science and Technology Agency (STA), and Agency of Natural Resources and Energy of the Ministry of International Trade and Industry (MITI)
Korea	Ministry of Science and Technology (MOST) Korea Institute of Nuclear Safety (KINS)
Mexico	Commision Nacional de Seguridad Nuclear y Salvguardras
Netherlands	Ministerie van Sociale Zaken en Werkgelegenheld
Pakistan	Pakistan Atomic Energy Commission
Romania	National Commission for Nuclear Activities Control
Slovakia	State Health Institute of the Slovak Republic
Slovenia	Slovenian Nuclear Safety Administration (SNSA)
Spain	Consejo de Seguridad Nuclear
Sweden	Statens strålskyddsinstitut (SSI)
Switzerland	Office Fédéral de l'Énergie, Division principale de la Sécurité des Installations Nucléaires, DSN
United Kingdom	Nuclear Installations Inspectorate
United States	U.S. Nuclear Regulatory Commission (US NRC)

ISOE TECHNICAL CENTRES

European Region (ETC)	Centre d'étude sur l'évaluation de la protection dans le domaine nucléaire (CEPN), Fontenay-aux-Roses, France
Asian Region (ATC)	Nuclear Power Engineering Corporation (NUPEC), Tokyo, Japan
IAEA Region (IAEATC)	International Atomic Energy Agency (IAEA), Vienna, Austria Agence Internationale de l'Energie Atomique (AIEA), Vienne, Autriche
North American Region(NATC)	University of Illinois, Champagne-Urbanna, Illinois, U.S.A.

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

INTERNATIONAL COOPERATION

- European Commission (EC)
- World Association of Nuclear Operators, Paris Centre (WANO PC)

ANNEX 3

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