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ISOE

INFORMATION SYSTEM ON OCCUPATIONAL EXPOSURE

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NEA

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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- 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), Korea (12th December 1996) and the Slovak Republic (14 December 2000). 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 28 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, Slovak Republic, 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 a communications network connects 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 Eleventh Annual Report of the ISOE Programme, 2001, as it is given here, represents the status of the ISOE Programme at the end of December 2001.

As of December 2001, the ISOE database includes occupational exposure data from a total of 461 reactors from 29 countries representing 72 utilities. Some 93% of the world's operating commercial nuclear reactors participate in the ISOE programme (407 from a total of 438), as well as the regulatory authorities of 25 countries. During 2001, the Bulgarian Nuclear Power Plant Kozloduy joined the ISOE Programme with 6 operating WWER reactors. In Korea, the new reactor Ulchin 4 came into operation. On 30 January 2002, the Japanese BWR Onagawa 3 started its commercial operation.

Since the beginning of the ISOE programme, the annual average dose per reactor has undergone a remarkable downward trend, which can be explained by improved communication and experience exchange between radiation protection managers of nuclear power plants world wide as well as by improved work management procedures prepared and published through the ISOE system. Although the data show some annual fluctuations, the average annual dose is still decreasing, for pressurised water reactors (PWR) from 0.96 man·Sv in the year 2000 to 0.91 man·Sv in 2001, for boiling water reactors (BWR) from 1.62 man·Sv in 2000 to 1.37 man·Sv in 2001. For CANDU reactors the dose decreased slightly from 0.92 man·Sv in 2000 to 0.89 man·Sv in 2001. The average collective dose per reactor for LWGRs (RBMK), represented in the database by only two units, decreased from 5.94 man·Sv in 2000 to 3.14 man·Sv in 2001, a value still higher than for all other types of reactors.

The ISOE database contains also dose data for reactors which are shut-down or in some stage of decommissioning. As the reactors represented in the database are of different type and size, and are, in general, at different phases of their decommissioning programmes, it is very difficult to identify clear dose trends and to draw definitive conclusions.

In 2001, 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 a short abstract of an interesting study on doses associated with waste handling in nuclear power plants.

In February 2001, the International ALARA Symposium was held in Anaheim, California, followed, in April 2002, by the third ISOE European Workshop on Occupational Exposure Management at Nuclear Power Plants in Portoroz, Slovenia. 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.

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

Finally, the ISOE Programme made significant progress during 2001, particularly in terms of data analysis and output. In order to promote further the ISOE System and to demonstrate its value for applied radiation protection in nuclear power plants, the report ***ISOE – Information System on Occupational Exposure, Ten Years of Experience, OECD, 2002*** was published in March 2002. The software to run the ISOE database was extended to easily produce and distribute ISOE 3 reports. Details of this progress as well as the programme of work for 2002 are provided in Chapter 3.

SYNTHÈSE DU RAPPORT

Le onzième rapport annuel du Programme ISOE a pour objet de faire le point sur l'avancement de ce programme à fin décembre 2000.

À cette date, la base de données ISOE comportait les données concernant les expositions professionnelles de 461 réacteurs nucléaires situés dans 29 pays et appartenant à 72 exploitants. Près de 93 % des réacteurs commerciaux en fonctionnement dans le monde (407 réacteurs sur un total de 438), ainsi que les Autorités de 25 pays, participent au programme ISOE. Durant l'année 2001, la centrale nucléaire de Kozloduy en Bulgarie a rejoint le Programme ISOE avec 6 réacteurs de type VVER en exploitation. En Corée, un nouveau réacteur, Ulchin 4, a été mis en service. Le 30 janvier 2002, le réacteur japonais à eau bouillante Onagawa 3 a commencé son exploitation commerciale.

Depuis le début du programme ISOE, la dose collective moyenne par réacteur a diminué de façon notable, ce qui peut pour partie s'expliquer par l'impact du système ISOE en termes d'amélioration de la communication et des échanges de retour d'expérience entre les *responsables* de la radioprotection des centrales nucléaires du monde entier ainsi que par l'amélioration des procédures de travail suite aux publications du système ISOE. Bien que les données montrent quelques fluctuations annuelles, la dose collective moyenne diminue toujours, pour les réacteurs à eau pressurisée (REP) passant de 0,96 homme.Sv en 2000 à 0,91 homme.Sv en 2001, pour les réacteurs à eau bouillante (REB) passant de 1,62 homme.Sv en 2000 à 1,37 homme.Sv en 2001. Pour des réacteurs CANDU la dose a légèrement diminué de 0,92 homme.Sv en 2000 à 0,89 homme.Sv en 2001. La dose collective moyenne par réacteur pour LWGRs (RBMK), représenté dans la base de données par seulement deux réacteurs, a diminué de 5,94 homme.Sv en 2000 à 3,14 homme.Sv en 2001, valeur qui reste plus élevée que celles des autres types de réacteurs.

La base de données ISOE contient également des données de dose collective concernant les réacteurs en arrêt à froid ou en phase de démantèlement. Cependant, les réacteurs présents dans la base de données sont de type et de puissance très différents et sont, en général, à des stades différents de leur programme de démantèlement. Pour ces raisons, il est très difficile de mettre en évidence des tendances de dose et de tirer des conclusions.

En 2001, les centres techniques ont publié plusieurs « ISOE information sheets » pour faciliter les échanges de retour d'expérience entre les participants ISOE. Afin de favoriser la préparation et la distribution de ces "ISOE information sheets", ce rapport présente le résumé d'une étude intéressante sur les doses associées à la gestion des déchets dans les centrales nucléaires.

En février 2001, le symposium international ALARA s'est tenu à Anaheim, Californie, suivi, en avril 2002, par le troisième séminaire ISOE européen sur la gestion des expositions professionnelles dans les centrales nucléaires à Portoroz, Slovénie. L'objectif commun de ces Séminaires était de favoriser les échanges sur la mise en œuvre d'ALARA et des problèmes liés aux expositions professionnelles, et de partager les leçons tirées du retour d'expérience. La large participation internationale à ces séminaires montre l'intérêt porté aux problèmes de radioprotection et à ALARA.

Un chapitre particulier résume les développements récents et les principaux événements dans chacun des pays participants à ISOE.

En conclusion, le programme ISOE a fait des progrès significatifs en 2001, en particulier en ce qui concerne l'analyse des données et les publications. Afin de promouvoir encore plus le système ISOE et de démontrer sa valeur pour la radioprotection appliquée aux centrales nucléaires, le rapport ***ISOE – Information System on Occupational Exposure, Ten Years of Experience, OECD, 2002*** a été publié en mars 2002. Le logiciel permettant la consultation de la base de données ISOE a été étendu afin de facilement générer et distribuer des rapports ISOE 3. Des détails sur ces progrès ainsi que sur le programme de travail pour l'année 2002 sont fournis dans le chapitre 3.

ZUSAMMENFASSENDE ÜBERSICHT

Der vorliegende elfte ISOE Jahresbericht 2001 gibt den Stand des ISOE Programms Ende Dezember 2001 wieder.

Die ISOE Datenbank umfaßte Ende 2001 Daten zur beruflichen Strahlenexposition in insgesamt 461 Kernkraftwerken von 72 Energieversorgungsunternehmen aus 29 Ländern. Damit nehmen etwa 93% der weltweit in Betrieb befindlichen kommerziellen Kernkraftwerke (407 von insgesamt 438), sowie die Genehmigungs- und Aufsichtsbehörden aus 25 Ländern am ISOE Programm teil. Im Jahre 2001 trat das bulgarische Krenkraftwerk Kozloduy dem ISOE Programm, mit 6 in Betrieb befindlichen WWER Reaktoren bei. In Korea ging der neue Reaktor Ulchin 4 ans Netz. Am 30. Januar 2002 wurde der japanische Siedewasserreaktor Onagawa 3 in Betrieb genommen.

Seit Anbeginn des ISOE Programms zeigte die mittlere jährliche Kollektivdosis pro Reaktor einen bemerkenswerten Abwärtstrend, der durch eine verbesserte Kommunikation und Erfahrungsaustausch zwischen Strahlenschutzexperten der Kernkraftwerke weltweit sowie durch ein, mit Hilfe des ISOE Systems, vorbereitetes und veröffentlichtes verbessertes Arbeitsmanagement erklärt werden kann. Obwohl die Daten jährlichen Schwankungen unterworfen sind, nimmt die mittlere jährliche Kollektivdosis pro Reaktor ab, für Druckwasserreaktoren (DWR) von 0,96 man·Sv im Jahre 2000 auf 0,91 man·Sv im Jahre 2001, für Siedewasserreaktoren (SWR) von 1,62 man·Sv (2000) auf 1,37 man·Sv (2001). Die mittlere jährliche Kollektivdosis für CANDU Reaktoren fiel von 0,92 man·Sv (2000) auf 0,89 man·Sv (2001). Die mittlere jährliche Kollektivdosis für Leichtwassergekühlte Graphitmoderierte Reaktoren (LWGR bzw. RBMK Reaktoren), in der Datenbank mit derzeit zwei Reaktoren vertreten, fiel von 5,94 man·Sv im Jahre 2000 auf 3,14 man·Sv im Jahre 2001, ein Wert, der deutlich über den gemittelten Werten aller anderen Reaktortypen liegt.

Die ISOE Datenbank enthält auch Dosiswerte von stillgelegten Reaktoren. Da sich die in der Datenbank vertretenen Reaktoren sehr stark in Typ und Leistung unterscheiden und sich zudem in unterschiedlichen Phasen ihrer Stillegungs- oder Rückbauprogramme befinden, ist es schwierig Dosistrends zu identifizieren oder definitive Schlußfolgerungen zu ziehen.

Die ISOE Technischen Zentren veröffentlichten im Jahre 2001 eine Reihe von ISOE Informationsblättern, um Erfahrungen zwischen ISOE Teilnehmern auszutauschen. Um die Vorbereitung und Verteilung weiterer ISOE Informationsblättern anzuregen, enthält dieser Jahresbericht eine kurze Zusammenfassung einer interessanten Studie über die Dosis bei der Abfallbehandlung in Kernkraftwerken.

Im Februar 2001 fand das internationale ALARA Symposium in Anaheim (Kalifornien, USA) statt. Im April 2002 wurde der dritte Europäische ISOE Workshop zum Thema „Berufliche Strahlenexposition in Kernkraftwerken“ in Portoroz (Slovenien) gehalten. Diese Treffen haben das gemeinsame Ziel, Erfahrungen und gelernte Lektionen bei der Durchführung von ALARA Programmen sowie bei der Lösung anderer Probleme der beruflichen Strahlenexposition auszutauschen sowie über die gezogenen Schlussfolgerungen zu berichten.

Aktuelle Entwicklungen und wichtige Ereignisse in ISOE Teilnehmerländern werden in einem ausführlichen Kapitel des Berichts dargestellt.

Kapitel 3 faßt die im Jahre 2001 erzielten Fortschritte im ISOE Arbeitsprogramm, insbesondere in den Bereichen Datenanalyse und Datendarstellung, zusammen. Um das ISOE System weiter zu fördern und seinen Wert für den angewandten Strahlenschutz in Kernkraftwerken zu demonstrieren, wurde im März 2002 der Bericht ***ISOE – Information System on Occupational Exposure, Ten Years of Experience, OECD, 2002*** veröffentlicht. Die Software zur Bearbeitung der ISOE Daten wurde um ein Modul zur schnellen Anfertigung und Verteilung von ISOE 3 Berichten erweitert. Schliesslich wird ein Ausblick auf das ISOE Arbeitsprogramm 2002 gegeben.

正文摘要

正如本摘要所述，“ISOE计划第11个年度报告，2001年”介绍了ISOE计划截至2001年12月底的情况。

截至2001年12月，ISOE数据库载有取自29个国家72个电力公司的共461座堆的职业照射数据。除25个国家的监管部门外，约93％的世界运行中的商用核反应堆（总数438座中的407座）也参加了该ISOE计划。在2001年期间，保加利亚Kozloduy核动力厂的6座运行中的WWER反应堆加入了ISOE计划。在韩国，新反应堆Ulchin 4号投入运行。2002年1月30日，日本的BWR Onagawa 3号开始其商业运行。

自ISOE计划开始以来，每座堆的年平均剂量一直有明显的下降趋势。这可用以下两点来解释，即核动力厂辐射防护经理之间的联系和经验交流有所改善以及有了通过ISOE系统编写和出版的经过改进的工作管理程序。虽然数据显示出某些年度的波动，但平均年剂量仍在下降，对压水堆（PWR）而言从2000年的0.96人·希下降到2001年的0.91人·希；沸水堆（BWR）从2000年的1.62人·希下降到2001年的1.37人·希。对CANDU反应堆而言，这种剂量从2000年的0.92人·希稍微下降到2001年0. 89人·希。对在该数据库中仅被两座堆所代表的LWGR（RBMK）而言，每座堆的平均集体剂量从2000年的5.94人·希下降到2001年3.14人·希，此值仍高于所有其他类型的反应堆。

ISOE数据库也含有已关闭或处于退役的某种阶段的反应堆的数据。由于该数据库中所涉及的这些反应堆属于不同类型和规模，并且总体上处于退役计划的不同阶段，因此，很难确定其清楚的剂量趋势和得出明确的结论。

2001年，技术中心发表了若干ISOE信息单，以便在ISOE参与者之间交流经验。为进一步促进这种信息单的编写和分发，本年度报告载有关于与核动力厂废物装卸作业有关的剂量的令人感兴趣的研究报告的简短摘要。

2001年2月，在加利福尼亚州的Anaheim召开了国际ALARA专题讨论会，之后于2002年4月在斯洛文尼亚的Portoroz召开了第三次ISOE欧洲核动力厂职业照射管理讲习班。这些讨论会和讲习班的共同目标是，交流ALARA执行和职业照射问题方面的经验，共享所汲取的教训。国际方面对这些会议的广泛参与，表明了对ALARA和职业照射问题的兴趣。

在扩编的一章里总结了ISOE参与国中最近的进展和主要事件。

总之，ISOE计划在2001年取得了重要进展，尤其是在数据分析和输出方面。为了进一步促进ISOE系统和证明其对核动力厂中应用辐射防护的价值，2002年3月印发了“**ISOE——有关职业照射信息系统的10年经验，OECD，2002年**”的报告。已扩展了ISOE数据库运行软件，以易于ISOE 3报告的编写和分发。这方面的进展和2002年工作计划的细节载于第3章。

要　約

この第 11 年次総括報告書は、2001 年 12 月末における ISOE プログラムの状況をまとめたものである。

2001 年 12 月末現在、ISOE データベースには 29 ヶ国から 72 の電気事業者の合計 461 基の原子力発電所に関する職業被ばくデータが含まれている。そして、ISOE に参加している運転中商用炉 407 基は、全世界の運転中商用炉（総計 438 基）の 93%を占めており、また、25 ヶ国からの規制当局が参加している。2001 年には、ブルガリアの Kozloduy 原子力発電所の運転中 WWER 原子炉 6 基が ISOE プログラムに参加した。韓国では、Ulchin4 号が運転開始した。日本は女川 3 号が 2002 年 1 月 30 日に商業運転を開始した。

ISOE プログラム開始以来、原子炉 1 基当たりの年間平均線量は顕著な減少傾向で推移してきている。これは、世界中の原子力発電所の放射線防護管理者間における連絡体系が確立され、経験を交換できるようになったことや、改善された作業管理手順が ISOE システムを通して作成・発行されたことの成果と言える。データは年度により変動はあるものの、年間平均線量は依然として減少し続けている。2001 年及び前年 2000 年の線量実績を各炉型別にみると、原子力発電所 1 基当たりの 2001 年の平均線量当量は前年の値に対し、PWR で 0.96 人･Sv から 0.91 人･Sv､BWR で 1.62 人･Sv から 1.37 人･Sv といずれも減少している。CANDU 炉では 0.92 人･Sv から 0.89 人･Sv と僅かな減少をしている。ISOE データベースには 2 基のみが登録されている LWGR 軽水冷却黒鉛炉（RBMK）は、5.94 人･Sv から 3.14 人･Sv に減少しているものの、他の炉型の原子力発電所よりも依然として高い値を示している。

ISOE データベースには、冷温停止または廃止措置の異なった段階にある原子炉のデータも含まれている。データベースに登録されている炉型や容量が異なっており、また、全般的に廃止措置計画の異なった段階にあることから、被ばく傾向を明確に把握し、結論を引き出すことは難しい。

2001 年に技術センターは ISOE 参加者間で被ばくに関する経験を交換するために、数多くの Information Sheet を発行した。Information Sheet の作成と配布を更に促進するために、この年次報告書では、原子力発電所における廃棄物の取扱いに関連した線量についての最近の興味深い研究の概要を紹介している。

2001 年 2 月のカリフォルニアのアナハイムにおける国際 ALARA シンポジウムに引き続いて、2002 年 4 月にスロベニアの Portoroz にて原子力発電所における職業被ばくに関する第 3 回 ISOE ヨーロッパワークショップが開催された。これらワークショップは ALARA の実施と職業被ばくの問題における経験を伝え合い、学んだ教訓を分かち合うことを共通の目的に開催された。ワークショップへの参加者が国際的で広範に渡ることから、ALARA と職業被ばくの問題に対する関心がうかがえる。

ISOE 参加国における最近の発展と主要事象の要約が、章を追加して記載されている。

最後に、2001 年の ISOE プログラムは、特にデータの分析と出力の点で大きく進展した。ISOE システムを更に促進させ、原子力発電所における放射線防護分野での重要性を実証すべく、ISOE 報告書「Information System on Occupational Exposure, Ten Years of Experience, OECD,2002 」を 2002 年 3 月に出版した。ISOE データベースを運用するためのソフトウェアに関しては、ISOE3 レポートを容易に生成し配布できるように拡張された。この進展の詳細は 2002 年の作業プログラムと共に第 3 章に記されている。

ОСНОВНЫЕ ИТОГИ

Одиннадцатый ежегодный доклад Программы ИСПО - за 2001 год, - являющийся предметом настоящего документа, отражает положение дел с осуществлением Программы ИСПО на конец декабря 2001 года.

По состоянию на декабрь 2001 года база данных ИСПО включает данные о профессиональном облучении в общей сложности по 461 реактору в 29 странах, принадлежащему 72 энергопредприятиям. В Программе ИСПО участвуют приблизительно 93% действующих коммерческих ядерных реакторов мира (407 из общего числа 438), а также регулирующие органы 25 стран. В течение 2001 года к Программе ИСПО присоединилась Болгарская АЭС "Козлодуй" с 6 действующими реакторами ВВЭР. В Корее введен в эксплуатацию новый реактор Улчин 4. 30 января 2002 года начата коммерческая эксплуатация японского BWR Онагава 3.

С начала осуществления Программы ИСПО наблюдается устойчивая тенденция к снижению среднегодовой дозы в расчете на реактор, что можно объяснить улучшенной связью и обменом опытом между руководителями служб радиационной защиты на атомных электростанциях во всем мире, а также улучшенными процедурами управления работами, которые были подготовлены и опубликованы через систему ИСПО. Хотя данные свидетельствуют о некоторых ежегодных колебаниях, среднегодовая доза по-прежнему снижается: для реакторов с водой под давлением (PWR) – с 0,96 чел.·Зв в 2000 году до 0,91 чел.·Зв в 2001 году, для реакторов с кипящей водой (BWR) – с 1,62 чел.·Зв в 2000 году до 1,37 чел.·Зв в 2001 году. Для реакторов CANDU доза несколько снизилась – с 0,92 чел.·Зв в 2000 году до 0,89 чел.·Зв в 2001 году. Средняя коллективная доза в расчете на реактор для LWGR (РБМК), которые в базе данных представлены только двумя блоками, снизилась с 5,94 чел.·Зв в 2000 году до 3,14 чел.·Зв в 2001 году, однако эта величина все еще выше, чем по всем другим типам реакторов.

База данных ИСПО содержит также данные о дозах для реакторов, которые находятся в состоянии останова или на каком-либо этапе снятия с эксплуатации. Поскольку эти представленные в базе данных реакторы относятся к различным типам и имеют различную мощность и вообще находятся на различных стадиях программ снятия с эксплуатации, определить четкие тенденции дозы и сделать категоричные выводы весьма трудно.

В 2001 году Техническими центрами в целях обмена опытом между участниками ИСПО опубликован ряд информационных бюллетеней ИСПО. В интересах дальнейшего содействия подготовке и распространению таких информационных бюллетеней в данном Ежегодном докладе содержится краткий реферат интересного исследования доз, связанных с обращением с отходами на атомных электростанциях.

В феврале 2001 года в Анахейме, шт. Калифорния, был проведен международный симпозиум по принципу АЛАРА, а затем в апреле 2002 года в Портороже, Словения, - третий европейский семинар-практикум ИСПО по управлению дозами профессионального облучения на АЭС. Общая цель этих семинаров-практикумов заключалась в распространении опыта осуществления принципа АЛАРА, обмене информацией по вопросам профессионального облучения и информацией об извлеченных уроках. Широкое международное участие в этих семинарах-практикумах свидетельствует об интересе к вопросам АЛАРА и профессионального облучения.

Большая глава посвящена краткому изложению последних и важных событий в странах – участницах ИСПО.

И в заключение, в 2001 году Программа ИСПО добилась существенного прогресса, особенно в сфере анализа данных и подготовки данных. В целях дальнейшего содействия развитию системы ИСПО и демонстрации ее ценности для прикладной радиационной защиты на атомных электростанциях в марте 2002 года был опубликован доклад ***ИСПО – Информационная система по профессиональному облучению, десятилетний опыт, ОЭСР, 2002 год***. Программное обеспечение для управления базой данных ИСПО было расширено и позволяет эффективно подготавливать и распространять доклады ИСПО 3. Подробная информация об этих достижениях, а также программа работы на 2002 год представлены в главе 3.

RESUMEN EJECUTIVO

El onceavo Informe anual del Programa ISOE, 2001, representa el estado del Programa ISOE al final de Diciembre 2001.

A esta fecha, la base de datos ISOE incluye datos de dosis ocupacionales de un total de 461 reactores de 29 países representando a 72 empresas eléctricas. Aproximadamente el 93% de los reactores comerciales en operación en el mundo participan en el Programa ISOE (407 de un total de 438), así como las autoridades reguladoras de 25 países. Durante el año 2001, la central nuclear búlgara de Kozloduy se ha incorporado al Programa ISOE con 6 reactores WWER en operación. En Corea, el nuevo reactor Ulchin 4 entro en operación. El 30 de Enero del 2002, el reactor BWR japonés Onagawa 3 también inicio su operación comercial.

Desde el comienzo del Programa ISOE, la dosis media anual por reactor ha tenido una significativa tendencia decreciente, que puede estar motivada por la mejora de la comunicación e intercambio de experiencias entre los responsables de la protección radiológica de las centrales nucleares a lo largo del mundo, así como a la implantación de los procedimientos de gestión de los trabajos elaborados y publicados en el Programa ISOE. Aunque los datos muestran algunas fluctuaciones anuales, la dosis media anual sigue decreciendo: para reactores de agua a presión (PWR) de 0,96 persona·Sv en el año 2000 a 0,91 persona·Sv en el año 2001; para reactores de agua en ebullición (BWR) de 1,62 persona·Sv en el año 2000 a 1,37 persona·Sv en el año 2001. Para reactores CANDU las dosis han disminuido ligeramente de 0,92 persona·Sv en el año 2000 a 0,89 persona·Sv en el año 2001. La dosis colectiva media para reactores LWGRs (RBMK), representados en la base de datos por solamente dos unidades, disminuyo desde 5,94 hombre·Sv en el año 2000 a 3,14 hombre·Sv en el año 2001, un valor todavía más alto que para los otros tipos de reactores.

La base de datos del ISOE también contiene datos de dosis de reactores que están parados o en alguna fase de desmantelamiento. Como los reactores representados en la base de datos son de distintos tamaños y tipos, y están por lo general, en distintas fases de desmantelamiento, es muy difícil identificar tendencias claras de la evolución de las dosis y extraer conclusiones definitivas.

En el año 2001, los Centros técnicos publicaron un numero de Hojas Informativas para promocionar el intercambio de experiencias entre los participantes en ISOE. Para promover la preparación y distribución de estas Hojas Informativas, este Informe anual contiene un breve resumen de un interesante estudio sobre las dosis asociadas a la gestión de residuos en las centrales nucleares.

En Febrero del 2001, el Simposio Internacional ALARA tuvo lugar en Anaheim, California, seguido, en Abril del 2002, por el tercer Seminario Europeo ISOE sobre la gestión de las dosis ocupacionales en centrales nucleares en Portoroz, Eslovenia. El objetivo común de ambos Seminarios fue el de intercambiar experiencias en la implantación del principio ALARA y en temas relacionados con las dosis ocupacionales, así como compartir lecciones aprendidas. La amplia participacion internacional a los mismos demuestran el interés en los temas ALARA y de exposiciones ocupacionales.

Un amplio capítulo resumen los avances y acontecimientos mas destacados en los países que participen en ISOE.

Con objeto de promocionar más el Programa ISOE y demostrar su valor para protección radiológica aplicada en centrales nucleares el informe ISOE – Information System on Occupational Exposure, Ten Years of Experience, OECD, 2002 fue publicado en Marzo del año 2002.

Finalmente, el Programa ISOE ha realizado avances significativos durante el año 2001, especialmente en los temas de análisis de datos y generación de informes. El programa de ordenador para gestionar la base de datos ejecutar ha sido revisado para generar y distribuir con facilidad informes ISOE 3. Los detalles de esta revisión, así como del programa de trabajo para el 2002, se recogen en el Capitulo 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 December 2001, the ISOEDAT database includes occupational exposure data from a total of 461 reactors (407 operating and 54 in cold-shutdown or some stage of decommissioning) from 29 countries representing 72 utilities. In addition, regulatory authorities from 25 countries participate in the ISOE Programme. The participation of 407 operating commercial nuclear reactors in the ISOE programme represents some 93% of the World's operating commercial nuclear reactors (total of 438). 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.

During 2001, the Bulgarian Nuclear Power Plant Kozloduy joined the ISOE Programme with 6 operating WWER reactors. In Korea, the new reactor Ulchin 4 came into operation. On 30 January 2002, the Japanese BWR Onagawa 3 started its commercial operation.

Table 1. **Participation summary**

Operating reactors participating in ISOE							
Country	**PWR**	**BWR**	**PHWR**	**GCR**	**LWGR**	**FBR**	**Total**
Armenia	1	–	–	–	–	–	1
Belgium	7	–	–	–	–	–	7
Brazil	2	–	–	–	–	–	2
Bulgaria	***6***	***–***	***–***	***–***	***–***	***–***	***6***
Canada	–	–	21	–	–	–	21
China	3	–	–	–	–	–	3
Czech Republic	4	–	–	–	–	–	4
Finland	2	2	–	–	–	–	4
France	58[1]	–	–	–	–	–	58
Germany	14	6	–	–	–	–	20
Hungary	4	–	–	–	–	–	4
Japan	23	29	1	–	–	–	53
Korea	12	–	4	–	–	–	16
Lithuania	–	–	–	–	2	–	2
Mexico	–	2	–	–	–	–	2
Netherlands	1	–	–	–	–	–	1
Romania	–	–	1	–	–	–	1
Russian Federation	13	–	–	–	–	1	14
Slovakia	6	–	–	–	–	–	6
Slovenia	1	–	–	–	–	–	1
South Africa	2	–	–	–	–	–	2
Spain	7	2	–	–	–	–	9
Sweden	3	8	–	–	–	–	11
Switzerland	3	2	–	–	–	–	5
Ukraine	13	–	–	–	–	–	13
United Kingdom	1	–	–	–	–	–	1
United States	27	16	–	–	–	–	43
Total	**213**	**67**	**27**	**–**	**2**	**1**	**310**

Operating reactors not participating in ISOE, but included in the ISOE database							
Country	**PWR**	**BWR**	**PHWR**	**GCR**	**LWGR**	**FBR**	**Total**
Pakistan	–	–	1	–	–	–	1
United Kingdom	–	–	–	34	–	–	34
United States	42	20	–	–	–	–	62
Total	**42**	**20**	**1**	**34**	**–**	**–**	**97**

Total number of operating reactors included in the ISOE database							
	PWR	**BWR**	**PHWR**	**GCR**	**LWGR**	**FBR**	**Total**
Total	**255**	**87**	**28**	**34**	**2**	**1**	**407**

1. Two of these 58 reactors (Civaux 1 and Civaux 2) are still in the pre-operational phase.

Table 1. **Participation summary** (continued)

Definitively shutdown reactors participating in ISOE						
Country	**PWR**	**BWR**	**PHWR**	**GCR**	**LWGR**	**Total**
France	1	–	–	5	–	6
Germany	–	1	–	1	–	2
Italy	1	2	–	1	–	4
Japan	–	–	–	1	–	1
Netherlands	–	1	–	–	–	1
Russian Federation	2	–	–	–	2	4
Spain	–	–	–	1	–	1
Sweden	–	1	–	–	–	1
Ukraine	–	–	–	–	1	1
United States	4	3	–	1	–	8
Total	**8**	**8**	**–**	**10**	**3**	**29**

Definitively shutdown reactors not participating in ISOE but included in the ISOE database						
Country	**PWR**	**BWR**	**PHWR**	**GCR**	**LWGR**	**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**	**PHWR**	**GCR**	**LWGR**	**Total**
Total	**20**	**13**	**2**	**16**	**3**	**54**

Number of **Utilities** Officially Participating:	**72**
Number of **Countries** Officially Participating:	**29**
Number of **Authorities** Officially Participating:	**25**

2. OCCUPATIONAL DOSE STUDIES, TRENDS AND FEEDBACK

One of the most important aspects of the ISOE Programme is 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.

2.1 Occupational exposure trends in operating reactors

The annual average dose per unit was constantly decreasing over the time period covered in the ISOE database, reaching a fairly low level in 2001. Yearly variations around these low levels of doses can be made responsible for slight increases in dose, however, in general, a downward dose trend can still be observed.

In most ISOE participating countries, the average dose per unit for PWRs could be reduced, in 2001, or stayed fairly constant. As can be seen in section 2.5, part of this reduction is due to the implementation of work management principles and the reduction in outage duration.

In 2001, 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.

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 2001 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. Figure 5 shows the trends in average collective dose per reactor for the years 1991 to 2001 by reactor type. Figure 6 gives the average collective dose per LWGR for the years 1984-2001.

Table 2. **Evolution of average annual dose per unit, by country and reactor type, from 1999-2001 (man·Sv)**

	PWR			BWR			CANDU		
	1999	2000	2001	1999	2000	2001	1999	2000	2001
Armenia	1.58	0.96	0.66						
Belgium	0.40	0.35	0.56						
Brazil	0.15	1.35	0.58						
Bulgaria	0.75	1.03	0.93						
Canada							0.82	0.81	0.80[d]
China	0.55	0.59	0.50						
Czech Republic	0.28	0.25	0.29						
Finland	0.68	1.13	0.56	0.47	0.86	0.59			
France	1.17	1.08	1.02						
Germany	1.23	1.13	0.89	0.81	0.88	1.06			
Hungary	0.53	0.76	0.63						
Japan	1.02	1.03	1.27	2.14	1.96	1.68			
Korea	0.84	0.77	0.67				0.85	0.55	0.67
Mexico				3.67	2.83	3.29			
Netherlands	0.30	0.56	0.52						
Pakistan							2.05	4.46	3.2
Romania							0.46	0.47	0.58
Russian Feder.	1.56	1.13	1.03						
Slovakia	0.59	0.81	0.37						
Slovenia	1.65	2.60	1.13						
South Africa	0.86	0.42	1.15						
Spain	0.71	0.59	0.43	2.45	1.52	0.93			
Sweden	0.43	0.43	0.35	1.12	0.85	0.71			
Switzerland	0.77	0.69	0.48	1.10	0.89	0.97			
Ukraine	1.37	1.53	1.29						
United Kingdom	0.66	0.46	0.19						
United States	1.05	0.96	0.91	1.84	1.68	1.38			

	GCR			LWGR		
	1999	2000	2001	1999	2000	2001
Lithuania				6.40	5.35	3.14
Ukraine				11.47	7.12	[c]
United Kingdom	0.17[a]	0.15[b]	0.11[b]			

a) This is the average annual dose for 26 AGR in United Kingdom.
b) This is the average annual dose for 14 AGR in United Kingdom.
c) Chernobyl Nuclear Power Plant, Unit 3 was shutdown in 2001.
d) This is the average annual dose for 11 CANDU reactors in Canada.

Figure 1. **2001 PWR average collective dose per reactor by country**

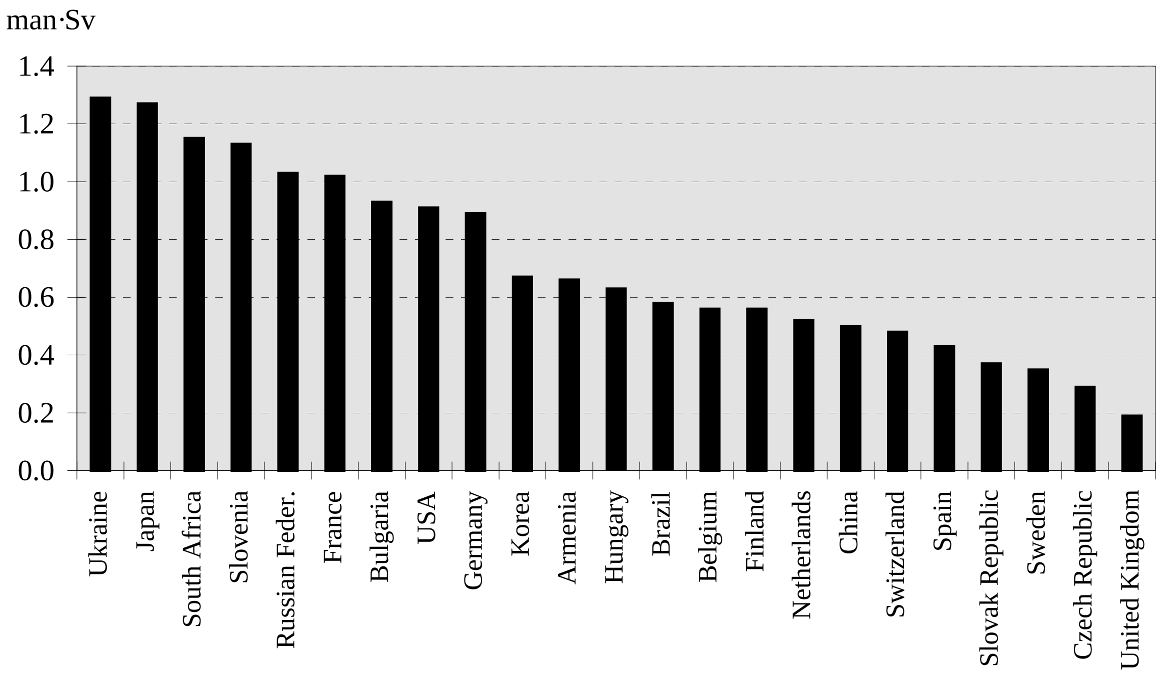


Figure 2. **2001 BWR average collective dose per reactor by country**

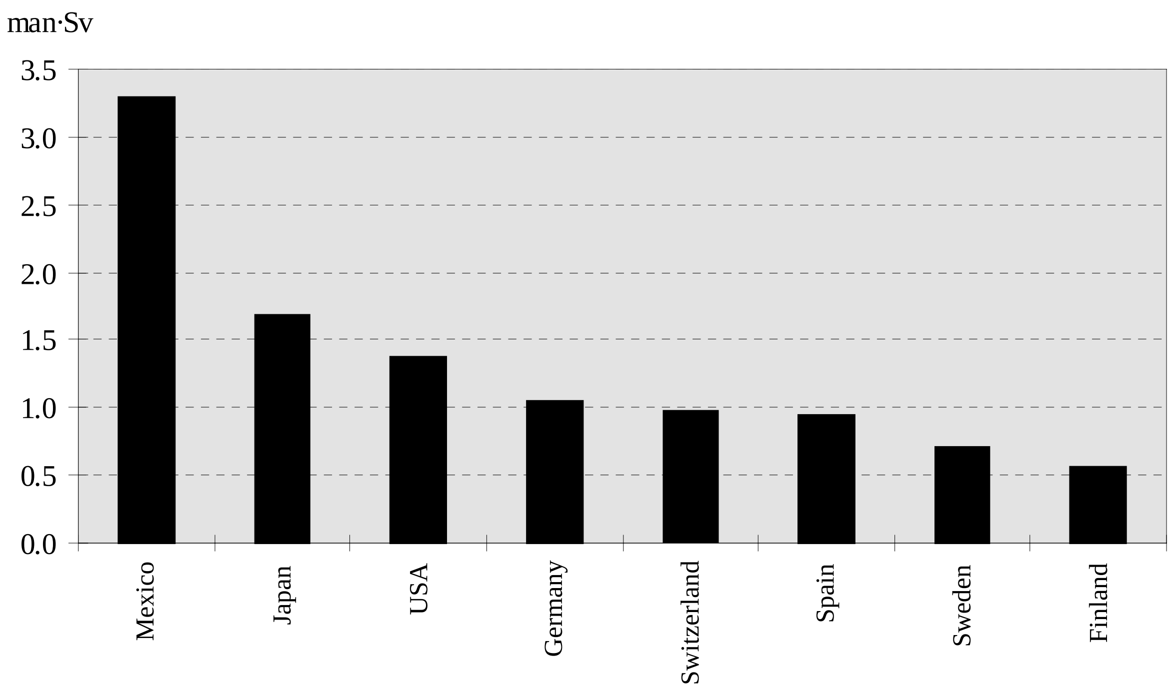


Figure 3. **2001 CANDU average collective dose per reactor by country**

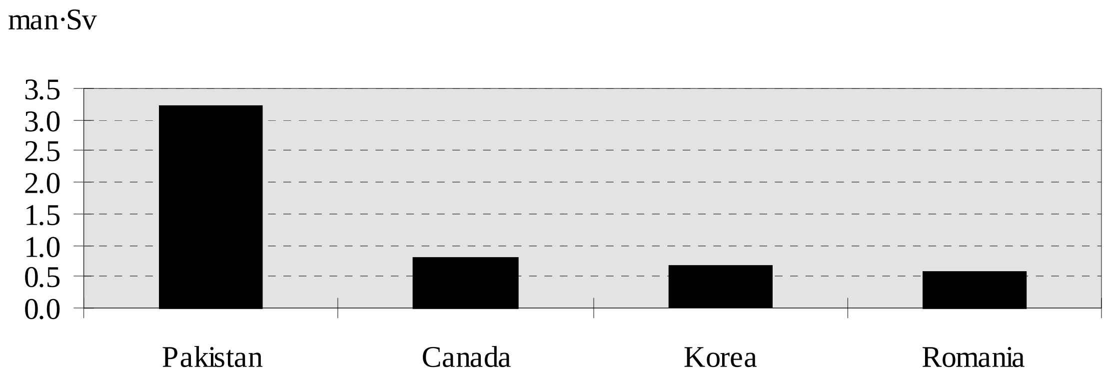


Figure 4. **2001 average collective dose per reactor type**

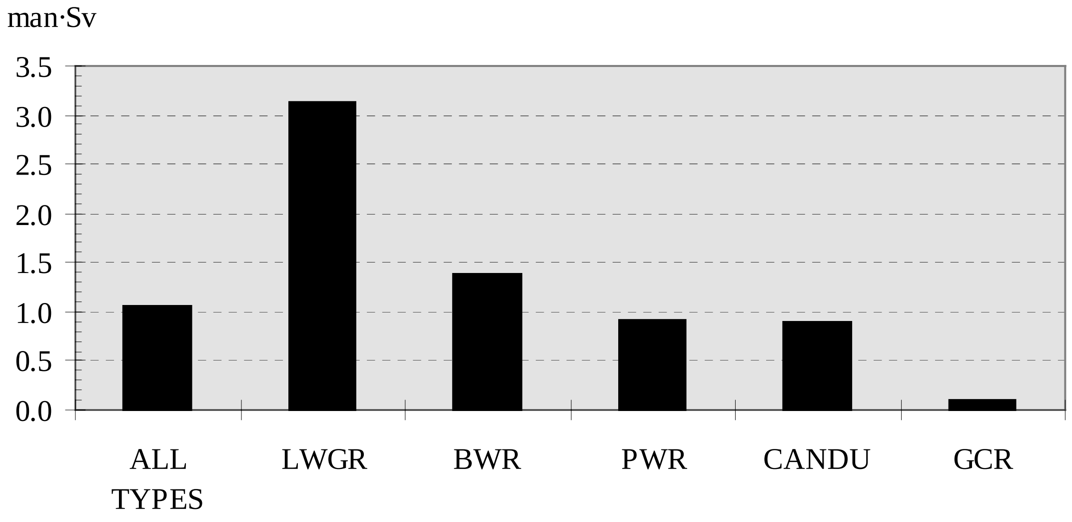


Figure 5. **Average collective dose per reactor for operating reactors included in ISOE by reactor type for the years 1991-2001**

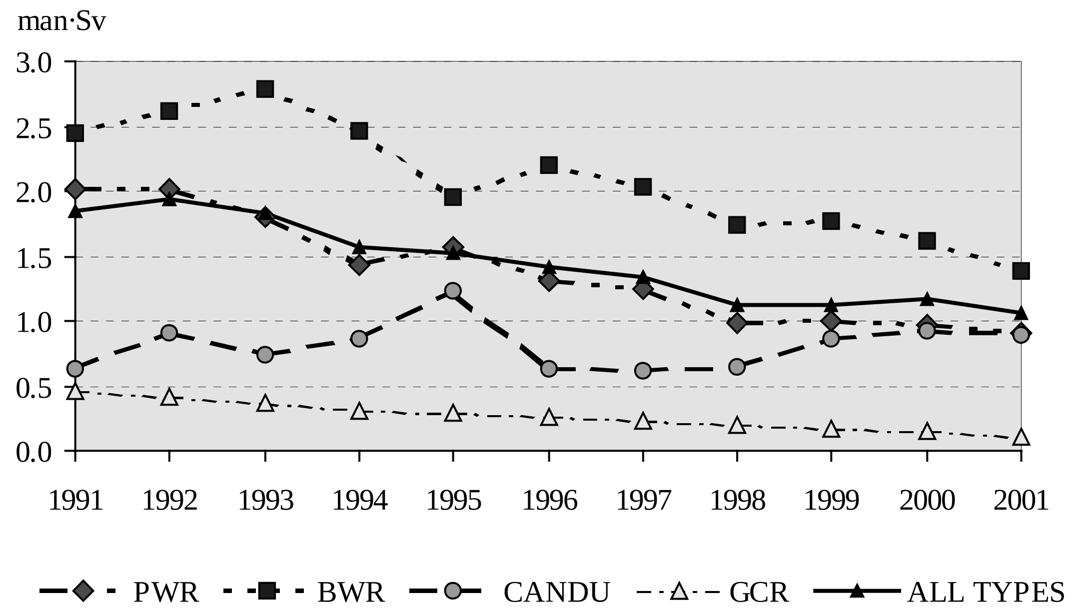
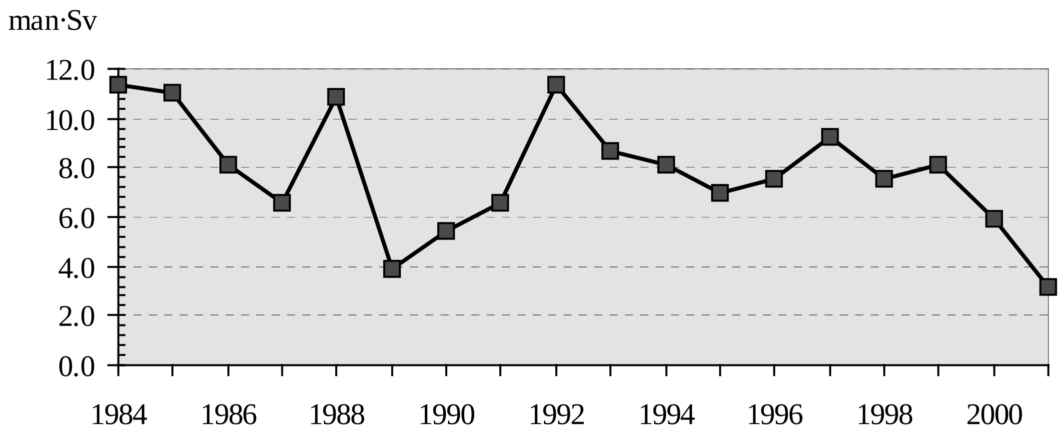


Figure 6. **Average collective dose per reactor for operating LWGRs included in ISOE (Number of reactors: 1984-1986 one unit, 1987-1998 two units, 1999-2000 three units, since 2001 two units)**



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 1990 to 2001. 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.

Unit 3 of the Chernobyl nuclear power plant in the Ukraine was definitely shut down in December 2000. The average annual dose of this reactor for the year 2001 is not yet available.

Table 3 shows the average annual dose per unit by country and type of reactor for the years 1999 to 2001. Figures 7 to 10 summarise the average collective dose per reactor for shutdown reactors and the number of shutdown reactors for the years 1991 to 2001 for PWRs, BWRs, GCRs and for all types.

Table 3. **Average annual dose per unit by country and reactor type for the years 1999-2001**

PWR						
	1999		**2000**		**2001**	
	No.	man·mSv	No.	man·mSv	No.	man·mSv
France	1	91	1	14	1	7
Germany	6	79	6	47	6	46
Italy	1	19	1	7	1	4
United States	9	366	9	563	8	307

BWR						
	1999		**2000**		**2001**	
	No.	man·mSv	No.	man·mSv	No.	man·mSv
Germany	4	317	4	256	4	269
Italy	2	53	2	34	2	38
Netherlands	1	217	1	318	1	95
Sweden			1	113	1	79
United States	4	252	4	403	4	164

GCR						
	1999		**2000**		**2001**	
	No.	man·mSv	No.	man·mSv	No.	man·mSv
France	5	40	5	35	5	13
Germany	1	30	1	34	1	19
Italy	1	42	1	8	1	44
Japan	1	170	1	280	1	20
Spain	1	39	1	87	1	197
United Kingdom	6	70		No data		No data

Figure 7. **Average collective dose per reactor for shutdown PWRs included in ISOE**

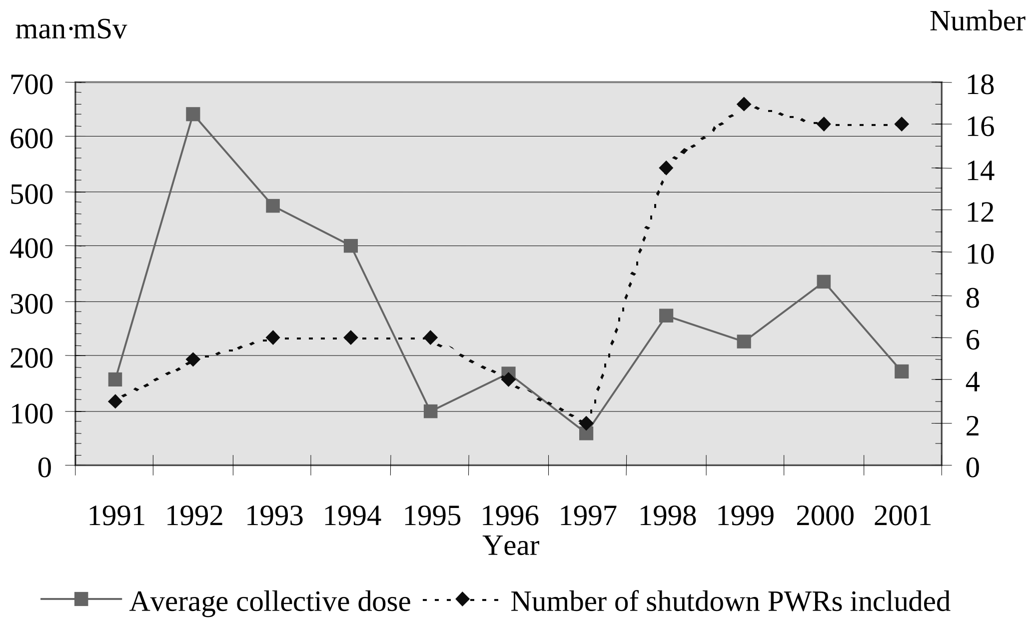


Figure 8. **Average collective dose per reactor for shutdown BWRs included in ISOE**

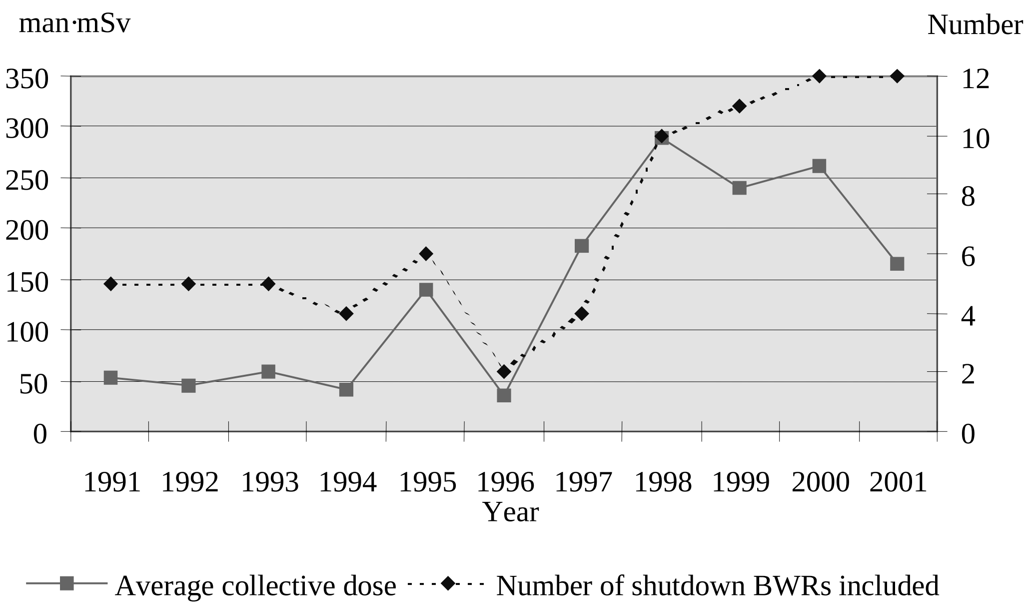


Figure 9. **Average collective dose per reactor for shutdown GCRs included in ISOE**

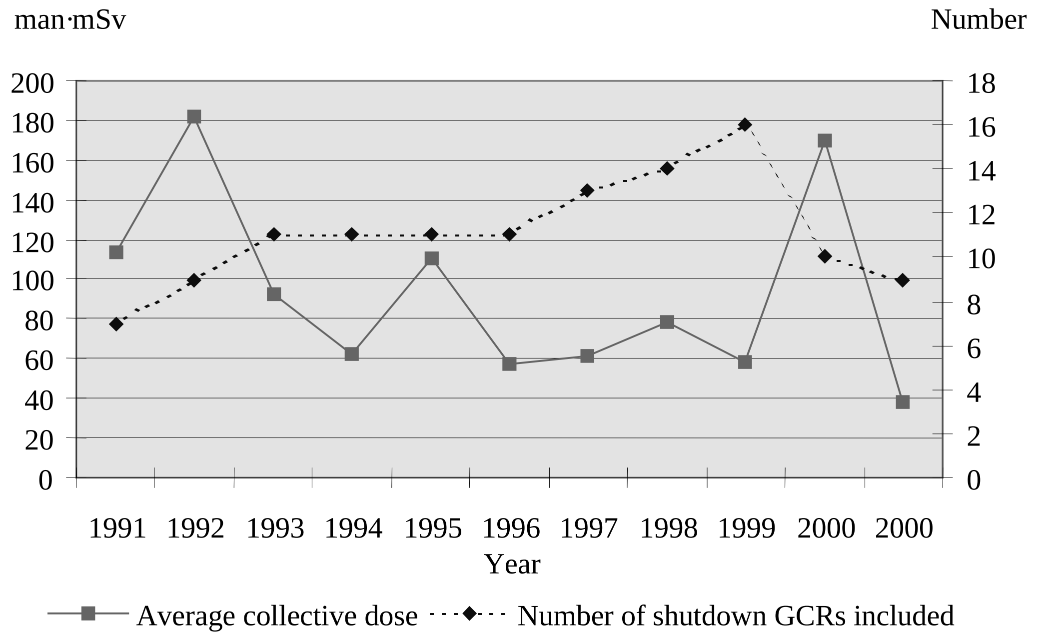
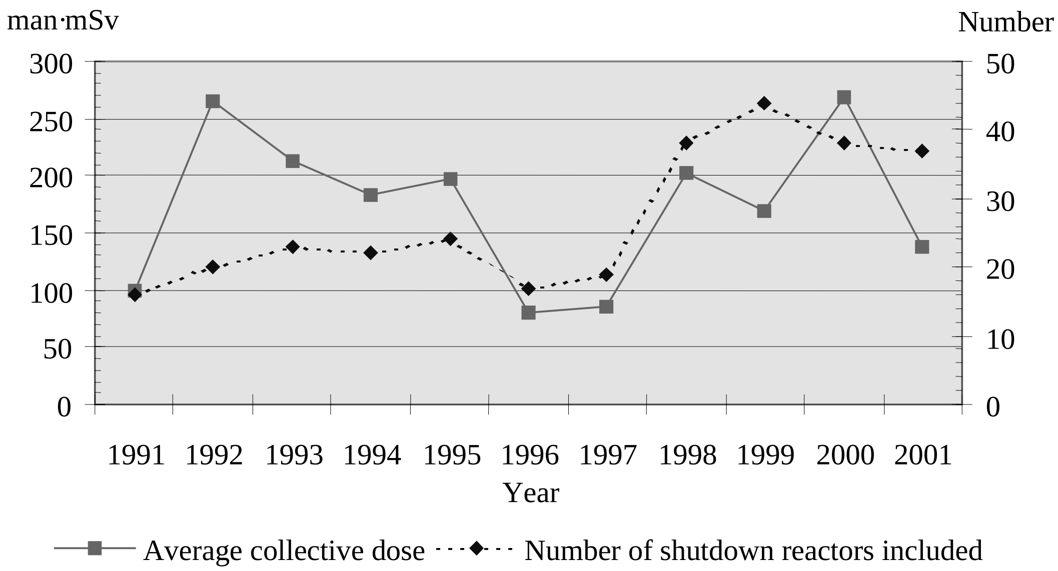


Figure 10. **Average collective dose per reactor for shutdown reactors (all types) included in ISOE**



2.3 Dose information on work performed with regard to waste management in nuclear power plants

On request of the French utility Électricité de France (EdF), the European Technical Centre performed a survey within the ISOE system to assess the collective dose associated with waste management in PWRs.

For the years 1998 to 2000, the ISOE database includes information on waste handling for 163 outages, mainly in Europe, Brazil and China. The average percentage of dose which is attributed to waste handling during outages shows considerable variations for the different countries considered (see table). This may be explained by differing definitions of waste handling (only during outage or during the whole year, including or not waste sorting, embedding, blocking…) and differences in practices (waste generation and management).

Table 4. **Doses associated with waste handling as a percentage of outage dose per country ("waste handling" task within "general work" job) in 1998-2000 for PWRs**

Country	Total number of outages	Waste handling dose / outage dose (%)	Standard deviation
Belgium	9	0,10%	0,10%
China	3	0,87%	0,74%
France	112	0,65%	0,84%
Germany	16	1,42%	2,79%
The Netherlands	3	3,87%	2,82%
Slovenia	3	1,25%	0,79%
Spain	7	0,93%	0,79%
Sweden	6	0,19%	0,21%
U.K.	2	3,65%	0,08%

The analysis of German data (see Figures), shows that the lower the outage dose, the higher is the percentage of waste handling dose. For outage doses of 1 man·Sv and above, the percentage of dose which is attributed to waste handling increases up to a value of around 1%. Below an outage dose of 500 man·mSv, the dose for waste handling remains at a constant value of around 10 man·mSv. One may therefore assume that waste handling does not benefit as much from the design effect as the major outage tasks (the most recent Siemens units have very low outage doses). A more detailed analysis should take care of the actual tasks performed, their location and the types of wastes generated.

A request has then been sent to the ISOE participants to analyse the breakdown of these doses as a function of the operations performed, but most NPPs do not follow in detail the doses corresponding to waste handling. A specific in depth survey in a few plants to perform benchmarking should therefore be of great interest.

Figure 11. **Waste handling dose during outages in Germany as a function of the outage dose**

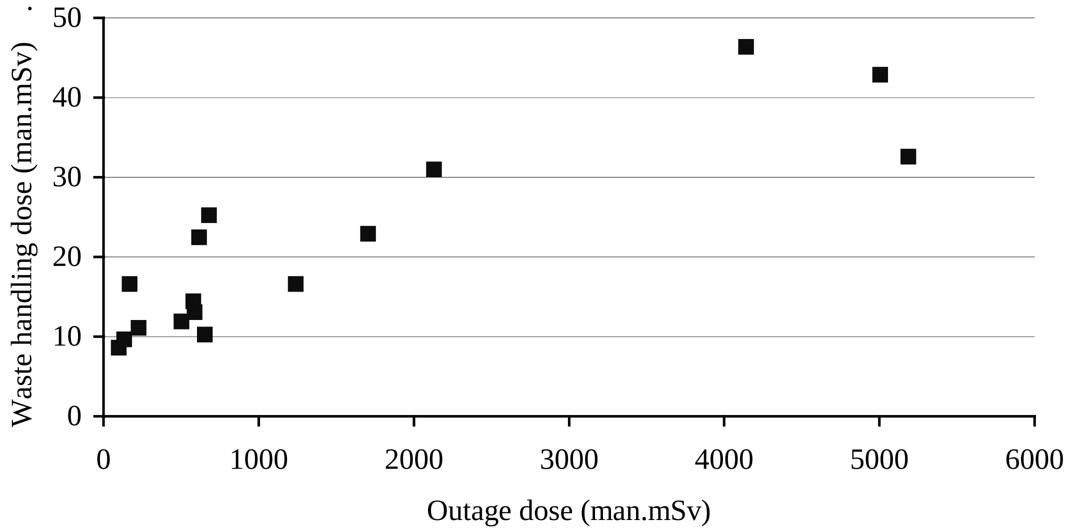
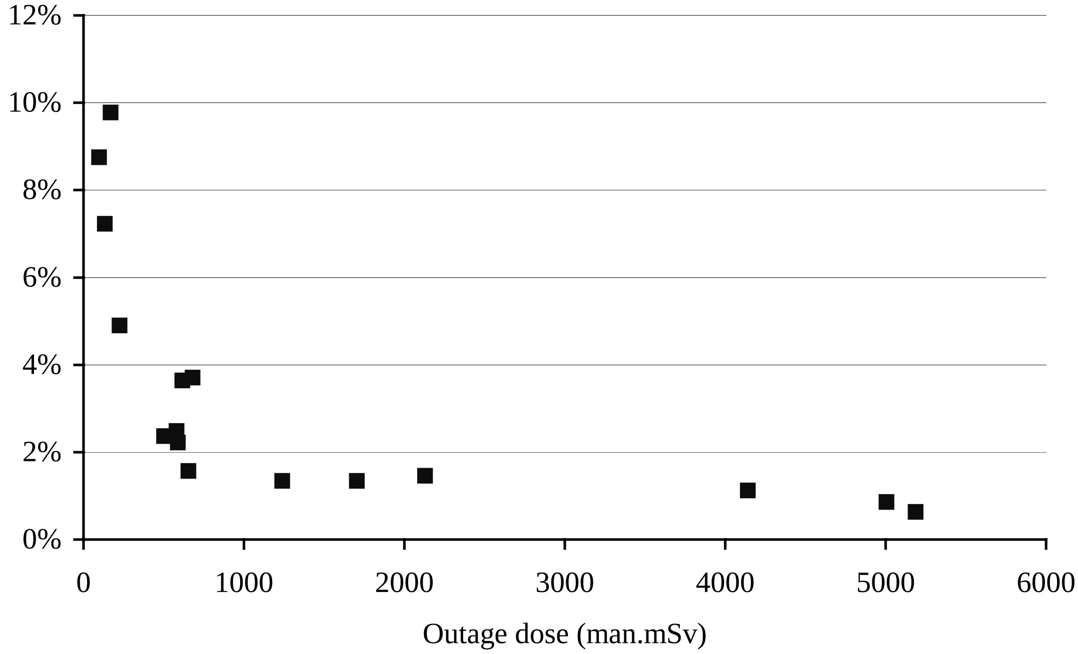


Figure 12. **The percentage of dose which is attributed to waste handling during outages in Germany as a function of the outage dose**



2.4 Summary of the 3rd ISOE European workshop on occupational exposure management at nuclear power plants

The European Technical Centre co-organised with the International Atomic Energy Agency and the European Commission the Third ISOE European Workshop on Occupational Exposure at Nuclear Power Plants in April 2002, at Portoroz, Slovenia. 130 participants from 26 countries, mainly European but also from the United States and Asia, attended the meeting with a good balance between utilities, regulatory bodies and contractors. The IAEA supported participants from Central and Eastern European countries as well as from Asia. The workshop allowed 35 oral presentations and 8 poster presentations to be provided, and vendors presented their products in very informative booths. All participants appreciated, as in the previous workshops, the work in small groups. The success of this Workshop is largely due to the important organisational support from the Krsko NPP and the Slovenian Regulatory body.

One major feature of the Workshop was the participation of representatives from Russian speaking countries, the IAEA having provided simultaneous interpretation between English and Russian. That has shown the important improvement of the occupational exposure management in these countries during the last few years, partly as a result of both the IAEA Technical Co-operation Programme and ISOE. In that context, a special award has been provided to A. Petrov for his presentation in Russian on “steam generator replacement at Balakovo NPP”.

The small group’s discussions, as well as the oral presentations were more focussed on the management aspects of occupational exposure reduction and on the influence of political and legal backgrounds than on technical matters. Three topics were particularly selected by the participants as topics of interest:

- The impact of deregulation on occupational exposure.
- The setting up of goals and radiological protection indicators.
- The setting up and use of dose constraints.

Deregulation and radiological protection

The problem of the impact of deregulation on radiological protection was raised for the first time at Malmö in 1998 (first EC/ISOE Workshop). At that time it appeared not to be a real concern. Two years later in 2000 at Tarragona (second EC/ISOE Workshop), the deregulation appeared clearly as a real challenge for the future for radiological protection. It led to a recommendation from the participants: “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”.

For the first time at Portoroz, participants from some countries mentioned “important reduction in radiological protection staff sizing, and loss of skilfulness” and “higher turnover of staff with less experience”. There was then a consensus from the present radiological protection specialists to give warnings and recommendations:

- The management should pay more attention to address the effect of down sizing radiological protection staffs.

- The regulatory bodies should negotiate with NPP's the minimum number of radiological protection and safety staff allowing to maintain a good radiological protection level.
- The utilities need to maintain regular investments in Radiological Protection and Safety Culture.

The setting up of goals and radiological protection indicators

In the context of competition, the setting up of goals and radiological protection indicators appears to the participants to be a very important management tool. The goals must be measurable, realistic and challenging. They must be communicated to all stakeholders. They may be proposed by the radiological protection specialists according, or not, to long term goals set up by the management. Deviations from the goals should require post job reviews.

Depending on the national cultures and facilities contexts, they may concern:

- Doses: distribution of individual doses, collective dose, unplanned doses.
- Events occurrence: contamination's, survey compliance, levels of training.
- Waste and effluent generation.

In the US the new INPO 2005 collective dose goals are 650 man·mSv/year for PWRs and 1200 man·mSv/yr for BWRs. (D. Wood presentation); in France the collective dose target per reactor is 800 man·mSv for 2005.

The setting up and use of dose constraints

The first consensual conclusion on this topic is that there is a need for clarification in order to have a common language: Are they action levels? Are they goals? Are they warning levels? The only certitude is that they should not be limits, and as they should be principally focussed on the individual, they should be below the limits. In most countries the opinion is that regulatory bodies should not state them. Their use is mainly for optimising protection in planning of tasks, in designing and in decommissioning of facilities and equipment.

Some plants already use dose constraints since quite a few years British Energy Generation in the UK started, for example, in 1991 with a 15 mSv annual "company dose restriction level (CDRL)" and has now a 10 mSv CDRL (S Morris presentation). "The benefit of having a CDRL of 10 mSv was that it provided motivation for enhanced dose reduction practices that resulted in minimising both individual and collective dose."

So dose constraints appeared to the participants as complementary to the above mentioned goals and radiological protection indicators.

However there was a strong opinion that there is a need for harmonisation of dose constraints to facilitate the optimisation of radiological protection of contractors itinerant workers.

Best paper awards

Finally three technical presentations were awarded and invited to make their presentation in 2003 at the ISOE international ALARA symposium in the United States of America. These papers were dealing with circuit contamination, fuel decontamination and occupational exposure related to spent fuel shipments:

1. "Impact of Main Radiological Pollutants on Contamination Risks (ALARA). Optimisation of Physico-Chemical Environment and Retention Techniques during Operation and Shutdown"; A. Rocher *& al*, France.
2. "Fuel decontamination at Ringhals 1 with the new decontamination process ICEDEC™"; E. Fredriksson *& al*, Sweden.
3. "Analysis of the doses associated with the spent fuel shipments from the French NPPs: are they ALARA?"; J.P Degrange *& al*, France.

2.5 Principal events of 2001 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 2001. 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 2001 and which may have influenced the occupational exposure trends. These are presented by country.

ARMENIA

Summary of national dosimetric trends

For the year 2001, the collective dose at the Armenian NPP has been reduced to 0.66 man·Sv:

Annual collective doses after restart of Armenian NPP (man·Sv)

Years	1995	1996	1997	1998	1999	2000	2001
Collective dose	4.18	3.46	3.41	1.51	1.58	0.96	0.66

Events influencing dosimetric trends

In-service inspections and spend fuel transfer to the dry storage.

Number and duration of outages

One outage (~ 100 days) with refuelling and maintenance works in safety systems(in-service inspections etc.) was performed. The transferring of spent fuel from the NPP's water pools to dry storage had special influence on the dosimetric trends.

The planned exposure doses were agreed with the regulatory body. While the planned collective dose was 0.93 man·Sv, the real collective dose was 0.59 man·Sv. The maximum individual dose equivalent was 16 mSv.

Major evolution

The collective dose for year 2001 at the Armenian (Medzamor) NPP was reduced to 0.66 man·Sv, which is the result of strict application of ALARA program, including both organisational and technical issues.

Component or system replacement

During the outage, no components or systems were replaced.

Unexpected events:

For the year 2001 unexpected events were not registered.

Issues of concern for 2002

There are foreseen medium activity radioactive waste including drums replacement (this activities are transferred from 2001 to 2002 year), which may have an impact on dosimetric trends.

BELGIUM

Summary of national dosimetric trends

Collective doses for the year 2001 (in man·mSv)

In Tihange	Tihange 1	Tihange 2	Tihange 3	Total
Plant Personnel	130	152	102	**384**
Contractor's Personnel	562	1387	483	**2432**
Total	**692**	**1539**	**585**	**2816**
In Doel	Doel 1 + 2	Doel 3	Doel 4	**Total**
Plant Personnel	147	82	48	**277**
Contractor's Personnel	422	224	150	**796**
Total	**569**	**306**	**198**	**1073**

For Doel 1 and Doel 2 is the annual dose for the two units together, because there is only one dosimetry system for both units. They have a joined controlled area.

Collective doses in Tihange are increasing compared to 2000. This is due to the number of outages (3 outages with one steam generator replacement) compared to the 2 outages of 2000.

Events influencing dosimetric trends

The outages are responsible for the major part of the collective doses. The steam generator replacement of Tihange 2 is responsible for half of the collective dose in Tihange.

Number and duration of outages

Unit	Outage information	Number of workers	Collective dose (in man·mSv)
Tihange 1	Outage duration 54 days, No exceptional work	917	618
Tihange 2	Outage duration 63 days, Steam generator replacement	1559	1446
Tihange 3	Outage duration 28 days, No exceptional work	487	885
Doel 1	Outage duration 19 days, No exceptional work	698	269
Doel 2	Outage duration: 23 days No exceptional work	709	186
Doel 3	Outage duration: 29 days No exceptional work	805	228
Doel 4	Outage duration: 19 days No exceptional work	805	175

Major evolutions

Implementation of a new federal regulation on radiation safety according to the recommendations of the ICRP and to the directive 96/29/Euratom.

This regulation defines new limits regarding:

- Protection of the population.
- Annual occupational exposure.

Component or system replacements

Tihange 2: Steam Generator Replacement.

Tihange 3: Replacement of Boraflex (2nd year).

- The spent fuel pool storage facility of Tihange 3 contains 18 racks, each one is able to receive either 6x7 or 7x7 fuel elements. Between the fuel cells, blocks of neutron absorber have been placed. This neutron absorber is called Boraflex. It is made of B4C scattered in an elastomere matrix (silicon). Due to the ageing, this Boraflex has to be replaced.
- During august 2000, a first rack has been removed, after US decontamination. The Boraflex plates have been replaced by borated stainless steel plates (Dose: 14 man·mSv).
- During the first part of 2001, a second rack has been adapted with a collective dose of 9 man·mSv. This improvement is clearly due to experience.
- The operations will continue in 2002.

Plans for major work in the coming year

All plants will go through normal outages.

BRAZIL

Number and duration of outages

Angra 1 had one refueling outage, with duration of 61 days.

Outage (P-10) - Main Tasks	man·mSv
Eddy Current Test	196.81
Refueling	190.20
Insulation	170.78
In Service Inspection	62.00
Scaffolding	52.58
Total	**610.37**

Angra 2 had no refuelling outage during 2001. A short shutdown was carried out (10 days) to perform a special maintenance in the Pressurizer' safety valves. The collective dose due to this task was 9.29 man·mSv. The collective dose in 2001 was 41.4 man·mSv (including the above mentioned maintenance).

New/experimental dose-reduction programme

Angra 1

Installation of Heli-coil in the SG#2, in order to avoid future difficulties during manways bolts removals at outages and special maintenance.

Replacement of the thermal insulation of Steam Generators and Reactor Coolant Pumps.

Angra 2

Depleted Zinc was added to the primary circuit in order to reduce doses related to corrosion products. Angra 2 is the first PWR utility to apply such a programme so soon after its start.

BULGARIA

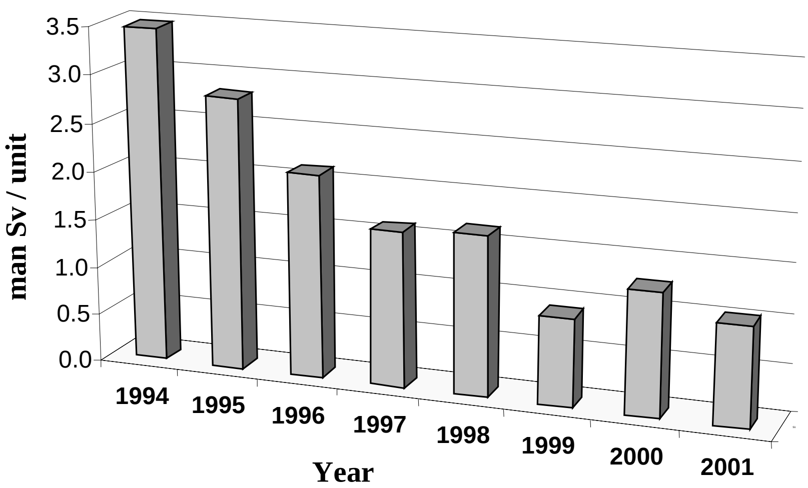
There are two independent sites at Kozloduy: Power plant 1 (PP-1) with 4 WWER 440 MW reactors, and Power plant 2 (PP-2), with 2 WWER1000 MW reactors. All units were in normal operation during 2001. During the year 2001 no events influencing dosimetric trends were reported.

The number and duration of outages were as follows:

Unit 1	58 days of outage
Unit 2	88 days of outage
Unit 3	no outage
Unit 4	122 days of outage
Unit 5	110 days of outage
Unit 6	136 days of outage

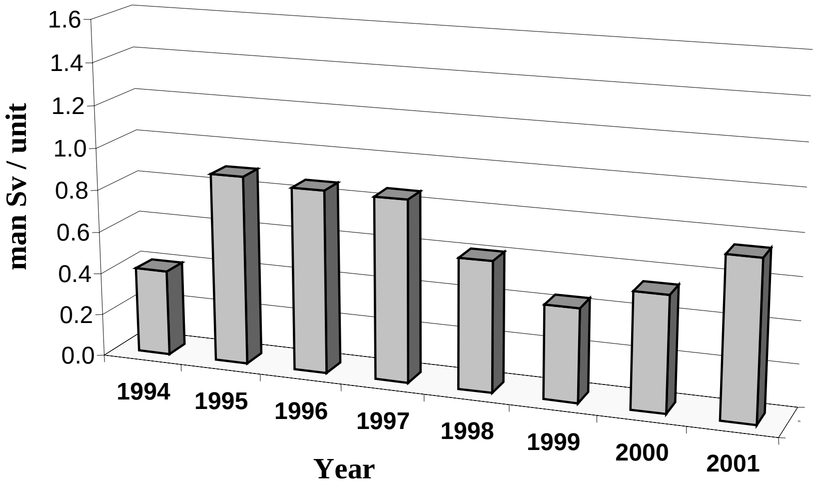
Average collective dose per reactor at PP-1

1994-2001



Average collective dose per reactor at PP-2

1994-2001



During 2001, a big modernisation of the Accident Localization System (ALS) was performed. The main part of the system is the constructed Jet Vortex Condenser. The same reconstruction is to be performed in 2002 for Unit 3 of PP-1.

No safety related issues and unexpected events were observed during 2001. No new dose reduction programmes were implemented.

CANADA

Canada's CANDU reactors are ageing. Increased service outages are required to maintain and upgrade the operating units. To assure that occupational doses are maintained as low as reasonably achievable, Canadian plants have focused on several dose reduction measures to achieve the proper balance between plant maintenance needs and site dose goals.

Subsequent to the new Nuclear Safety and Control Act and Regulations implemented in May 2000, the Canadian regulatory body has developed new approaches to radiation protection inspections. A formal ALARA program is now required by the Canadian regulatory body. The Canadian Nuclear Safety Commission (CNSC) staff conducts ALARA inspections of the Canadian nuclear plants.

Highlights of the Canadian ALARA initiates in 2001 are provided below:

Ontario Power Generation: Pickering's ALARA Programme

Ontario Power Generation operates eight (8) CANDU reactors, consisting of Pickering 5-8, and Darlington 1-4, plus 4 laid up reactors (Pickering 1-4). Considerable effort has been devoted to maintenance on Pickering 1-4 to permit a return to service for these units in the future.

Pickering 1-4 ALARA staff has developed major ALARA initiatives to support the extensive maintenance being performed on the units. Some examples include the following:

1. Hot Spot Reduction which has been fully implemented in Pickering 1-4.
2. Heat Transport Filtration which has reduced the filtration size from 2 microns to 0.1 microns to reduce the size of radioactive particles in plant piping.
3. Temporary Shielding has been used to reduce dose rates from plant equipment near maintenance activities.
4. Tele-dosimetry has been implemented to allow operators to monitor in-plant work activities using remote cameras to visually observe radworkers at the work site. Based on the Canadian self-protection programme, tele-dosimetry facilitates roving fully qualified radworkers to communicate easily among work sites and the work control center. The radworker's dose is monitored by radiation protection on a real time basis using EPD telemetry system.
5. Low Dose Waiting Areas are utilitized whenever feasible.
6. Tritium Reduction Programme is aimed at internal dose reduction by the following initiatives:
   - Moderator detritiation.
   - Heat transport.
   - Ensuring the vapour recovery system is fully functional.
   - Use of bulldog portable tritium scrubbers.
   - Use of temporary tritium off-gassing facility (pending construction of a permanent facility).
   - Aggressive follow-up by line management when individuals receive excessive tritium exposure.

7. Personnel Contamination events are being reduced through greater use of High Efficiency Particulate Absorbers (HEPA's), control at the source (CATS) containments and improved free release program.

Pickering 5-8 ALARA staff is implementing ALARA initiatives similar to Unit 1-4 except the programs are applied to operating units. The tritium reduction initiative is part of the source term reduction programme with a goal of optimising the reduction of dose exposures to radworkers. The Heat Transfer Curie content contributes to 95% of the station's internal dose. Hence, the goal of the programme is to achieve low Curie D2O transfers of Heat Transport or Moderator D2O during operating conditions or service outages.

Smaller Heat Transport filtration pore sizes combined with increase Heat Transport purification flow rates to achieve lower dose exposures and hot spots reduction.

The dose reduction strategy is used on the Heat Transport bleed, gland and fueling machine. The hot spot reduction program has achieved a reduction of 7 man·mSv per year. An estimated 30 man·mSv per year could be saved by elimination of all hot spots on Pickering 5-8. Replacement of oxygen sensors and other equipment on the moderator sampling cabinets will further reduce hot spots in repetitive plant work areas.

A reduction of approximately 5 person mSv was achieved during service outages by the use of tele-dosimetry. Temporary shielding packages have resulted in a reduction in annual exposure of 35 man·mSv. Limited use of lead aprons on the reactor face task demonstrated potential extremity exposure reductions of 15-30%. Quick disconnect scaffolding is being evaluated to reduce worker dose and improve industrial safety.

Darlington 1-4 ALARA Staff are reducing occupational dose through wider application of the teledosimetry system. Also, the radiation signage and postings are being improved especially related to high dose rate areas. Improvements in Fuel Handling area hot particle detection and control are being implemented. Low dose waiting areas are being established with dose display boards available for the radworker.

Darlington management has challenged plant staff to take on non-traditional roles to assist radiation protection during service outages. Clerical, stockkeeping and support function skill sets were trained for radiation protection technical job coverage during a 2001 service outage. The results were outstanding according to senior management. It is a good example of broadening skillsets from within the site organization. Also, the reduction in external contractor employment saves the company labor costs.

A reduction of D2O leaks is being accomplished by tightening of leaking closure during outage. Also, an improved D2O leak search and tracking process has been implemented.

A reduction in containment and confinement tritium concentrations is being achieved by a complete refurbishment of D1 and D2 dryers. Also, a permanent tritium off-gas facility is being installed at Darlington. A temporary power supply is provided to dryers during bus outages.

Finally, the reduction of crud levels in the Heat Transport System is being addressed by increased purification flow and balanced flow for the north and south loops. Also, the bleed filter size is being reduced to sub-micron levels to improve the source term removal rate.

Bruce Power ALARA Programme

Bruce Power operated Units 5-8 in 2001 under the management and 18-year lease of British Energy. Summer regional electricity rates have doubled in Ontario due to hot weather and an increasing air conditions load. Two service outages are scheduled to be performed each year for Bruce B. Bruce B, Unit 5 completed a service outage from October 2001 to February 2002. Bruce B, Unit 6 completed a service outage from, April 2002 to August 2002. The restart of Bruce A, Units 3&4 is a near term goal of British Energy.

New security systems and procedures have been implemented at Bruce Power. Truck monitors have been added at the Security Guardhouse. A source term reduction initiative to reduce the tritium concentration in the moderator by 30-35% has significantly reduced the internal dose at Bruce (less than 8% of the total whole body dose). A dedicated group to perform ALARA reviews of appropriate work packages is being formed to better integrate ALARA in the work planning process.

Gentilly-2 ALARA Programme

Gentilly 2 had its annual planned outage from March 31 to Mai 12. There was no forced shutdown in 2001. Gentilly broke its record of 275.9 days of continuous operation of April 1990 with reaching 300.5 continuous production days between 2000 and 2001 planned annual outages. Main shutdown activities were related to steam generators eddy current inspection, heat transport system feeders thickness measurements, MOV's refurbishing and fuel channel inspection.

Total External	943.6 mSv
Total Internal (tritium)	245.2 mSv
Total Whole Body	1188.8 mSv
Normal operation	320 mSv
Planned outage	868.8 mSv
Forced outages	None

CHINA

Qinshan 1

For Qinshan 1 NPP, the annual collective dose for the year 2001 is 120.64 man·mSv, or 0.049 man·Sv/TWh.

Number and duration of outages

The 5th refuelling outage took place from 14 November 2001 to 15 January 2002 with a total duration of 63 days. An additional forced outage lasted one day 10 May 2001.

Issues of concern for 2002

1. Dose Reduction of SG works.
2. ALARA Data Bank setting up.
3. Dose reduction of Scaffolding /insulation.

Plans of major work in the coming year

The 6th refuelling outage will be performed in the coming year. Radiation protection personnel will mainly focus on the dose reduction and contamination control during the outage.

CZECH REPUBLIC

Legislation process in Czech Republic

In the year 2001 the amendment of the Atomic Law was approved by the Parliament. This amendment harmonised Czech law with the degree of European Union, mainly in the area of radiation protection. In continuation with this amendment several actualisation degrees of SONS were prepared.

Radiation Passport

The first proposal of the degree on the radiation protection of outside workers exposed to the risk of ionising radiation during their activities in controlled areas was prepared. This proposal:

- will determine a way for arrangement of radiation protection of outside workers;
- will define the requirements for monitoring and registration of outside workers by the system of personal radiation passports, ensuring by this way their equal radiation protection as have the regular employees;
- will determine the content and form of personal radiation passport.

The activity of outside worker in controlled area of operator can be performed only under the contract between the outside undertaking and operator, which contains the time of work and the determination of responsibilities for radiation protection assurance of outside workers.

Dukovany NPP

- The total collective effective dose for 2001 was 1.171 man·Sv, well under the target of 1.4 man·Sv. The CED for utility employees was 0.117 man·Sv, respectively 1.054 man·Sv for contractors. The average collective effective dose per unit was 0.293 man·Sv (Dukovany NPP has installed four units of WWER-440, Model 213).
- The total value of CED (1.171 man·Sv) for 2001 is slightly higher in comparison with previous year (CED for 2000 was 0.987 man·Sv), because at third unit was the major outage (with inspection of reactor internal parts) with increased value of CED (0.550 man·Sv).
- The maximal individual effective dose was 19.1 mSv, which was reached by one of the contractor workers during performing the SG internal equipment fittings and inspections at all outages.

The planned outages at Dukovany NPP in 2000

Unit 1	30 days standard maintenance outage with refuelling; total CED during outage was 0.309 man·Sv
Unit 2	37 days standard maintenance outage with refuelling; total CED during outage was 0.172 man·Sv
Unit 3	58 days major maintenance outage with refuelling; total CED during outage was 0.550 man·Sv
Unit 4	31 days standard maintenance outage with refuelling; total CED during outage was 0.107 man·Sv

Events influencing dosimetric trends

The total electric energy production for year 2001 was the highest in the operation history of the Dukovany NPP-13.59 TWh which represents 20% of total production in Czech republic.

The total annual activities both gaseous effluents (all components) and liquid releases reached in 2001 one of the lowest value for the whole operation history of Dukovany NPP.

Major evolutions

The international OSART mission, delegated by the International Atomic Energy Agency, performed the overall inspection of Dukovany NPP in November 2001. The results of the mission were positive evaluation of the management and operation of NPP.

Dukovany NPP got also the significant EMS (Environment Management System) Certificate – ISO 14001.

Also continued the preparation of the reconstruction of body contamination monitors for workers at the exit of the controlled area and the reconstruction of others “hygienic loop” equipment, which will be realise in years 2003 to 2004.

Unexpected Events

There were no registered unexpected events for year 2001.

Temelín NPP

In the year 2001 the tests of energetic start-up phase continued on the Unit 1. Second unit got through non-active testing phase.

Summary of dosimetric trends

The total collective effective dose for 2001 was 0.044 man·Sv. The CED for utility employees was 0.016 man·Sv, respectively 0.028 man·Sv for contractors. The data for evaluation of CED are appointed by film dosimeters.

The maximal individual effective dose was 0.32 mSv, which was reached by one of the employee.

There was no registered exposure from internal contamination for the year 2001.

Major evolutions

The international OSART mission, delegated by the International Atomic Energy Agency, performed the overall inspection of Temelin NPP in February 2001. The OSART team found the NPP management prepared to improve the operational safety and reliability.

The second IAEA mission in November 2001 was aimed to the solution of project safety issue and evaluated the progress in this area from the year 1996.

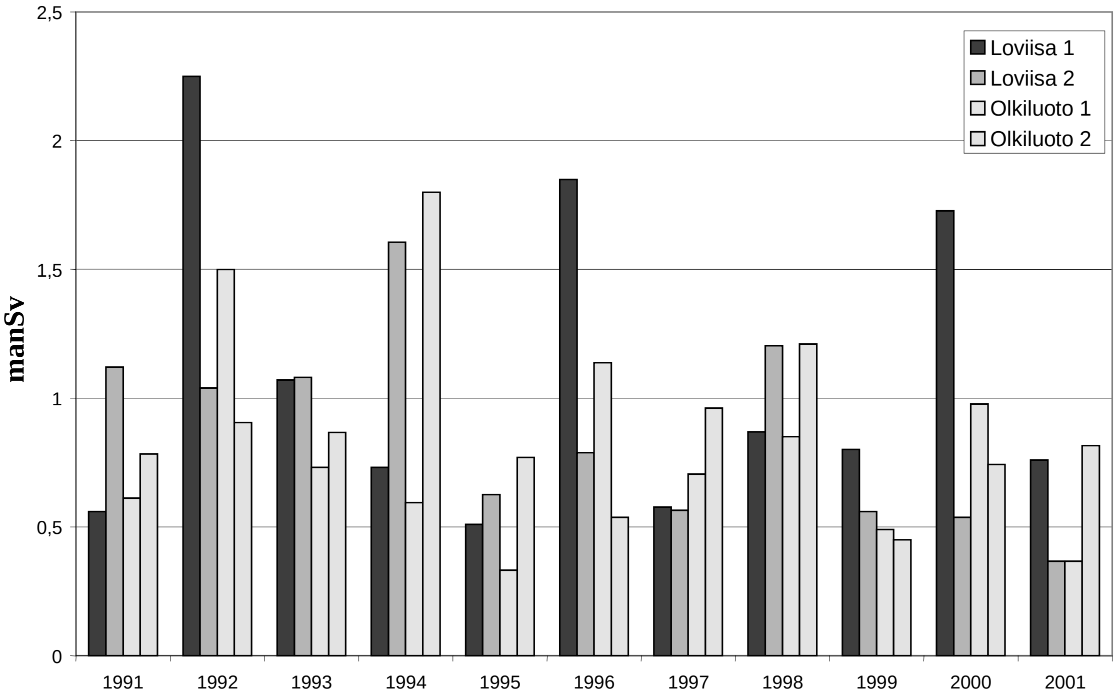
FINLAND

General

As a consequence of the implementation of the new European Basic Safety Standard Directive, medical surveillance of the employees of the nuclear power plants has been performed since 1999 according to a practice based on the new Directive. Otherwise the implementation of the Basic Safety Standard Directive concerned mainly radiation safety regulations in Finland, and caused no major changes to YVL Guides.

So far the year 2001 has been quite normal in radiation protection in the Finnish NPPs. The positive trends in collective and individual doses have continued. The development of collective doses can be seen in the figure.

Collective dose / reactor



Olkiluoto

Starting this year, a new outage programme is being introduced, consisting of alternatively service or refuelling outages every year at each plant unit. The typical length of a refuelling outage is about 8 days. A service outage, with an average length of 14 days, includes all the work tasks of a refuelling outage together with system overhauls and plant modifications or improvements. Extra long outages are scheduled for 2005 (Olkiluoto 2) and 2006 (Olkiluoto 1).

The collective dose from the beginning of the year 2001 to the end of December was 1.183 man·Sv (inclusive outage doses).

This year, the service outage was carried out at **Olkiluoto 2**. The annual outage lasted 14 days and 15 hours. The received collective dose was 0.72 man·Sv (0.67 man·Sv in 2000). A total of 1625 persons were under dose monitoring during the outage. The highest individual dose was 7.8 man·Sv.

The most extensive work tasks of the service outage of **Olkiluoto 2** were replacements of the electrical and I&C systems, pipe exchange at the reactor plant, the containment leak rate test, renovation of three feed water pumps and work in the sea water channels. The largest modifications at **Olkiluoto 2** were the piping and valve repairs in the vessel head cooling system.

From the radiation protection point of view, the exchange of a part of the reactor vessel head spray system and a valve replacement in the shut down cooling system were the most extensive jobs at **Olkiluoto 2**. The collective dose received from this work was 0.14 man·Sv. ASME inspections (non-destructive testing) caused 0.042 man·Sv.

At **Olkiluoto 1** unit the annual outage lasted 7 days and 20 hours. The received collective radiation dose was 0.27 man·Sv (0.87 man·Sv in 2000). A total of 1389 persons were under dose monitoring during the outage. The highest individual dose was 8.8 man·Sv.

The completion of the **Olkiluoto 1** outage in less than 8 days was a new record.

On **Olkiluoto 1**, work was carried out within the limited scope of the refuelling outage. As an additional work task, the motors of two recirculation pumps were replaced. The most significant work task was a replacement of an auxiliary feedwater pump motor.

ASME inspections caused 0.043 man·Sv at Olkiluoto 1.

Observations

The high steam moisture content (0.30 to 0.35%) at both units continues and increases dose rates in the main steam lines by a factor of 2 to 10. However, in the turbine building the increased steam moisture caused minor increase in individual doses. The high steam moisture was observed after the new power level (2500 MW) licensed in the year 1998.

In the measurements of the internal contamination of workers, there were three findings over the registration level (0.1 mSv).

Loviisa

The collective dose from the beginning of the year 2001 to the end of December was 1.12647 man·Sv (inclusive outage doses), Loviisa Unit 1: 759.80 man·mSv and Loviisa Unit 2: 366.67 man·mSv. The number of workers individually monitored for radiation exposure was 1142. The average dose was 1.98 mSv.

Loviisa nuclear power plant has a project for the renewal of the installed radiation monitoring systems (area monitors, air monitors, process monitors and effluent monitors) at the plant during 2001-2003.

The 24th **Loviisa 1** refuelling and annual maintenance outage was from 11 to 31 August 2001. It was about four days longer than planned due to cracks in the supporting structures of primary coolant pump internals and vibrations of the pumps in connection with the start-up. Altogether about 900 workers participated in the outage in the controlled area. The collective radiation dose incurred in the outage was 0.69 man·Sv (1.68 man·Sv in 2000). The highest individual dose was 11.5 mSv.

The most significant inspections, maintenance work and modifications carried out in the outage of **Loviisa 1** were:

- external inspection of the reactor pressure vessel;
- periodic tests;
- inspection and testing of control rod drive mechanisms;
- maintenance of two primary coolant pumps;
- oil leak repairs of two primary coolant pump motors;
- change of supporting structures of two primary coolant pump internals;
- some parts of the severe accident management modifications;
- replacement of electric and I&C cables in the steam generator room was continued;
- paintwork of the whole steam generator room floor was started at the sector 135-180^{o}.

Paintwork of the steam generator room floor causes the highest collective work dose (0.089 man·Sv). The highest individual dose was 7.14 mSv. The highest individual dose, 11.5 mSv, was incurred partly from this work.

The other significant works in view of radiation protection were:

- replacement of actuator cables (0.021 man·Sv), max. ind. dose 2.14 mSv;
- fuel unloading (0.034 man·Sv), max. ind. dose 2.92 mSv;
- fuel reloading (0.031 man·Sv), max. ind. dose 2.82 mSv;
- cleaning in steam generator room (0.057 man·Sv), max. ind. dose 3.71 mSv.

The 21st **Loviisa 2** refuelling and annual maintenance outage was held from 1 to 23 September 2001. The planned schedule was extended by six days due to vibrations of the main circulation pumps in connection with start up. The plant unit was brought at the start-up from the hot stand-by to the cold shutdown to change one main circulation pump to the pump in reserve. About 900 workers participated in the outage in the controlled area. The collective radiation dose incurred in outage work was 0.29 man·Sv (0.47 man·Sv in 2000). The only collective workdose that exceeded 0.020 man·Sv was the final cleaning of the steam generator room (0.021 man·Sv). The highest individual dose was 4.4 mSv.

The inspections, maintenance works and modifications carried out in the outage of Loviisa 2 were quite the same as performed at Loviisa 1. In the steam generator room, there has not been any major increase in dose rates after the full circuit decontamination performed in 1994.

Observations

After the shut down in **Loviisa 1** the dose rates in the steam generator room were 20-40% higher when compared to the measurements on loops in earlier years. The increase in dose rates resulted from activated silver Ag-110m (T½ 253 d) and antimony isotopes Sb-122 (T1/2 2.72 d) and Sb-124 (T1/2 60.3 d). However, the change in dose rates is not significant compared with the results of the measurement in previous years.

In the measurements of the internal contamination of workers, there were three findings over the registration level (0.1 mSv).

FRANCE

Summary of national dosimetric trends

Collective doses

The average collective dose decreased from 1.08 man·Sv per reactor in 2000 to 1.02 man·Sv per reactor in 2001. The number of short outages decreased from 23 in 2000 to 11 in 2001. There were eight ten yearly outages in 2001 instead of 6 in 2000. The number of standard outages increased from 15 in 2000 to 28 in 2001. The average 2001 collective dose for the 900 MWe units (34 reactors) was about 1.29 man·Sv. The average 2001 collective dose for the 1300 MWe units (22 reactors) was about 0.62 man·Sv.

Individual doses

In 2001, nobody received an annual dose in excess of 20 mSv. At the beginning of 2001, the EDF national alarm level for individual dose over 12 months was reduced from 20 to 18 mSv. This level needed a review of each individual dose situation. Local alarm has been set up at 16 mSv over 12 months.

Events influencing dosimetric trends, number of outages

EDF 4 loop reactors

In 2001, the main contributors were 12 standard outages, 2 short outages, 2 ten yearly outages, a Steam Generator Replacement in TRICASTIN 3 and a Vessel Head Replacement in GRAVELINES 6. The lowest collective dose for a short outage was GOLFECH 2 with 0.25 man·Sv.

The lowest dose for a standard outage was CATTENOM 2 with 0.36 man·Sv. The highest dose for an outage in 2001 was PALUEL 2 with 1.67 man·Sv for a standard outage.

EDF 3 loop reactors

In 2001, the main dose contributors were 16 standard outages, 9 short outages and 6 ten yearly outages. The lowest collective dose for a short outage in 2001 was BLAYAIS 1 with 0.37 man·Sv. The lowest dose for a standard outage was DAMPIERRE 3 with 0.69 man·Sv. The highest outage dose was BUGEY 4 with 2.43 man·Sv for a ten yearly outage.

Organisational evolutions

The reinforcement of the Radiation Protection organisation at EDF continued in 2001. Many technicians, high level technicians and experts have been and should be recruited in the radiation protection field.

Actions to place Radiation Protection on an equal footing with Nuclear Safety

- Drawing up of a radiation protection reference base; Some key-areas were validated : management of radioactive sources, management of collective and individual doses, management of controlled and monitored areas. Each item included the list of regulatory texts, the EDF requirements and a practical manual.
- Creation of a working group on the missions of RP staff at NPPs.
- Provision of additional resources; NPPs RP staffs were boosted by an extra 40 staff in 2001.
- Feedback of international experience.

Futures activities (Outages and dosimetry)

In 2002, EDF NPP Operation Division is planning 28 short outages, 14 standard outages, 5 ten-yearly outages, a steam generator replacement in FESSENHEIM 1 and a vessel head replacement in SAINT LAURENT B1. With such a number of short outages, the decreasing of collective dose will be significant in 2002.

GERMANY

In 2001, the average collective dose by reactor type in Germany was 0.89 man·Sv for pressurised water reactors (PWR) and 1.06 man·Sv for boiling water reactors (BWR).

Experimental Dose Reduction Programme

Since September 1996, NPP Obrigheim, and February 1998, NPP Biblis, perform a depleted Zinc injection programme. Accompanying investigations show good chemical compatibility with respect to material features and a significant dose reduction (in average 40-50%) in areas with high dose rates. Based on these positive experiences, the VGB – Organisation recommends the implementation of Zinc injection for all Siemens NPP with significant Stellite inventory in the core area.

Mayor evolutions

The discussion about modernisation of dosimetric systems in German NPPs is continuing. In order to support the development, a pilot project in NPP Isar was performed where new electronic dosimeters and systems for reading out and administration of dose data were tested under operational practice conditions. Three contractor companies, two official dose control institutes and one supervision authority participated in the project. Regarding technical and administrative aspects the project showed good results. Therefore the VGB Working Panel and the dose control institutes worked out a concept which shall serve to convince the supreme regulatory body, that the new system represents a safe dose control system with benefits for operators and supervision authorities. In the next steps, a pilot project is planned in a second NPP and in a large hospital. In parallel discussions for clarification of regulatory and commercial aspects will be intensified.

HUNGARY

Hungary has only one nuclear power plant at Paks site. The Paks Nuclear Power Plant Ltd. operates four WWER-440 type reactors. Unit 1 has been operating since 1982, Unit 4 connected to the grid in 1987.

In 2001, the annual collective dose for Paks NPP, on the basis of legal dosimetry control (using film badges), was 2592 man·mSv including plant personnel as well as contractors. Upon the result of operational dosimetry (using EPDs) the collective dose was 2687 man·mSv. The highest individual radiation exposure was 15.5 mSv. There was no internal radiation exposure reaching or exceeding 0.1 mSv committed effective dose.

Just like in the previous years the outages of the units resulted the major part of the collective dose in 2001, 83% of the collective dose was due to works carried out during the outages. The duration of outages were 28.5 days on Unit 1, 32.2 days on Unit 2, 60.4 days on Unit 3 and 24.6 days on Unit 4.

In addition to the usual outage works the replacement of feedwater distribution pipes of steam generator and the execution of the earlier decided safety-upgrading program continued in 2001 as well.

The replacement of feedwater distribution pipes was carried out on 14 steam generators. The ALARA approach played important role in preparation phase as well as in implementation phase of replacement work. The resulted collective dose was 433 man·mSv.

The reconstruction of the Reactor Protection System of Unit 3 and preparation for the same reconstruction of Unit 4 were completed. The modification to manage PRISE, and the reconstruction of cold overpressure protection system have been carried out for Unit 3. Upon the result of operational dosimetry the implementation of the safety enhancement measures involved a collective dose of 209 man·mSv.

In 2001 the plant investigated 5 events on radiation protection. One of them had to be reported according to pertinent directive of the Nuclear Safety Regulations. This number is insignificant, it shows an decreasing in comparison with the value of the previous year.

JAPAN

Fiscal year 2001

Onagawa Unit 3 BWR, 825 MWe (2436 MWt), owned by Tohoku EPCO started its commercial operation 30 January 2002.

Total Nuclear of Japanese NPPs in operation is 52 units (29 BWRs and 23 PWRs) and the total Capacity is 45,742 MWe, as of the end of FY2001.

Summary of National Dosimetric Trends

Collective doses

The fiscal year 2001 has resulted in almost the same level in dosimetry as the previous year for both BWRs and PWRs. The average annual collective dose per unit is 1.50 man·Sv, 1.68 man·Sv, and 1.27 man·Sv for all operating units, BWRs and PWRs, respectively.

In FY 2001, the major improvement works having significant collective dose during the planned outage were as follows:

BWRs:

- replacement of a shroud and other reactor internals (2.8 man·Sv for 1 unit);
- replacement of Steam Generator (1.9 man·Sv for 2 units);
- replacement of Primary Loop , Valve (0.9 man·Sv for 1 unit).

Individual doses

The annual average exposure of radiation workers was 1.2 mSv, which was the same level as previous year and the highest annual individual exposure was 25.5 mSv, which was well below the dose limit of 50 mSv/y.

Periodical inspections were completed at 21 BWR units and 19 PWR units. The average duration for periodical inspection was 103 days for BWRs and 82 days for PWRs. The shortest outage lasted 29 days.

For the following years

Neither steam generator replacements nor shroud replacements are scheduled for FY 2002 at present.

KOREA, REPUBLIC OF

Summary of national dosimetric trends

The dosimetric trend at the Korean NPPs shows continuous reduction in collective dose and this trend is expect to be continued by the view of the KHNP (Korea Hydro & Nuclear Power Corporation) head office who are currently implementing the second “ten-year dose reduction plan” to improve radiation protection programs in NPPs.

For the year of 2001, 16 NPPs were in operation; 12 PWR units and 4 CANDU units. A new PWR, Yonggwang Unit 5 had done the test operation in 2001. The average collective dose per unit for the year 2001 was 0.67 man·Sv dropping from 0.71 man·Sv in 2000, 0.85 man·Sv in 1999.

As in previous years, the outages of units in 2001 contribute the major part to the collective dose, 79.7% of the collective dose was due to works carried out during the outages. Average annual collective doses of both reactor types for 5 years and average annual collective doses per unit in 2001 are shown in the following tables:

Average annual collective doses for 5 years (man·Sv)

Year	1997	1998	1999	2000	2001
PWR (number of reactors)	0.88 (10)	1.04 (11)	0.84 (11)	0.77 (12)	0.67 (12)
CANDU (number of reactors)	0.62 (2)	1.01 (3)	0.85 (4)	0.55 (4)	0.67 (4)

Average annual collective and individual doses per unit for the year of 2001 (man·Sv)

NPP	Type	Outage Duration (days)	Collective Doses (man·Sv)	Average Individual Doses (mSv)
Kori 1	PWR	27	0.69	1.03
Kori 2	PWR	47	0.74	1.03
Kori 3	PWR	37	1.06	1.57
Kori 4	PWR	35	1.30	1.57
Yonggwang 1	PWR	-	0.04	0.95
Yonggwang 2	PWR	45	1.20	0.95
Yonggwang 3	PWR	-	0.08	0.44
Yonggwang 4	PWR	57	0.47	0.44
Ulchin 1	PWR	29	0.93	1.52
Ulchin 2	PWR	34	1.00	1.52
Ulchin 3	PWR	31	0.28	0.43
Ulchin 4	PWR	37	0.27	0.43
Wolsong 1	CANDU	67	1.44	1.44
Wolsong 2	CANDU	-	0.28	1.44
Wolsong 3	CANDU	44	0.65	0.86
Wolsong 4	CANDU	28	0.30	0.86

Events influencing dosimetric trends

The second “ten-year dose reduction plan” started in 2001 and financial support has been provided for the target NPPs. Accordingly, several areas of system such as SG, RCP, CRUD reduction, in-service inspections and spent fuel transfer to the dry storage have been improved. Additionally, implementation of the optimization principle has been emphasized and its result was being evaluated by the KHNP head office. The adaptation of several industry Good Practices: quick installation of shielding during outages; continuous monitoring of RHR piping during oxygenation process to identify the optimum dose rates; upgrading of the ADR system; regular ALARA Sub-Committee meetings; has recognized as good achievement.

Plans for major work in the coming year

The second “ten-year dose reduction plan” including the financial support will be continued until the year of 2010. The plan, which has been approved by the president of KHNP, includes detailed information on the scope of improvement as well as financial support. According to the plan, the average collective dose in target NPPs will be saved by a factor of 0.15 man·Sv per reactor.

LITHUANIA

Summary of national dosimetric trends

The average annual collective dose per unit for the year 2001 for the Ignalina nuclear power plant (INPP) (2 units with LWGR (RBMK) reactors): INPP personnel – 2.55 man·Sv, outside workers – 0.59 man·Sv. Total collective dose per unit was 3.14 man·Sv.

In 2001 the average annual collective dose per unit was 41% lower than in 2000 (in 2000 – 5.35 man·Sv). Such dosimetric trends were caused by effective implementation of ALARA program, using of work management programs and modernization of equipment at the INPP. The comparison of planned and actual doses illustrates the effectiveness of the measures made in order to reduce occupational exposure. Planned annual collective dose for INPP personnel was 9.03 man·Sv, for outside workers – 2.26 man·Sv. Total planned annual collective dose was 11.29 man·Sv or 5.65 man·Sv per Unit. Total number of workers wearing individual dosimeters was 4375 (3187 INPP personnel, 1188 outside workers). The maximal effective dose was 19.3 mSv. Average effective individual dose was 1.93 mSv.

In 2001 the assessment of internal exposure for 782 workers was carried out. There was no internal overexposure detected.

Number and duration of outages

In 2001 two outages were performed at the INPP. In 2001 the outage of Unit 1 took 63 days, outage of Unit 2 was 96 days. During the year 2001 the collective dose has distributed as following: normal operation – 23%, outage of Unit 1 – 32.4%, outage of Unit 2 – 44.6%.

The overall dose obtained by INPP personnel and outside workers after the implementation of jobs during the outages was 2.21 man·Sv for Unit 1 and 2.87 man·Sv for Unit 2.

The main works contributed to collective dose in Units 1, 2 were:

1. Reactor vessel: maintenance, repairs, replacement and inspection of the reactor fuel channels.
2. Main circulation circuit: preparation for the inspection, inspection and repairing of the primary system pipes.
3. Repairing of the reactor equipment and refuelling.

Issues of concern for 2002

Goals for Ignalina Nuclear Power Plant for the year 2002:

- the maximal individual dose should be below 20 mSv;
- the collective dose shall not exceed 9.15 man·Sv. This limit is determined in the dose budget for the year 2002 and approved by the Radiation Protection Centre;

- further implementation of the ALARA principle will be continued by conducting appropriate activities, such as: management of jobs, training of personnel, improving of working conditions, improving of technological processes, strengthening of quality assurance, safety culture, avoiding negative influence of the human factor. The measures foreseen for implementation of the ALARA principle are included in the Ignalina NPP ALARA Programme.

Regarding occupational exposure, the Radiation Protection Centre intends for the year 2002:

- to control how the requirements of legal radiation protection acts are implemented at the INPP;
- to evaluate trends of the occupational exposure of INPP personnel and outside workers;
- to improve constantly the form and contents of performed inspection activities at the plant;
- to control how the radiation protection requirements are implemented at the spent nuclear fuel storage;
- to perform an evaluation of the implementation of optimisation principle at the plant;
- to draft legal document establishing radiation protection requirements during the decommissioning of nuclear power plant.

MEXICO

2001 Collective Dose

Laguna Verde NPP (LVNPP): Two BWR Units rated 684 MWe each		
Unit 1	Total dose	**3.97 man·Sv**
	Normal operations	0.74 man·Sv
	8th Refueling outage	3.23 man·Sv
Unit 2	Total dose	**2.60 man·Sv**
	Normal operations	0.44 man·Sv
	5th Refueling outage	2.16 man·Sv
	Average Unit 1 and Unit 2	**3.29 man·Sv/Unit**

Main events influencing dosimetric trends /results

2001 was a year with two refuelling outages.

Unit 1, 8th refuelling outage (05/05/2001–13/07/2001), main dose contributing works (man·mSv):

- In Service Inspection 10 years to reactor vessel nozzles, Drywell (444.86).
- Change/Maintenance 32 Control Rod Drives (338.79).
- Condensate chambers (nuclear instrumentation) installation inside the Drywell (146.78).
- Cancellation Condensate mode of Residual Heat Removal System (93.35).

Unit 2, 5th refuelling outage (27/10/2001-31/12/2001), main dose contributing works (man·mSv):

- Condensate chamber (nuclear instrumentation) installation inside the Drywell (157.9).
- Change/maintenance 20 Control Rod Drives (148.4).
- Recirc Loop valve MV-8247 major maintenance (106.0).
- Cancellation Condensate mode of Residual Heat Removal System (102.2).

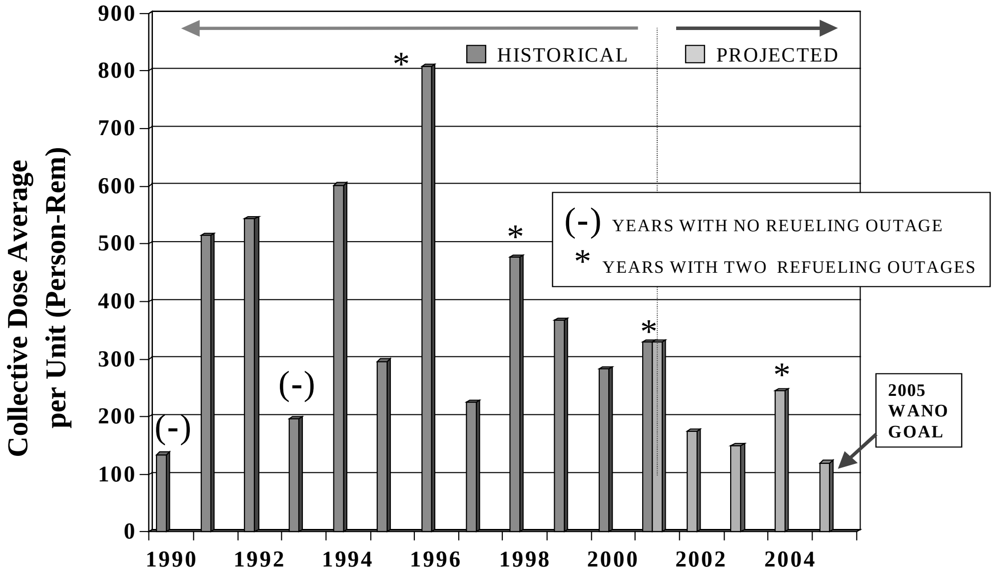
Major evolutions

- After the source term reduction LVNPP has been implementing since 1998, the BRAC index of U1 has reached a similar value as it was in 1992 (second year of commercial operations). A similar situation is observed as to Unit 2.
- Water Chemistry/source term:
  LVNPP Units are currently among the North American BWRs with lowest total Cobalt concentration in the reactor water. Unit 1 and Unit 2 are currently rated the 2nd and 6th lowest among 29 Units.
- LVNPP collective dose decreasing trend has been evident since 1996, even taking into account the anticipated 2001 peak due to concurrent refuelling outages in both LVNPP units. It is expected this was the last year with an average collective dose over 2 man·Sv per unit, at least under previsible scenarios.

Component or systems replacement

- Cancellation in both Units of the Condensation Mode of the Residual Heat Removal System (regulatory commitment).
- Substitution of old nuclear instrumentation for a new one (SRNMs).

Laguna Verde Nuclear Power Plant:
historical and projected collective dose



Dose reduction program evolution

The continuity of a reactor water chemistry control strategy based on Zinc injection and Iron concentration reduction has given excellent results as to the source term reduction (see discussion in the Major Evolutions section, above). Now, a complementary strategy is considering the optimisation of the time of exposure of radiological workers through: an upgraded planning process, a restrictive access control to radiation areas, a thorough implementation of the ALARA tools, an improved personnel training and an enhancement of the personnel safety culture.

Year 2002 technical aspects

The collective dose decreasing trend for Laguna Verde station continues. For 2002 the projected average collective dose per year per unit is expected in the order of 1.74 man·Sv, our lowest historical value, then continue improving to try to reach 1.2 man·Sv in 2005.

NETHERLANDS

The Dodewaard BWR (57 MWe) operated by GKN was shut down in March 1997 for political and economical reasons. The “Post Operation activities” and the project to realise a “safe enclosure” are progressing according to plan. At the moment, it is expected that defuelling will be completed in the early part of 2003. Afterwards, the unit will be converted in a “safe enclosure” facility, prior to final dismantling after a 40 year period.

The collective dose for the Dodewaard plant in 2001 was 95 man·mSv.

Regulatory:

The radiation protection standards based on the Euratom Guidelines are implemented in the Netherlands in March 2002.

ROMANIA

SNN-CNE PROD CERNAVODA operates a single Nuclear Power Plant of CANDU-600 type. The year of 2001 is the fifth full year of commercial operation.

In 2001, the collective dose was 575 man·mSv (including both external & internal doses), distributed over 451 exposed individuals i.e. those receiving reportable doses.

The highest individual dose was 7.94 mSv and the average dose for exposed workers was 1.26 mSv. Approximately 58% of exposed individuals received doses less than 1 mSv and further on less than 4 percent received doses above 5 mSv. No individual received doses above 10 mSv.

In comparison to previous years, there is an increase of number of exposed individuals but the highest and average dose is comparable to previous two years.

Station collective dose was higher compared to the previous year. The main contribution was from annual planned outage which counts for about 65% of the total collective dose of the year.

The main activities having significant impact on collective dose were as follows:

- steam generator inspection (two boilers);
- work in feeder cabinets (swagelock replacement, tubing inspection) during the planned outage;
- N 21 feeder replacement.

For the following year the main projects refer to:

- lower the dose recording level;
- start replacing electronic dosimeters;
- start revision of Radiation Protection Training Programme.

Further Information

Annual collective doses

- total effective dose: 574.9 man·mSv;
- external effective dose: 433.4 man·mSv;
- internal effective dose (due to tritium): 141.4 man·mSv;
- internal effective dose (due to other radionuclides, excluding tritium): none.

Summary of annual dosimetric trends

Years	Internal man·mSv	External man·mSv	Total man·mSv	Number of exposed workers	Number of individual doses between 5 and 10 mSv	Average individual dose by exposed worker
1996	0.60	31.70	32.30	74	0	0.40
1997	3.81	244.48	248.29	251	3	0.99
1998	54.37	203.35	257.72	339	2	0.76
1999	85.42	371.11	456.53	355	3	1.29
2000	110.81	355.39	466.20	372	6	1.25
2001	141.40	433.40	574.90	451	16	1.26

All individual doses were below 10 mSv.

Events influencing dosimetric trends

The main contribution to collective dose is from planned outage; compared to previous year, substantial contribution is from activities related to feeder replacement.

Major evolutions

- The main contribution to collective dose is due to annual outage which contributed with approximately 65% to the collective dose of year 2001.
- The annual outage included a feeder pipe replacement and a boiler inspection.

Issues of concern for 2002

Technical

- Improvement of Radiation Protection Training Programme.
- Replacement of old electronic dosimeters.
- Adjustments of dose recording levels to the latest IAEA recommendations.

Regulatory

- Issuing and implementation of specific regulations applicable to NPP (e.g. regulation on assignment of qualified experts, regulation on approving dosimetric health services).
- Licensing the siting and construction of the Cernavoda NPP Spent Fuel Dry Storage, including the assessment of the impact of the construction activities carried out on the safe operation of NPP.

RUSSIAN FEDERATION

Main data from Russian NPPs type WWER

The average annual collective dose per unit (personnel and contractors) in man·Sv/unit

Nuclear Power Plant		Collective dose (man·Sv/unit)							
Name	**Number &type**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Balakovo	4 units, WWER-1000	0.62	1.21	0.92	0.94	1.03	0.92	0.67	0.68
Kalinin	2 units, WWER-1000	2.77	2.22	1.83	1.77	1.52	1.46	1.49	1.24
Kola	4 units, WWER-440	2.21	1.56	1.76	0.89	1.02	1.71	1.02	1.10
Novovoronezh	5 units: 1,2-shut down 3,4-WWER-440; 5-WWER-1000	2.63	2.98	1.67	1.58	1.34	2.16	1.36	2.12
Volgodonsk	1 unit, WWER-1000								0.03
Average		2.07	1.99	1.55	1.30	1.23	1.56	1.13	1.03

Note: Volgodonsk NPP was started 30 March 2001.

Due to efforts of Operating Utility ("Rosenergoatom" concern) and NPPs management, NPPs radiation services were implemented, including organisational and technical measures and the collective doses were decreased in 2001 by a factor of 1.1 in comparison with 2000, and after the beginning of transition to new dose limits (1996) – by a factor of 1.5.

Number and duration of outages (including non-scheduled)

NPP	Unit	Number of outages	Duration of outages [days]
Balakovo	1	3	27
	2	2	54
	3	1	67
	4	2	60
Kalinin	1	1	72
	2	2	70
Kola	1	1	63
	2	1	42
	3	1	41
	4	2	46
Novovoronezh	3	1(reconstruction)	218
	4	2	67
	5	1	51

New plants on line

The Volgodonsk nuclear power plant started operation 30 March 2001.

New/experimental dose-reduction programmes

New dose-reduction programme has been elaborated for NPPs RBMK type (duration 2002-2005, cost – 6 million €).

Plans for major works in the coming year

- implementation in practice of woven shielding impregnated with lead;
- implementation of electronic personnel dosimeters (EPD) in NPPs.

SLOVAK REPUBLIC

The average annual collective dose per unit and reactor type PWR-WWER in Slovak republic for 2001 is 365.77 man·mSv

Bohunice Nuclear Power Plant (4 units)

The total annual effective dose in Bohunice NPP in 2001 calculated from legal film dosimeters was 1497.44 man·mSv (employees 798.45 man·mSv, outside workers 698.99 man·mSv). The maximum individual dose was 16.56 mSv (contractor).

Events influencing dosimetric trends in 2001

As it can be seen from the outages' review the main contributors to the total collective dose at Bohunice NPP were the Units 1 and 2. During those outages the specific modifications were performed in higher radiation fields than at Unit 3 and 4. All activities had been optimised.

Number and duration of outages

Unit 1 – 71 days major maintenance outage. Total collective dose was 521.00 man·mSv.

Unit 2 – 40 days standard maintenance outage. Total collective dose was 651.36 man·mSv.

Unit 3 – 45 days standard maintenance outage. Total collective dose was 121.33 man·mSv.

Unit 4 – 44 days standard maintenance outage. Total collective dose was 155.64 man·mSv.

Note: all data in this paragraph came from electronic operational dosimetry.

Major evolutions

Since January 1st the new "Slovak Radiation Law" had been put in force defining the financial equivalent of man·Sv. That significantly influenced the optimisation process at NPPs.

Component and system replacement

Old portal monitors at the exits from radiation-controlled areas were replaced by new ones fulfilling the national and international requirements.

The modification of the plant calibration facility for RP instrumentation started. The finishing of the works is planned in November 2002.

Safety-related issues

Replacement of the portal monitors at the exits from radiation controlled areas

New / experimental dose – reduction programmes

There were several programmes performed in 2001 aimed the elimination of the possible release of the iodine into the working environment (and thus to protect the workers against the internal contamination) in the beginning of the Unit 2 outage due to the leakage from the fuel elements. The other programmes were dedicated to test the gas purification system at the same unit.

The new optimisation process had started involving the new man·Sv financial equivalent.

Organisational evolutions

Lowering of the number of NPP RP employees by three persons.

Expected Principal Events for the Year 2002

Plans for major works in the coming year:

Unit 1 – 43 days standard maintenance outage.

Unit 2 – 43 days standard maintenance outage.

Unit 3 – 46 days standard maintenance outage.

Unit 4 – 46 days standard maintenance outage.

Technical issues of concern from radiation protection point of view

Following events in the field of modernisation of radiation instrumentation are expected: finishing of the installation of N16 monitors for Unit 3 and 4, finishing of the installation of spectrometry system for monitoring gas releases in ventilation stacks.

Mochovce Nuclear Power Plant (2 units)

Total collective effective dose (CED) for the two units was 697.2 man·mSv (CED was evaluated from legal film personal dosimeters), maximum individual effective dose was 8.06 mSv (contractor).

Events influencing dosimetric trends in 2001

The main contributors to the total CED at Mochovce NPP were planned outages and safety improvement projects at Units 1 and 2. The total CED for both units from normal operation was

38.98 man·mSv and CED from outages was 663.74 man·mSv (CED was evaluated on a base of results of operational electronic personal dosimeters).

Number and duration of outages

Unit 1 – 84 days long planned outage. Total CED was 585.58 man·mSv (plant pers. 255.74 man·mSv, contractors 329.84 man·mSv).

Unit 2 – 60 days long planned outage. Total CED was 78.16 man·mSv (plant pers. 36.25 man·mSv, contractors 41.91 man·mSv).

Note: The collective effective doses during outages were evaluated from electronic operational dosimetry.

Component and system replacement:

Old portal monitors at the exits from radiation-controlled areas were partly replaced by new ones fulfilling the national and international requirements. Gamma spectrometry system of the primary coolant for both units was put into operation.

Expected principal events for the Year 2002

Plans for major works in the coming year:

Unit 1 – 47 days standard maintenance outage combined with safety measures implementation.

Unit 2 – 78 days major maintenance outage combined with safety measures implementation.

Technical issues of concern from radiation protection point of view

Following events are expected in 2002 – finalising of installation of new radiation measurements – stack instrumentation, central radiation monitoring computer system, and teledosimetry system in vicinity of the NPP.

SLOVENIA

Radiological performance indicators of Krsko nuclear power plant for the year 2001

Collective radiation exposure was 1.13 man-Sv (0.215 man·mSv per GWh electrical output). Maximum individual dose was 15.81 mSv, average dose per person was 1.27 mSv.

Planned outage (9.5.01-18.6.01), 40 days

Outage collective dose was 0.995 man·Sv. Main additional activities were planned according to ALARA and their collective doses (in man·mSv) were:

- inspection of reactor coolant pump and replacement of its internals (63), inspection of primary system and reactor vessel (63), eddy current testing of 50% steam generators tubes (98), SG nozzle dams installation (20), replacement of split pins on the upper internals of reactor vessel (32), replacement of regenerative heat exchanger (86), installation of loose parts monitoring instrumentation (21), testing of hangers (53);
- replacement of one part of RHR System piping (33).

Major evolution

Krško NPP

There is a plan to reduce outage days to about 25 or 35 every second year. A longer-term ALARA programme will be implemented to reduce collective doses in the future.

In the years 2002-2003 reracking of the spent fuel pool will take place to provide enough space for the spent fuel of plant lifetime.

Regulation

In year 2002, the new Law on protection against ionising radiation and nuclear safety is going to be endorsed by Ministry of Environment and Ministry of Health.

Reviews

In year 2001, the first IAEA Occupational Radiation Protection Assessment Service (ORPAS) was in Slovenia.

SOUTH AFRICA

Summary of national dosimetric trends

In 2001, the annual collective dose for the nuclear power plant Koeberg Unit 1 (PWR) was 1316 mSv, for Koeberg Unit 2 (PWR) 992 mSv.

Events influencing dosimetric trends

During the outage of Koeberg Unit 2, evidence of through-wall leakage was found on the Safety Injection suction piping which connects the refuelling water storage tank to the low-head safety injection and containment spray pumps. Further external surface dye penetrant and metallurgical inspections confirmed stress corrosion cracking (SCC) at a number of locations – linked to residual forming stresses in the piping and adverse environmental (marine) conditions. The flaws found during the outage were potentially linked to storage tank room environmental conditions, including affected piping where penetrations from tank room are not sealed, resulting in salt-laden air ingress from the tank room into the Fuel Building. All the pipework considered to be at risk is 304L Austenitic stainless steel seamed thin walled pipework in the non-annealed state. This was inspected during the Refuelling Outage early in 2001 and three pipe elbows and one section of straight pipe was replaced. A Visual Inspection programme was put in place for other pipes in the same area.

At the first such inspection, three months into the operating cycle, evidence of leakage in the form of boron crystals was detected on the piping. The Regulator was notified and an immediate evaluation confirmed the defects were of the same type as previously experienced and were limited in size so that the functional capability of the pipe was not impaired. The pipe was declared “operable but degraded” and further inspections and engineering evaluations were launched which has shown that the SCC is more extensive than originally determined. The extent was underestimated due to the subsurface nature of some of the cracking. Inspection methods have been adjusted accordingly. This includes removal of approximately 250 microns of surface material of all affected pipework to expose cracking that mostly initiates at the base of corrosion pitting. Expert assessment did not show an immediate threat to pipe integrity but further assessments and completion of inspections in the short term on all potentially affected pipework for both the Koeberg units are needed to substantiate this. Koeberg management took a conservative decision to shut down Unit 2 while the above inspections are completed.

Stress Corrosion Cracking on a portion of the Unit 2 Safety Injection system piping resulted in additional dose of 85.67 mSv.

Number and duration of outages

Two re-fuelling outages were performed in 2001.

- Outage on Unit 1: duration 58 days.
- Outage on Unit 2: duration 61 days.

Major evolutions

The Radiation Protection rules in Eskom were revised and the latest IAEA safety fundamentals and safety standards were applied via a Radiation Protection Policy, Directives, Regulations and Standards. National Nuclear Regulator has accepted the Radiation Protection rules for implementation at Koeberg Nuclear Power Station.

New/experimental dose-reduction programmes

Dose targets have been derived for all Departments, Section and Groups at Koeberg Nuclear Power Station in order to maintain the focus on dose reduction.

A Radiation Protection Forum review and approve dose significant jobs.

Issues of concern for 2002

- Radiation Protection skills retention and development.
- Improved compliance to radiation protection rules.

Technical

Vehicle radiation monitors and gamma walk-through contamination monitors were installed at Koeberg Nuclear Power Station.

Regulatory

Implementation of a process-based licensing strategy for Koeberg Nuclear Power Station by the Eskom, Generation Safety & Assurance Division and the National Nuclear Regulator.

SPAIN

In the year 2001, the average dose per outage has been 0.470 man·Sv for PWR (5 units) and 1.398 man·Sv for BWR (1 unit). Per plant, these collective doses are shown in the following table.

NPP	Type	Duration (days)	Coll. Doses (man·Sv)	Comments
J. Cabrera	PWR	44	0.856	
Almaraz I	PWR	–	0.110	No outage
Almaraz II	PWR	21	0.419	
Ascó I	PWR	27	0.750	
Ascó II	PWR	26	0.608	
Vandellos II	PWR	–	0.028	No outage
Trillo	PWR	27	0.225	
S.M Garoña	BWR	1.034	34	
Cofrentes	BWR	–	–	No outage

Relating the total annual collective dose, the PWR average for this year is 0.428 man·Sv and the 3 year rolling average is 0.58 man·Sv.

For BWR the total collective dose average for this year is 0.935 man·Sv and the three-year rolling average is 1.62 man·Sv.

	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	2	2.45	1.79
2000	6	0.59	0.62	1	1.47	1.48
2001	5	0.43	0.58	1	0.94	1.62

As it can be seen, in PWR the downward trend in the three-year rolling average continues, with values in line with those of the previous years. The annual collective dose in 2001 is the lowest of the last 5 years, taking into account that there have been 5 outages. For BWR, the yearly value is quite lower than in 2000, with also a unique refuelling outage. The three-year rolling average has increased by 0.14 man·Sv, because this time all the three years considered within the average have had at least one outage.

The 1 034 man·mSv outage dose in Garoña BWR beats a record in its history after the efforts devoted to optimisation of work management and source term reduction strategies. Individual doses have also been reduced.

In Trillo NPP, a new interim storage building has been constructed to contain the dry spent fuel casks. The first casks will be used after the 2002 outage.

Decommissioning labours in Vandellos I NPP are going on. In the year 2001 the following main activities were carried out: Decontamination of different areas, Clearance material disposal, Scarifying of walls, ceilings and floors in the spent fuel pool and in the Graphite Silos Sleeves. Dismantling of the liquid radwaste tank, the spent fuel pool water treatment system, the graphite sleeves crushing cell, and the cell for separation of crushing graphite and braces. On the other hand, 395 exposed workers participated in the different tasks during 2001, receiving a total collective dose of 197.45 man·mSv.

The new Regulation on Ionising Radiations Sanitary Protection (Royal Decree 783/01 based on the European Directive 96/29/Euratom) was finally issued on July 6th 2001, to come into force in January 2002. A working group with representatives from the utilities the and the regulatory body was created with the objective of developing a “Generic Radiation Protection Plan” in order to harmonise the practical criteria to comply with the regulations. This working group successfully completed this task by December 2001, creating a new framework that includes items such as:

- Limiting values and reference levels for radiological zones in terms of dose rate, airborne contamination and surface contamination.
- Reference levels for internal and external Dosimetry and surface contamination.
- Regulation of access and permanence conditions for visits to radiological areas.
- New values for ALIs (Annual Limits of Intake) and DAC (Derived Air Concentration) resulting from 20 mSv of annual dose and a working year of 2000 hours.
- Criteria for clothing and protective equipment reuse.

SWEDEN

Collective dose and dosimetric trends

The total collective dose for the Swedish NPPs was 6.7 man·Sv.

This year was the fourth year with decreasing collective dose. This is a result of long time efforts to try to reduce the dose rates and to improve the radiation management. The modernisation work at some of the plants has resulted in less maintenance work and inservice inspections.

The average collective dose per unit is 0.71 man·Sv for BWRs and 0.35 man·Sv for PWRs.

Collective doses and length of outages in Swedish NPPs in 2001

Reactor	Type	Length (days)	Collective Dose (man·Sv)
Barsebäck 2	BWR	36	0.54
Forsmark 1	BWR	13	0.25
Forsmark 2	BWR	13	0.24
Forsmark 3	BWR	48	1.18
Oskarshamn 1	BWR	25	0.35
Oskarshamn 2	BWR	24	0.66
Oskarshamn 3	BWR	17	0.19
Ringhals 1	BWR	32	0.77
Ringhals 2	PWR	29	0.33
Ringhals 3	PWR	31	0.27
Ringhals 4	PWR	39	0.29
Total	**LWR**	**307**	**5.07**

Thus the collective dose per day and reactor is 16.5 man·mSv /outage day.

Plans for major work in the coming year (2002)

On 7 December Oskarshamn 1 was shut down for further modernisation. The start up is according to the plan on 23 October 2002. Among other things the turbine will be exchanged as well as the pumphousing of the reactor main recirculation pumps. There will also be a new control room and a four subbed electrical support. The collective dose is calculated to be round about 5 man·Sv.

During this year outage of Barsebäck 2 the modernisation programme starts and will continue during the coming three years outages. This year, the reactor main recirculation system will be exchanged among other things.

SWITZERLAND

Summary of dosimetric trends

Plant	Unit	Planned outage (man·Sv)	Production (man·Sv)	Annual collective dose (man·Sv)
KKB	Beznau I	0.076	0.0705	0.1465
	Beznau II	0.690	0.0705	0.7605
KKG	Gösgen	0.429	0.111	0.540
KKL	Leibstadt	0.710	0.300	1.010
KKM	Mühleberg	0.542	0.380	0.922

Events influencing dosimetric trends

KKB II

During the outage in KKB II there was a significant increase of the dose rates in some parts of the containment after the cooling of the primary system. It is assumed that ^{58}Co was mobilised from the reactor core to the different components of the reactor coolant and residual heat systems. The effect became stronger because of the not planned shortening of the cleaning process from 12 to 6 hours at a temperature of 120°C. The collective dose therefore reached 0.69 man·Sv, while 0.441 man·Sv was planned.

KKL

The collective dose for the outage in KKL was about 25% lower than planned. This was reached partly thanks to mock-up-training and careful planning of tasks.

KKM

There was a significant reduction of the average dose rate on the components in the primary circuit, thanks to the adding of noble metals and hydrogen in the cooling medium. The average dose rate for 2001 was 1.82 mSv/h compared with 4.61 mSv/h for 2000. This especially had a positive influence on the collective dose for the workers in the drywell.

The adding of hydrogen to the cooling medium leads to an increase of the radioactive nitrogen (N-16). The average dose rate by the fence around KKM reached 0.063 mSv/week. In the HSK guideline HSK-R-11 the limit is laid down at 0.1 mSv/week.

Number and duration of outages

Unit	Outages	Outage duration
KKB I	1	11 days
KKB II	1	68 days (due to the renewal of the reactor protection and control system - computer based system PRESSURE).
KKG	1	22 days
KKL	1	24 days
KKM	1	24 days

New plants on line/plants shut down

ZWILAG

Construction began for a storage for low and medium radioactive waste. In the storage for spent fuel and vitrified waste there were 3 containers (2 with spent fuel and 1 with vitrified waste) at the end of 2001. Improvements on the furnace for radioactive waste; the supply of oxygen and the system for the charging of barrels into the furnace were modified.

Components or system replacements, safety related issues, unexpected events

In KKB II, the old reactor control system was replaced by a new computer based system (project PRESSURE).

Safety-related issues

Falsification of checklists in KKL Leibstadt power plant led to the dismissal of 2 persons (INES 1).

Unexpected events

In KKL, a temporary increase of ^{131}I was detected in the containment air after shutdown due to fuel damage (1 fuel rod). One person incorporated iodine which led to a dose of 0.2 mSv.

New/experimental dose reduction programmes

In KKM, a mobile transport system for lead-blankets was successfully tested. The system allows a faster and easier transport of lead for the shielding in the controlled area (i.e. drywell) with a reduction of time, dose and effort.

Plans for major work in 2003

Starting up of the furnace for radioactive waste in ZWILAG.

UKRAINE

Summary of national dosimetric trends

In 2001, the average annual collective dose per WWER reactor in Ukraine according to NNEGC “EnergoAtom” was 1.29 man·Sv/unit, 7% lower than the corresponding value in 2000.

Events influencing dosimetric trends

By the end of 2001, an exposure dose analysis was performed and radiation safety of the personnel during NNEGC “EnergoAtom” NPP planned unit outages was ensured.

In 2001 collective and individual personnel exposure dose prognoses for the outage period were prepared based on the outage schedule, current radiation situation at the unit and previous outage analysis. According to the unit outage results personnel exposure analysis was performed and special reports issued.

Number and duration of outages

Annual average duration of the outage in NNEGC "EnergoAtom" over recent 5 years is (days/unit):

Year	Annual average outage duration [days/unit]
1997	71.5
1998	89.2
1999	92.6
2000	89.8
2001	70.2

Organisational evolution

Currently integrated approach to exposure dose accounting is absent concerning separate NPP systems and activity types.

As a result it impossible to perform a high quality comparative analysis and organise NPP personnel experience exchange on its basis which in turn makes it difficult to perform activities reducing NPP personnel exposure doses.

To resolve this problem NNEGC "EnergoAtom" has developed the methodology for personnel exposure dose analysis in time of radiation dangerous activities.

The methodology was developed on the basis of existing NPP practical experience taking into consideration international recommendations (adapted to the international ISOE system).

Implementation of the methodology will allow to compare and assess NPP activity directed at exposure dose reduction that will lead to outage exposure dose reduction.

Safety-related issues

A range of activities was performed at Zaporozhe NPP using ALARA principle widely used at NPPs abroad.

During the planned unit outages ALARA working groups were working, refining methodology modes during radiation dangerous activity organisation.

According to exposure dose analysis the major dose expenditure is connected with such activities as inspection and maintenance of the reactor, steam generators and MCP (main circulation pump).

To reduce the doses during activities connected with examination and maintenance of high-level activity equipment it is necessary to keep on looking for and implementing automatic metal quality examination and control systems and efficient remote methods of decontamination.

Utilisation of remote measures of visual control (television systems) and steam generator tightness control systems as well as high-level activity equipment control reduces the number of personnel having doses close to allowable or control doses and reduces personnel collective exposure dose.

New dose reduction programme

In January 2002, a joint meeting of Regulatory bodies (Ministry of Health Protection and State Committee on Nuclear Regulation) and NNEGC "EnergoAtom" took place, where the implementation of the" "Program of transition of nuclear power enterprises of Ukraine to operation meeting the requirements of RSSU-97" was analysed. The main objective of the "Programme" is transition to new NPP personnel occupational exposure dose standards (20 mSv/year) – revision of regulations and requirements to meet the new standards – introduction of exposure dose planning during the planned outage etc. was accomplished.

UNITED STATES

Summary of USA occupational dose trends

The USA PWR and BWR occupational dose averages for 2001 continued a downward trend for the 104 commercial reactors:

Reactor type	Number of Units	Total collective dose	Dose per reactor
PWR	69	62.732 man·Sv	0.91 man·Sv/unit
BWR	35	48.354 man·Sv	1.38 man·Sv/unit

The total collective dose for the 104 reactors in 2001 was 111.085 man·Sv, a reduction of 11.6% from the 2000 total. The resulting average collective dose per reactor for USA LWR was 1.08 man·Sv/unit: the lowest average collective dose ever recorded for US light water reactors.

The 2001 PWR dose represents a 5% decrease from the 2000 value and is only the third time since 1969 that the average PWR annual dose has been below 1.00 man·Sv/unit.

The 2001 BWR dose represents an 18% decrease from the 2000 value and is less than half of the US BWR average dose seven years ago.

Events influencing dose trends

The Institute of Nuclear Power Operations (INPO) published the year 2005 collective dose goals for USA LWRs including 0.65 man·Sv per reactor unit for PWRs and 1.20 man·Sv per reactor unit for BWRs. Station ALARA organizations have prepared 5-year dose reduction plans to meet the challenging 2005 INPO dose goals.

In the year 2001, US nuclear power plants generated 21 percent of the electricity generated by U.S. utilities. Net capacity factors for all units have increased from 70% in 1991 to 90% in 2001.

Shorter refueling outages were a significant factor in achieving higher annual megawatt output. The average/mean outage duration for US LWRs have decreased from 105/76 days in 1990 to 37/34 days, respectively, in 2001. Careful outage work planning and aggressive outage management, based, in part, on concepts contained in the NEA Expert Group Report on Radiological Work Management (1997), have accomplished significant improvements in outage duration and dose reduction at US plants.

The addition of noble metals shortly after depleted zinc addition resulted in 10 times dose rate increases at Quad Cities (BWR). Fuel failures are Browns Ferry (BWR) and LaSalle County (BWRs) has resulted in unscheduled unit shutdowns.

Steam generator replacements

Steam Generator Replacements were completed at Farley 2, Kewaunee 1 and Shearon Harris 1 in 2001 with the following duration and dose results:

Plant	Duration (days)	Number of Steam Generators	Total Dose	Dose per Steam Generator replaced
Farley 2	73	3	1.34 man·Sv	0.45 man·Sv
Shearon Harris 1	83	3	1.35 man·Sv	0.45 man·Sv
Kewaunee 1	73	2	1.18 man·Sv	0.59 man·Sv

Safety-related issues

A significant contributor to PWR dose has been the discovery of boric acid corrosion of PWR reactor heads starting with the Oconee plant in May, 2001. Regulatory mandated PWR reactor head inspections were required. Significant repairs were necessary on the Palisades reactor head. Significant wastage of the reactor head at Davis Besse has resulted in extensive engineering analysis and regulatory attention. A replacement head from the canceled Midland Plant, Unit 2 has been secured to replace the Davis Besse head. ISOE information sharing on the French 1994-97 experience with PWR reactor head replacements has been beneficial to the current US PWR industry efforts.

Regulatory focus

Plant life extensions were granted to several licensees by the US Nuclear Regulatory Commission to provide an additional 20 years of operation. The US NRC management deleted sensitive nuclear power plant data from the public web sites (e.g., nuclear plant longitude and latitude numbers) since the tragic September 11, 2001 terrorist attack on the World Trade Center in New York and the Pentagon in Washington DC. Security systems have been strengthened at US nuclear power plants.

The industry-regulatory interface continues to be focused on control of access to high and very high radiation areas. Also, the control of unplanned or unintended dose is a strong radiation protection management issue at US LWRs. Further, there is considerable discussion on means of assessing the efficacy of plant ALARA programs via utility self-assessments and/or periodic regulatory inspections.

Future issues

Five US nuclear utilities have announced intentions to go through the site permitting process as a first step to potentially constructing new nuclear units in the next 5 years. Additionally, TVA plans to bring Browns Ferry Unit 1 back on line after being in administrative shutdown since 1984.

The price of existing nuclear power plants appears to have peaked in 2001 with the following nuclear units being purchased:

Nine Mile Point 1,2	Indian Point 2, 3
Crystal River	Connecticut Yankee
Fitzpatrick	Pilgrim

In 2002, Seabrook was purchased and Clinton, TMI 1 and Oyster Creek were offered for sale to 5 US nuclear utilities by partial-owner British Energy.

New operating companies were also formed in 2001 including Nuclear Management Company, which manages but does not own the following units:

Palisades	Point Beach 1,2
Kewaunee	Monticello
Prairie Island 1,2	Duane Arnold

3. ISOE PROGRAMME OF WORK

3.1 Achievements of the ISOE Programme in 2001

The Information System on Occupational Exposure made the following achievements in the year 2001:

Data collection and management

Collection of ISOE 1 data

ISOE participants provided their 2000 data using the ISOE Software under Microsoft ACCESS. ETC received all 2000 data from European, Asian, Canadian and Mexican utilities. All IAEATC participants provided data, except the Russian Federation, which joined the ISOE programme during 2000. Pakistan provided 2000 data and historical data. The US NRC supplied data from US nuclear power plants (tables A, B, C) for the years 1999 and 2000.

Data release

In June 2001, the ISOEDAT database with data from 1969 to 2000 was sent to the European participants and to the other Technical Centres for distribution. A second release including the Asian data was sent end October 2001 (The data from Japanese and Canadian reactors could not be included due to the late arrival of the data).

Database and ISOE Software were provided on CD-ROM in ACCESS 97, ACCESS 2000 and in a run-time version of ACCESS 97. Between these official releases on CD-ROM, several updates of the database could be downloaded from the password protected ETC server.

Collection of ISOE 2 data, once the input module has been developed

The input module to collect ISOE 2 data is under development.

Collection of ISOE 3 data

The input module to collect ISOE 3 data has been distributed to ISOE participants in February 2002. Historical ISOE 3 (NEA 3) reports have been included in the ISOE database. Collection of ISOE 3 data has started.

After writing a new ISOE 3 report, the author will produce a database file, using the ISOE Software export module. This file will be sent via e-mail to the European Technical Centre for processing and distribution. The ETC will check whether the report contains a proposal for a new entry to the descriptors, if relevant prepare and amend the retrieval lists, and will then distribute the file via the NEA e-mail remailing system to all ISOE participants.

Documents and reports

ISOE Annual Report 2000 – The report was published and distributed in October 2001.

Ten years of ISOE – **Report**: As the ISOE System reached its 10th anniversary, the programme collected, analysed and discussed numerous results, studies, experiences, trends etc. in the arena of occupational exposure. In order to promote further the ISOE System and to demonstrate its value for applied radiation protection in nuclear power plants, the report ***ISOE – Information System on Occupational Exposure, Ten Years of Experience, OECD, 2002*** was published in March 2002.

Information Sheets issued in 2001: The ISOE Technical Centres performed in 2001 a series of analyses, which were published as Information sheets. A complete list of Information sheets can be found in Annex 1: List of publications.

International ISOE Workshop on occupational exposure in nuclear power plants

Organisation of the 2001 International ALARA Symposium, 3-7 February 2001 in Anaheim, California (USA)

The 2001 International ALARA Symposium was held 3-7 February 2001, in Anaheim, California (USA), to provide a global forum to promote the exchange of ideas and management approaches to maintaining occupational radiation exposures As Low As Reasonably Achievable (ALARA). The theme of the symposium was "Excellence in Occupational Dose Reduction in the New Millennium: The First International ALARA Symposium in the 21st Century." The symposium was sponsored by the North American Technical Centre (NATC), held in conjunction with the National Registry of Radiation Protection Technologist and the Health Physics Society mid-year meeting.

The symposium featured 36 technical papers, 10 continuing education short courses and 53 vendor exhibits on the latest approaches in radiological work management, dose control and dose measurement. Over 485 individuals attended the Joint ISOE-HPS meeting representing over 18 countries. (Actual ISOE registrants were approximately 150 ISOE members and vendors.)

Organisation of the Third EC/ISOE Workshop on "Occupational Exposure Management at Nuclear Power Plants", Portoroz, Slovenia, 17-19 April 2002

The ETC prepared, in close collaboration with EC, and with the support of the IAEA, the third EC/ISOE Workshop on Occupational Exposure Management at NPPs, in Portoroz, Slovenia, 17-19 April 2002.

Data analysis

Special Meeting on Data Codification

At its June 2001 meeting, the WGDA suggested to convene a Special Meeting on Data Codification, in order to resolve existing problems with the data codification structure of new ISOE 3 reports and of the ISOE 1 data in the ISOEDAT database. To achieve broad participation on this issue, members of the ISOE Bureau, the ISOE Working Group on Data Analysis and the ISOE Working Group on Software Development were invited to the meeting on 1-2 October 2001.

The special meeting was successful to suggest a data codification structure for the ISOE 3 reports, which was included in the software.

The special meeting also agreed on a sensible compromise on how to structure the list of tasks in the ISOE 1 data. The ISOE Working Groups will present a proposal to the ISOE Steering Group for discussion and final approval.

Software development

ISOE 2 Software development

The implementation of ISOE 2 in the ISOE Software under Microsoft ACCESS had to be postponed until the finalisation of the ISOE 3 Software development.

ISOE 3 Software development

The input module to collect ISOE 3 data has been developed, tested and approved by the ISOE Working Group on Software Development and by the Working Group on Data Analysis. Collection of ISOE 3 data has started.

Contact with WANO

In order to improve collaboration and synergy with WANO, the ISOE Steering Group started a process to establish a close co-operation between ISOE and WANO in the field of occupational exposure at nuclear power plants.

Web pages

ISOE Web information at the NEA's, IAEA's and ISOE Technical Centres' web sites is co-ordinated, continuously maintained and regularly updated by the Joint Secretariat and the 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
NATC	http://hps.ne.uiuc.edu
NEA	http://www.nea.fr/html/jointproj/isoe.html
WANO	http://www.wano.org.uk

3.2 Proposed programme of work for 2002

The Information System on Occupational Exposure programme for the year 2002 includes:

Status of participation

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

Data collection and management

- Promotion of the preparation of ISOE 3 reports.
  - Commitment of National co-ordinators to organise the preparation and inclusion of at least a few ISOE 3 reports into the system.
  - Promotion of ISOE 3 reports by the Technical Centres.
  - The best ISOE 3 reports will be awarded each year at the annual ISOE ALARA Workshop/Symposium.
- Reorganisation and collection of ISOE 2 data, using the ISOE data input module.
- Collection of ISOE 1 data for the year 2001.
- Issuance of two updates of the ISOEDAT database and distribution in June 2002 and September 2002.

Documents and reports

ISOE Annual Report 2001 – objective to publish the report in September 2002

Information Sheets planned for 2002:

	Yearly analyses	**Technical Centre**
1	Asian dosimetric results: 2001 data and trends	ATC
2	Preliminary European Dosimetric Results for the year 2001	ETC
3	Annual outage duration and doses in European reactors (update)	ETC
4	Information on exposure data collected for the year 2001	IAEATC
5	3-year rolling average annual dose comparisons US PWR, 1999-2001	NATC
6	3-year rolling average annual dose comparisons US BWR, 1999-2001	NATC
7	3-year rolling average annual dose comparisons Canadian CANDU, 1999-2001	NATC
8	US PWR refuelling outage duration and dose trends	NATC
9	US BWR refuelling outage duration and dose trends	NATC

Special analyses		Technical Centre
1	Asian occupational exposure during periodic inspection outages	ATC
2	Analysis of the vessel head replacement – update	ETC
3	Survey on neutron doses	ETC
4	Steam generator analysis – update	ETC
5	Partial replacements of the Residual Heat Removal system piping in France	ETC
6	Efficiency of zinc and noble metal injection for PWRs	ETC
7	Radiation Protection during industrial radiography in NPPs	ETC
8	Status of decommissioning data in the ISOEDAT database	ETC and NEA
9	Control rod drive maintenance dose trends at BWR	NATC
10	Dose trends with motor operated valves at CANDU plants	NATC
11	North American experience with reactor head inspections	NATC
12	Experience with zinc and noble metal injection in BWRs	NATC

Data analysis

Promotion of the preparation of ISOE 3 reports.

Initiation of new ISOE data analyses.

Software development

The general objective is to finalise software development in 2002. The following items remain to be developed:

- Implementation of the modified structure of data codification (task list for ISOE 1 data).
- Implementation of ISOE 2 data in the ISOE Software under Microsoft ACCESS.
- Including necessary translations in other languages.
- Further improvement of the MADRAS software by implementing new push-buttons.
- Finalisation and publication of User’s Manuals for the management of ISOE 1 data, ISOE 2 data and ISOE 3 reports using the ISOE Software.

The ETC offers to organise training sessions in the different European countries on request in order to meet the user’s needs.

Launching of a new ISOE Working Group for interaction with ICRP

Launching of an ***ISOE Working Group: New concepts of ICRP, the view of radiation protection in nuclear facilities*** to interact with the International Commission on Radiological Protection (ICRP) in order to provide the occupational radiation protection specialists’ views on the development of new ICRP recommendations.

Web pages and e-mail re-mailing system

Regular update of the co-ordinated ISOE Web information Further promotion of the e-mail re-mailing system installed at the NEA.

Further topics of interest

Topic
Dosimetry: • Electronic vs TLD; Active vs Passive. • Lessons learned by those who use electronic dosimetry as official dosimetry. • Neutron dosimetry (important for fuel transport). – technical abilities; – calibration; – possible use in emergency situations with high dose rates
Optimisation and training in radiation protection (How to train the next generation?)
Ageing workforce
External companies responsibilities in optimisation
Criteria for the calculation of collective dose (reporting level)

Annex 1

LIST OF ISOE PUBLICATIONS

Reports

1. *ISOE – Information System on Occupational Exposure, Ten Years of Experience, OECD, 2002.*

2. *ISOE – Tenth Annual Report of the ISOE Programme: Occupational Exposures at Nuclear Power Plants: 2000*, OECD, 2001.

3. *ISOE – Ninth Annual Report of the ISOE Programme: Occupational Exposures at Nuclear Power Plants: 1999*, OECD, 2000.

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

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

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

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

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

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

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

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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 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
No. 13, September 2000	Japanese Dosimetric Results: FY 1999 Data and Trends
No. 14, September 2000	Japanese Occupational Exposure During Periodical Inspection at LWRs Ended in FY 1999
No. 15, October 2001	Japanese Dosimetric results: FY 2000 data and trends
No. 16, October 2001	Japanese occupational exposure during periodical inspection at PWRs and BWRs ended in FY 2000
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 1994-1996 data (restricted distribution)
No. 15, September 1998	PWR collective dose per job 1994-1996 data (general distribution)
No. 16, July 1998	Preliminary European Dosimetric Results for 1997 (general distribution)

European Technical Centre (cont'd)	
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
No. 21, May 2000	Investigation on access and dosimetric follow-up rules in NPPs for foreign workers
No. 22, May 2000	Analysis of the evolution of collective dose related to insulation jobs in some European PWRs
No. 23, June 2000	Preliminary European Dosimetric Results 1999
No. 24, June 2000	List of BWR and CANDU sister unit groups
No. 25, June 2000	Conclusions and recommendations from the 2nd EC/ISOE workshop on occupational exposure management at nuclear power plants
No. 26, July 2001	Preliminary European Dosimetric Results for the year 2000
No. 27, October 2001	Annual outage duration and doses in European reactors
No. 28, December 2001	Trends in collective doses per job from 1995 to 2000
No. 29, April 2002	Implementation of Basic Safety Standards in the regulations of European countries
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
No. 5, September 2000	Preliminary dosimetric results for 1999
No. 6, June 2001	Preliminary dosimetric results for 2000
North American Technical Centre	
No. 1, July 1996	Swedish Approaches to Radiation Protection at Nuclear Power Plants: NATC site visit report by Peter Knapp
No. 2, 1998	Monetary Value of person-REM Avoided 1997
No. 3, 2001	3-year rolling average annual dose comparisons US PWR, 1998-2000
No. 4, 2001	3-year rolling average annual dose comparisons US BWR, 1998-2000
No. 5, 2001	3-year rolling average annual dose comparisons CANDU, 1998-2000
No. 6, 2001	U.S. PWR 2000 Occupational Dose Benchmarking Charts
No. 7, 2001	U.S. BWR 2000 Occupational Dose Benchmarking Charts
No. 8, 2001	Monetary Value of person-REM Avoided: 2000

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
February 2001, Anaheim, California, USA	Third International ALARA Symposium
February 2002, Orlando, Florida, USA	North-American National ALARA Symposium
European Technical Centre	
September 1998, Malmö, 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
April 2002, Portoroz, Slovenia	Third ISOE European Workshop on Occupational Exposure Management at Nuclear Power Plants

Annex 2

ISOE PARTICIPATION AS OF DECEMBER 2001

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, 2
Bulgaria	***Nuclear Power Plant Kozloduy***	***Kozloduy 1, 2, 3, 4, 5, 6***
Canada	Bruce Power Ontario Power Generation Hydro Quebec New Brunswick Power	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*, 2* pre-op. units 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 BadenWürttemberg (EnBW)	Obrigheim Philippsburg 1, 2
	E.On	Grafenrheinfeld Isar 1, 2 Brokdorf Grohnde Stade Unterweser
	Neckarwerke AG, TWS Stuttgart	Gemeinschafts – Kernkraftwerk Neckar, Neckarwestheim (GKN) 1, 2
	Hamburgische Elektrizitäts-Werke AG (HEW)	Brunsbüttel
	HEW and PE	Krümmel
	RWE Power	Biblis A, B Mülheim-Kärlich Gundremmingen B, C Emsland
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, 3
	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
	Japan Atomic Power Co.	Tokai 2 Tsuruga 1, 2
	Japan Nuclear Cycle Development Institute (JNC)	Fugen ATR
Korea	Korean Hydro and Nuclear Power	Wolsong 1, 2, 3, 4 Kori 1, 2, 3, 4 Ulchin 1, 2, 3, 4 Yonggwang 1, 2, 3, 4

Country	Utility	Plant Name
Lithuania	Ignalina 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
Russian Federation	Rosenergoatom	Balakovo 1, 2, 3, 4 Beloyarsky 3 Kalinin 1, 2 Kola 1, 2, 3, 4 Novovoronezh 3, 4, 5
Slovakia	Jaslovské Bohunice NPP Slovenske Electrarna	Bohunice 1, 2, 3, 4 Mochovce 1, 2
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 Ringhals AB	Barsebäck 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 Mühleberg Beznau 1, 2 Gosgen
Ukraine	Ministry of Energy of Ukraine	Khmelnitski 1 Rovno1,2,3 South Ukraine 1,2,3 Zaporozhe 1,2,3,4,5,6
United Kingdom	Nuclear Electric	Sizewell B

Country	Utility	Plant Name
United States	Amergen Energy Company	Clinton 1 Oyster Creek 1 TMI 1
	American Electric Power	D.C. Cook 1, 2
	Arizona Public Service Co.	Palo Verde 1, 2, 3
	Calvert Cliffs Nuclear Power Plant Inc.	Calvert Cliffs 1, 2
	Carolina Power and Light Co.	H. B. Robinson 2
	Entergy Nuclear NE	Indian Point 3 Pilgrim 1
	Exelon	Braidwood 1, 2 Byron 1, 2 Dresden 2, 3 LaSalle County 1, 2 Limerick 1, 2 Peach Bottom 2, 3 Quad Cities 1, 2
	FirstEnergy Corporation	Beaver Valley 1,2 Davis Besse 1 Perry 1
	Nuclear Management Corporation	Palisades 1 Point Beach 1, 2
	Pacific Gas and Electric Company	Diablo Canyon 1, 2
	PPPL Susquehanna LLC	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

Definitively Shutdown Reactors

Country	Utility	Plant Name
France	Électricité de France	Bugey 1 Chinon 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
Russian Federation	Rosenergoatom	Beloyarsky 1, 2 Novovoronezh 1, 2
Spain	UNESA	Vandellos 1
Sweden	Barsebäck Kraft AB	Barsebäck 1
Ukraine	Ministry of Energy of Ukraine	Chernobyl 3
United States	Amergen Energy Company Consumers Power Company Exelon Pacific Gas and Electric Company Southern California Edison Co.	TMI 2 Big Rock Point 1 Dresden 1 Peach Bottom 1 Zion 1, 2 Humboldt Bay 1 San Onofre 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	Ministry of Economy, Trade and Industry (METI)
Korea	Ministry of Science and Technology (MOST) Korea Institute of Nuclear Safety (KINS)
Lithuania	Radiation Protection Centre
Mexico	Commision Nacional de Seguridad Nuclear y Salvaguardias
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)
South Africa	Council for Nuclear Safety
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	http://isoe.cepn.asso.fr
Asian Region (ATC)	Nuclear Power Engineering Corporation (NUPEC), Tokyo, Japan	http://www.nupec.or.jp/isoe/
IAEA Region (IAEATC)	International Atomic Energy Agency (IAEA), Vienna, Austria Agence Internationale de l'Énergie Atomique (AIEA), Vienne, Autriche	http://www.iaea.org/ns/rasanet/programme/ radiationsafety/ radiationprotection/isoe/ techcentreact.htm
North American Region (NATC)	University of Illinois, Champagne-Urbanna, Illinois, U.S.A.	http://hps.ne.uiuc.edu

INTERNATIONAL COOPERATION

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

COUNTRY – TECHNICAL CENTRE AFFILIATIONS

Country	Technical Centre
Armenia	IAEATC
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
Russian Federation	IAEATC
Slovakia	ETC
Slovenia	IAEATC
South Africa	IAEATC
Spain	ETC
Sweden	ETC
Switzerland	ETC
Ukraine	IAEATC
United Kingdom	ETC
United States	NATC

Annex 3

ISOE BUREAU AND CONTACT INFORMATION

Bureau of the ISOE Steering Group

Mr. Borut Breznik (Chairman) Radiation Protection Department, Krsko NPP Vrbina 12 SI-8270 Krsko Slovenia	Tel: Fax: E-mail:	+386 7 4802 287 +386 7 49 21 006 borut.breznik@nek.si
Mr. Carl Göran Lindvall (Chairman Elect) Barsebäck Kraft AB Box 524 S-246 25 Löddeköpinge Sweden	Tel: Fax: E-mail:	+ 46 46 72 43 50 + 46 46 72 45 80 carl-goran.lindvall@ barsebackkraft.se
Mr. Pio Carmena Servert (Past-Chairman) Subdirección Nuclear ENDESA Generación,S.A. Principe de Vergara 187 28002 Madrid Spain	Tel: Fax: E-mail:	+34 91 213 1426 +34 91 213 1668 pcarmena@endesa.es
Ms. Cheryl Trottier (Vice-Chairperson) Branch Chief, Research Division U.S. Nuclear Regulatory Commission Mail Stop T-9-F-31 Washington, D.C. 20555 United States	Tel: Fax: E-mail:	+1 (301) 415 62 32 +1 (301) 415 53 85 cat1@nrc.gov

ISOE Joint Secretariat

Dr. Khammar Mrabit International Atomic Energy Agency Division of Radiation and Waste Safety P.O. Box 100 A-1400 Wien Austria	Tel: Fax: E-mail:	+43 1 2600 22722 +43 1 2600 7 K.Mrabit@iaea.org
Dr. Stefan Mundigl OECD Nuclear Energy Agency 12, boulevard des Iles F-92130 Issy-les-Moulineaux France	Tel: Fax: E-mail:	+33 1 45 24 10 45 +33 1 45 24 11 10 mundigl@nea.fr

ISOE Technical Centres

Asia

Naoyuki MURATA	Tel:	+81 (3) 4512 2865
Plant Operation Evaluation Div.,	Fax:	+81 (3) 4512 2889
Safety Information Research Center	E-mail:	isoe-atc@nupec.or.jp
Fujitakanko-Toranomon Bldg. 8th Fl.,		
3-17-1 Toranomon, Minato-ku,		
TOKYO 105-0001		
Japan		

Europe

Dr. Christian Lefaure	Tel:	+33 1 58 35 79 08
European Technical Centre (ETC)	Fax:	+33 1 40 84 90 34
CEPN	E-mail:	lefaure@cepn.asso.fr
B.P. 48		
F-92263 Fontenay-aux-Roses Cedex		
France		

IAEA Countries

Dr. Monica Gustafsson	Tel:	+43 1 2600 22725
IAEA Technical Centre (IAEATC)	Fax:	+43 1 2600 7
International Atomic Energy Agency	E-mail:	M.Gustafsson@iaea.org
Division of Radiation and Waste Safety		
P.O. Box 100		
A-1400 Wien IAEA		
Austria		

North America

Dr. D.W. MILLER	Tel:	+1 (217) 333 1098
NATC Regional Coordinator	Fax:	+1 (217) 333 2906
University of Illinois at	E-mail:	dwmphd@aol.com
Urbana-Champaign		
103 S. Goodwin Avenue		
Urbana, Ill 61801		
United States		

ISOE Working Groups

ISOE Working Group on Data Analysis

Jean-Yves Gagnon	Gentilly-2 nuclear power station, Canada (Chairman)
Christian Breesch	Electrabel, Belgium
Ingolf Briesen	Kernkraftwerk Obrigheim, Germany
Philippe Colson	EdF, France
Christian Lefaure	CEPN, France
Monica Gustafsson	IAEA
Staffan Hennigor	Forsmark, Sweden
Mats Hjelm	Oskarshamn, Sweden
Jianqi Jiang	Quinshan Nuclear Power Company, Peoples Republic of China
Bozena Jurochova	NPP Dukovany, Czech Republic
Kari Kukkonen	TVO, Finland
Teresa Labarta	Consejo de Seguridad Nuclear, Spain
Marc Maree	Koeberg Nuclear Power Station, South Africa
Marco A. Medrano	Central Laguna Verde, Mexico
David Miller	University of Illinois, United States
Stefan Mundigl	NEA

ISOE Working Group Software Development

Wolfgang Pfeffer	GRS, Germany (Chairman)
Vovik Atoyan	Armenian Nuclear Power Plant Company, Armenia
Monica Gustafsson	IAEA
Tertius Karsten	Koeberg Nuclear Power Station, South Africa
Christian Lefaure	CEPN, France
David Miller	Clinton Power Station, United States
Juan Jose Montesinos	Consejo de Seguridad Nuclear, Spain
Stefan Mundigl	NEA
Seong-Ho Na	IAEA
Maochun Yang	Daya Bay NPP, Peoples Republic of China

OECD PUBLICATIONS, 2 rue André-Pascal, 75775 PARIS CEDEX 16
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