Radiation Protection

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Occupational Exposures at Nuclear Power Plants

Twelfth Annual Report of the ISOE Programme, 2002

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NUCLEAR ENERGY AGENCY
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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

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

The original member countries of the OECD are Austria, Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The following countries became members subsequently through accession at the dates indicated hereafter: Japan (28th April 1964), Finland (28th January 1969), Australia (7th June 1971), New Zealand (29th May 1973), Mexico (18th May 1994), the Czech Republic (21st December 1995), Hungary (7th May 1996), Poland (22nd November 1996), 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, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, the Netherlands, Norway, Portugal, Republic of Korea, the 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 the International Commission on Radiological Protection (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 can 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 database, ISOEDAT. Three linked databases are used for data storage, retrieval and analysis. Second, in creating the network required 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 worldwide, providing occupational exposure data for analyses of dose trends, technique comparisons, and cost-benefit and other analyses promoting the application of the ALARA principle.

TABLE OF CONTENTS

List of tables

List of figures

EXECUTIVE SUMMARY

This Twelfth Annual Report of the ISOE Programme, 2002 represents the status of the ISOE Programme at the end of December 2002.

The ISOE database currently includes information on occupational exposure levels and trends at 465 reactor units (406 operating and 59 in cold-shutdown or some stage of decommissioning) operated by 68 utilities in 29 countries. This database thus covers 92% of the total number of power reactors (441) in commercial operation throughout the world. In addition, the regulatory authorities of 25 countries participate actively in ISOE. During 2002, the Japanese BWR Onagawa 3 started its commercial operation. In April 2003, the utilities from Pakistan joined the ISOE programme with one PWR and one CANDU reactor.

For more than ten years, the ISOE programme facilitates and supports the optimisation of worker doses in nuclear power plants through a communication and experience exchange network for radiation protection managers of nuclear power plants world wide, and through the development and publication of improved work management procedures. In 2002, the average annual dose reached a fairly low level with a slight decreasing trend to 0.89 man·Sv for pressurised water reactors (PWR), 1.70 man·Sv for boiling water reactors (BWR), 0.91 man·Sv for CANDU reactors, and 4.4 man·Sv for LWGRs (RBMK).

In addition to information on operating reactors, the ISOE database contains dose data from 59 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.

Radiological protection professionals are very interested in the current development of new recommendations from the International Commission on Radiological Protection, ICRP. To assist in this development, ISOE decided to actively participate in the discussion with ICRP, through its Working Group on Operational Radiological Protection (WGOR), stressing the practical aspects of radiological protection. A subchapter of this report provides the current status of these discussions.

In April 2002, the third ISOE European Workshop on Occupational Exposure Management at Nuclear Power Plants was held in Portoroz, Slovenia, followed by the 2003 International ALARA Symposium, held in January 2003 in Orlando, Florida, USA. 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 optimisation of radiation protection and occupational exposure issues.

Recent developments and principal events in ISOE participating countries are summarised in Chapter 2.6.

Finally, the ISOE Programme made significant progress during 2002, 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. Details of this progress as well as the programme of work for 2003 are provided in Chapter 3.

SYNTHÈSE DU RAPPORT

Le douzième rapport annuel du Programme ISOE a pour objet de faire le point sur l'avancement de ce programme à fin décembre 2002.

À cette date, la base de données ISOE comportait les données concernant les expositions professionnelles de 465 réacteurs nucléaires situés dans 29 pays et appartenant à 68 exploitants. Elle couvre ainsi près de 92 % des réacteurs commerciaux en fonctionnement dans le monde (441 réacteurs). Les autorités de 25 pays participent également au programme ISOE. Durant l'année 2002, le réacteur japonais Onagawa 3 a été mis en service commercial. En avril 2003, les exploitants du Pakistan ont rejoint le Programme ISOE avec un réacteur de type REP et un réacteur de type CANDU.

Depuis plus de dix ans, le programme ISOE facilite et améliore l'optimisation de la radioprotection des travailleurs dans les centrales nucléaires grâce à la communication et au réseau d'échanges de retour d'expérience entre les *responsables* de la radioprotection des centrales nucléaires du monde entier, mais également grâce au développement et à la publication de bonnes pratiques en matière d'organisation du travail. En 2002, la dose collective moyenne par tranche présente une légère tendance à la baisse par rapport aux années précédentes, atteignant ainsi un niveau assez bas de 0,89 H.Sv pour les réacteurs à eau pressurisée (REP), 1,70 pour les réacteurs à eau bouillante (REB), 0,91 H.Sv pour les réacteurs CANDU et 4,4 H.Sv pour les LWGR (RBMK).

Par ailleurs, la base de données ISOE contient également des données de dose collective de 59 réacteurs en arrêt à froid ou en phase de démantèlement. Étant donné que les réacteurs présents dans la base de données sont de types et de puissances très différents et sont, en général, à des stades différents de leur programme de démantèlement, il est très difficile de mettre en évidence des tendances sur l'évolution des expositions et d'en tirer des conclusions.

Les professionnels de la radioprotection sont très intéressés par les travaux en cours sur les nouvelles recommandations de la Commission internationale de protection radiologique (CIPR). Pour apporter sa contribution à ces réflexions, le système ISOE a décidé de créer un Groupe de travail sur la radioprotection opérationnelle (WGOR) qui analyse les propositions de la CIPR du point de vue de leur mise en œuvre pratique. Un sous chapitre de ce rapport fournit l'état actuel des réflexions de ce Groupe de Travail.

En avril 2002, le troisième Séminaire international sur la gestion des expositions professionnelles dans les centrales nucléaires s'est tenu à Portoroz, en Slovénie, suivi en janvier 2003 par le symposium International ALARA à Orlando, Floride (USA). 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 à l'optimisation de la radioprotection et aux questions liées aux expositions professionnelles.

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

En conclusion, le programme ISOE a fait des progrès significatifs en 2002, 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. Des détails sur ces progrès ainsi que sur le programme de travail pour l'année 2003 sont fournis dans le chapitre 3.

ZUSAMMENFASSENDE ÜBERSICHT

Der zwölfte ISOE Jahresbericht 2002 gibt den Stand des ISOE Programmes Ende Dezember 2002 wieder.

Die ISOE Datenbank enthält zur Zeit Daten zur beruflichen Strahlenexposition in insgesamt 465 Kernkraftwerken (406 Reaktoren in Betrieb und 59 stillgelegte Reaktoren) von 68 Energieversorgungsunternehmen aus 29 Ländern. Diese Datenbank deckt damit etwa 92% der weltweit in Betrieb befindlichen kommerziellen Kernkraftwerke (441) ab. Außerdem nehmen die Genehmigungs- und Aufsichtsbehörden aus 25 Ländern am ISOE Programm teil. Die Teilnahme an ISOE nimmt stetig zu: Im Jahre 2002 wurde der japanische Siedewasserreaktor Onagawa 3 in Betrieb genommen. Im April 2003 trat Pakistan, mit je einem Druckwasserreaktor und einem CANDU Reaktor, dem ISOE Programm bei.

Seit mehr als zehn Jahren trägt das ISOE Programms dazu bei, die berufliche Strahlenexposition in Kernkraftwerken durch ein Kommunikations- und Erfahrungsaustauschnetzwerk zwischen Strahlenschutzexperten der Kernkraftwerke weltweit, sowie durch die Entwicklung und Veröffentlichung verbesserter Arbeitsmanagementverfahren, zu optimieren. Im Jahre 2002 erreichte die mittlere jährliche Kollektivdosis pro Reaktor, bei leichtem Abwärtstrend, ein vergleichsweise niedriges Niveau von 0,89 man·Sv für Druckwasserreaktoren (DWR), 1,70 man·Sv für Siedewasserreaktoren (SWR), 0,91 man·Sv für CANDU Reaktoren und 4,4 man·Sv für Leichtwassergekühlte Graphitmoderierte Reaktoren (LWGR bzw. RBMK Reaktoren).

Zusätzlich zu den Daten für in Betrieb befindliche Reaktoren enthält die ISOE Datenbank auch Dosiswerte von Arbeiten an 59 stillgelegten Reaktoren. Da sich die in der Datenbank vertretenen Reaktoren sehr stark in Typ und Leistung unterscheiden und sich zudem in unterschiedlichen Phasen ihrer Stilllegungs- oder Rückbauprogramme befinden, ist es zur Zeit noch schwierig Dosistrends zu identifizieren oder definitive Schlußfolgerungen zu ziehen.

Strahlenschutzexperten sind sehr an der gegenwärtigen Entwicklung neuer Strahlenschutzempfehlungen durch die Internationale Strahlenschutzkommission (ICRP) interessiert. Um diese Entwicklung zu unterstützen, hat ISOE beschlossen aktiv an dieser Diskussion durch die Gründung einer Arbeitsgruppe Angewandter Strahlenschutz („Working Group on Operational Radiation Protection – WGOR“) beizutragen. Diese Arbeitsgruppe soll die praktischen Aspekte des Strahlenschutzes hervorheben. Ein Kapitel dieses Berichts faßt den gegenwärtigen Stand der Diskussionen zusammen.

Im April 2002 fand der dritte Europäische ISOE Workshop zum Thema „Berufliche Strahlenexposition in Kernkraftwerken“ in Portoroz (Slovenien) statt. Im Januar 2003 folgte das internationale ALARA Symposium in Orlando, Florida (USA). Diese Treffen haben das gemeinsame Ziel, Erfahrungen und gelernte Lektionen bei der Durchführung von ALARA Programmen sowie bei der Lösung unterschiedlicher Probleme der beruflichen Strahlenexposition auszutauschen sowie über die gezogenen Schlussfolgerungen zu berichten. Die internationale und breit gefächerte Teilnahme an diesen Workshops demonstriert das Interesse an Optimierung des Strahlenschutzes und an Problemen der beruflichen Strahlenexposition.

Aktuelle Entwicklungen und wichtige Ereignisse in ISOE Teilnehmerländern werden in Kapitel 2.6 des Berichts zusammengefaßt.

Das ISOE Arbeitsprogramm erzielte grosse Fortschritte im Jahre 2002, insbesondere in den Bereichen Datenanalyse und Datendarstellung. 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. Einzelheiten zu den Fortschritten im laufenden ISOE Arbeitsprogramm sowie ein Ausblick auf das ISOE Arbeitsprogramm 2003 werden in Kapitel 3 gegeben.

执行摘要

这份“2002年职业性照射信息系统计划第12期年度报告”介绍了该计划截至2002年12月底的状况。

职业性照射信息系统数据库目前包括29个国家的68家电力公司运营的465台反应堆机组（406台正在运行，59台处于冷停堆或某个退役阶段）职业性照射水平和趋势方面的资料。因而，该数据库涵盖全世界正在商业运行的动力堆总数（441座）的92%。此外，25个国家的监管机构积极参加了职业性照射信息系统的工作。2002年期间，日本女川3号沸水堆开始商业运行。2003年4月，巴基斯坦的电力公司加入职业性照射信息系统计划，涉及一座压水堆和一座坎杜堆。

10多年来，职业性照射信息系统计划通过遍布世界的核电厂辐射防护管理人员通讯和经验交流网络以及通过制订和发布经改进的工作管理程序，促进并支持开展核电厂工作人员剂量优化工作。2002年，年平均剂量达到了相当低的水平并略有下降趋势，压水堆的年平均剂量达到0.89人·希、沸水堆1.70人·希、坎杜堆0.91人·希和水冷却石墨慢化堆（大功率沸腾管式堆）4.4人·希。

除了正在运行的反应堆的资料外，职业性照射信息系统数据库也包含了59座已关闭或处于某个退役阶段的反应堆的剂量数据。由于数据库中描述的这些反应堆的类型不同，规模各异，而且基本上都处在退役计划的不同阶段，因此，很难确定明显的剂量趋势和得出明确的结论。

放射防护专业人员对国际放射防护委员会目前提出的新建议非常感兴趣。为了协助建议的拟订工作，职业性照射信息系统决定通过其运行放射防护工作组积极参加与国际放射防护委员会的讨论，并着重强调放射防护的实践问题。本报告的一个分章阐述了这些讨论的当前状况。

2002年4月，在斯洛文尼亚玫瑰港举办了“职业性照射信息系统第三次核电厂职业性照射管理欧洲讲习班”，随后于2003年1月在美国佛罗里达州奥兰多举行了“2003年合理可行尽量低原则国际专题讨论会”。这些讲习班和讨论会的共同目的是交流在执行“合理可行尽量低原则”和处理职业性照射问题方面的经验，并共同借鉴汲取的教训。国际上对这些讲习班和讨论会的广泛参与表明对辐射防护的优化和职业性照射问题的兴趣。

第2.6章概述了职业性照射信息系统参加国的近期发展和主要事件。

最后，职业性照射信息系统计划在2002年期间取得了重要进展，特别是在数据分析和输出方面。为了进一步宣传职业性照射信息系统和证明其对核电厂应用辐射防护的价值，2002年3月出版了《**经合组织职业性照射信息系统10年经验，2002年**》。第3章提供了有关进展的详细情况和2002年的工作计划。

概　略

この第 12 年次総括報告書は、2002 年 12 月末における ISOE プログラムの状況を示したものである。

最新の ISOE データベースには 29 ヶ国における 68 の電気事業者からの 465 基（406 基は運転中、59 基は停止または廃止措置の異なった段階にある原子炉）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。このデータベースは、全世界の運転中商用炉（総計 441 基）の 92%を占めている。更に、25 ヶ国の規制当局が ISOE 活動に参加している。2002 年には、日本の女川 3 号（BWR）が商業運転を開始した。2003 年 4 月にはパキスタンの電気事業者が PWR 1 基、CANDU 炉 1 基とともに ISOE プログラムに参加した。

ISOE プログラムは、10 年以上経ち、世界中の原子力発電所の放射線防護管理者による連絡体系でのコミュニケーションと経験交換、および改善した作業管理手順書の作成・発行を通し、原子力発電所の作業線量の最適化を促進およびサポートしている。2002 年には、PWR で 0.89 人･Sv 、BWR で 1.70 人･Sv 、CANDU 炉で 0.91 人･Sv 、LWGRs(RBMK)炉で 4.4 人･Sv と僅かに減少し、年間平均線量は十分に低いレベルに達した。

運転中の原子炉情報に加えて、ISOE データベースには、停止または廃止措置の異なった段階にある 59 基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原子炉は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。

放射線防護専門家は現在開発中の国際放射線防護委員会(ICRP)からの新勧告に最大の関心を寄せている。この開発支援の為、ISOE は、放射線防護の実践的な側面を強調するため、放射線防護の運用に関するワーキンググループ(WGOR)を通して ICRP との議論に積極的に参加することを決定した。この報告書の章立ては、討論の最新状況を提供している。

2002 年 4 月のスロベニアの Portoroz で開催された原子力発電所における職業被ばく管理に関する第 3 回欧州ワークショップに引き続いて、2003 年では、国際 ALARA シンポジウムが 2003 年 1 月に米国フロリダのオーランドにて開催された。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多くの参加者が、ALARA と放射線防護の問題に関心を示した。

ISOE 参加国における最近の情勢と主要事象が、2.6 章に要約されている。

最後に、ISOE プログラムは 2002 年に、特にデータの分析と報告書の点で大きく進展した。また、更なる ISOE システムの促進および原子力発電所における放射線防護への有効性を明示するため「ISOE（職業被ばく情報システム）／OECD 10 年史」が 2002 年 3 月に出版された。この詳細は 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

Настоящий двенадцатый Ежегодный доклад программы ИСПО за 2002 год отражает положение дел с осуществлением программы ИСПО на конец декабря 2002 года.

База данных ИСПО в настоящий момент включает данные об уровнях и тенденциях, касающихся профессионального облучения на 465 реакторах, эксплуатируемых 68 энергопредприятиями в 29 странах (из которых 406 находятся в эксплуатации и 59 – в состоянии холодного останова или на определенной стадии снятия с эксплуатации). Таким образом, эта база данных охватывает 92% общего числа энергетических реакторов (441), находящихся в промышленной эксплуатации во всем мире. Кроме того, в работе ИСПО активно участвуют регулирующие компетентные органы 25 стран. В 2002 году была начата промышленная эксплуатация японского реактора BWR третьего энергоблока АЭС “Онагава”. В апреле 2003 года энергопредприятия Пакистана присоединились к программе ИСПО, предоставив данные, касающиеся одного реактора PWR и одного реактора CANDU.

В течение более чем десяти лет программа ИСПО оказывает содействие и поддержку деятельности по оптимизации получаемых работниками АЭС доз облучения посредством использования сети связи и обмена опытом для руководителей служб радиационной защиты на АЭС во всем мире, а также путем разработки и публикации усовершенствованных процедур управления рабочим процессом. В 2002 году наблюдалась небольшая тенденция к понижению и средняя годовая доза достигла довольно низкого уровня в 0,89 чел.-Зв для реакторов с водой под давлением (PWR); 1,7 чел.-Зв для кипящих реакторов (BWR); 0,91 чел.-Зв для реакторов CANDU и 4,4 чел.-Зв для реакторов LWGR (РБМК).

В дополнение к информации о находящихся в эксплуатации реакторах база данных ИСПО содержит также данные о дозах по 59 реакторам, которые находятся в состоянии останова или на определенной стадии снятия с эксплуатации. Поскольку в базе данных представлены реакторы различных типов и мощности, а также, как правило, находятся на различных стадиях снятия с эксплуатации, определение четких тенденций дозы и формулирование окончательных выводов представляется весьма затруднительным.

Специалисты в области радиационной защиты проявляют большой интерес к осуществляемой в настоящее время Международной комиссией по радиологической защите (МКРЗ) разработке новых рекомендаций. Для оказания помощи в этой разработке ИСПО решила активно участвовать в обсуждениях с МКРЗ через свою Рабочую группу по радиологической защите при эксплуатации (WGOR), уделяя особое внимание практическим аспектам радиологической защиты. В одном из подразделов настоящего доклада сообщается о нынешнем статусе этих обсуждений.

В апреле 2002 года в Портороце, Словения, был проведен третий Европейский семинар-практикум ИСПО по профессиональному облучению на АЭС, а затем в январе 2003 года в Орландо, Флорида, США, – Международный симпозиум по ALARA. Общая цель этих мероприятий состояла в том, чтобы обменяться опытом в отношении осуществления принципов ALARA и вопросов профессионального облучения, а также информацией об извлеченных уроках. Широкое международное участие в этих мероприятиях свидетельствует об интересе к вопросам оптимизации радиационной защиты и профессионального облучения.

Последние и важнейшие события, произошедшие в участвующих в ИСПО странах, кратко излагаются в главе 2.6.

Таким образом, в течение 2002 года в осуществлении программы ИСПО был достигнут существенный прогресс, особенно в сфере анализа и вывода данных. В целях содействия дальнейшему развитию системы ИСПО и демонстрации ее роли в обеспечении радиационной защиты на АЭС в марте 2002 года был опубликован доклад **ИСПО – "Информационная система по профессиональному облучению, десять лет работы, ОЭСР, 2002 год"**. Подробности, касающиеся этого прогресса, а также программа работы на 2003 год содержатся в главе 3.

RESUMEN EJECUTIVO

El décimosegundo Informe Anual del ISOE, correspondiente al año 2002, presenta el estado del ISOE a finales de diciembre de dicho año.

La base de datos del ISOE actualmente incluye información sobre exposiciones ocupacionales y sus tendencias para 465 reactores (406 en operación y 59 en estado de desmantelamiento), operados por 68 instalaciones nucleares en 29 países.

Esta base de datos cubre así el 92% del número total de reactores comerciales en operación (441) en todo el mundo. Además, Organismos Reguladores de 25 países participan activamente en el ISOE. Durante el año 2002, la central japonesa Onagawa 3, de tecnología BWR comenzó su explotación comercial. En abril del 2003, los reactores nucleares pakistaníes, uno tipo PWR y otro tipo CANDU se unieron al Programa ISOE.

Durante más de 10 años, el ISOE ha facilitado y fomentado la optimización de las dosis de los trabajadores de instalaciones nucleares a través de la comunicación y de una red de intercambio de experiencias operativas para los jefes de protección radiológica a nivel internacional y además a través del desarrollo y publicación de procedimientos de mejora de gestión de trabajos. En 2002, la media de dosis anual alcanzó un nivel moderadamente bajo con una suave tendencia decreciente, alcanzando los 0.89 mSv.persona para los reactores PWR, 1.70 mSv.persona para los reactores BWR, 0.91 mSv.persona para los reactores tipo CANDU y finalmente, 4.4 mSv.persona para los reactores LWGRs (RBMK).

Además de la información sobre los reactores en operación, la base de datos del ISOE contiene datos sobre las dosis de 59 reactores parados o en estado de desmantelamiento. Como los reactores presentes en la base de datos son de diferente tipo y tamaño, y están en general en distinta fase de sus programa de desmantelamiento, es muy difícil identificar tendencias de dosis y llegar a conclusiones definitivas.

Los profesionales de la protección radiológica están muy interesados en el desarrollo actual de las nuevas recomendaciones por parte de la Comisión Internacional de Protección Radiológica, ICRP. Para colaborar en este desarrollo, ISOE decidió participar activamente en la discusión con la ICRP a través de la creación de un grupo de trabajo denominado WGOR (Grupo de Trabajo sobre Protección Radiológica Operacional), enfatizando los aspectos prácticos de la protección radiológica. Un subcapítulo de este documento proporciona información sobre el estado actual de estas discusiones.

En abril del 2002, se celebró el Tercer Workshop sobre Gestión de la Exposición Ocupacional en Centrales Nucleares, en Portoroz, Eslovenia. Por otro lado, en enero del 2003 se celebró en Orlando, Florida, el Simposium ALARA Internacional. El objetivo común de ambos workshops ha sido comunicar experiencias en la implementación ALARA, tratar temas referentes a la exposición ocupacional y compartir lecciones aprendidas. La amplia participación internacional en estos congresos demuestra el interés existente en la optimización de la protección radiológica y en otros aspectos de la exposición ocupacional.

Los progresos más recientes y los sucesos principales acaecidos en los países participantes en el ISOE se resumen en el capítulo 2.6 de este documento.

Finalmente, el Programa ISOE realizó progresos significativos durante el año 2002, particularmente en términos de análisis y presentación de datos. Para promover el sistema ISOE y para demostrar su validez en la aplicación de la protección radiológica en centrales nucleares, se publicó en marzo del 2002 el informe ***ISOE – Sistema de Información sobre Exposición Ocupacional, Diez Años de Experiencia, OCDE, 2002***. Los detalles sobre este progreso y sobre el programa de trabajo del 2003 se presentan en el capítulo 3 de este documento.

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 2002, the ISOEDAT database includes occupational exposure data from a total of 465 reactors (406 operating and 59 in cold-shutdown or some stage of decommissioning) operated by 68 utilities in 29 countries. In addition, regulatory authorities from 25 countries participate actively in the ISOE Programme. The participation of 406 operating commercial nuclear reactors in the ISOE programme represents some 92% of the World's operating commercial nuclear reactors (total of 441). 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 2002, the United States utility Nuclear Management Company officially joined the ISOE programme with all its reactors. On 30 January 2002, the Japanese BWR Onagawa 3 started its commercial operation. In April 2003, the utilities from Pakistan joined the ISOE programme with one PWR and one CANDU reactor.

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[1]	–	–	21	–	–	–	21
China	3	–	–	–	–	–	3
Czech Republic	4	–	–	–	–	–	4
Finland	2	2	–	–	–	–	4
France	58[2]	–	–	–	–	–	58
Germany	13	6	–	–	–	–	19
Hungary	4	–	–	–	–	–	4
Japan	23	29	1	–	–	–	53
Korea	13	–	4	–	–	–	17
Lithuania	–	–	–	–	2	–	2
Mexico	–	2	–	–	–	–	2
Netherlands	1	–	–	–	–	–	1
Pakistan[3]	1	–	1	–	–	–	2
Romania	–	–	1	–	–	–	1
Russian Federation	14	–	–	–	–	1	15
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	33	18	–	–	–	–	51
Total	**221**	**69**	**28**	**–**	**2**	**1**	**321**

Operating reactors not participating in ISOE, but included in the ISOE database							
Country	**PWR**	**BWR**	**PHWR**	**GCR**	**LWGR**	**FBR**	**Total**
United Kingdom	–	–	–	32	–	–	32
United States	36	17	–	–	–	–	53
Total	**36**	**17**	–	**32**	**–**	**–**	**85**

Total number of operating reactors included in the ISOE database							
	PWR	**BWR**	**PHWR**	**GCR**	**LWGR**	**FBR**	**Total**
Total	**257**	**86**	**28**	**32**	**2**	**1**	**406**

1. In 2002, 14 CANDU reactors were in operation. The reactors Bruce A2, A3, A4, and Pickering A1, A2, A3, A4 did not operate during 2002.
2. Two of these 58 reactors (Civaux 1 and Civaux 2) are still in the pre-operational phase.
3. The Pakistan Atomic Energy Commission joined ISOE with two reactors Chasnupp 1, a 300 MW(e) PWR, and Kanupp, a 125 MW(e) PWHR, officially in 2003.

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

Definitively shutdown reactors participating in ISOE						
Country	**PWR**	**BWR**	**PHWR**	**GCR**	**LWGR**	**Total**
Canada	–	–	1	–	–	1
France	1	–	–	6	–	7
Germany	1	1	–	1	–	3
Italy	1	2	–	1	–	4
Japan	–	–	–	1	–	1
Netherlands	–	1	–	–	–	1
Russian Federation	2	–	–	–	2	4
Spain	–	–	–	1	–	1
Sweden	–	1	–	–	–	1
Ukraine	–	–	–	–	3	3
United States	4	3	–	1	–	8
Total	**9**	**8**	**1**	**11**	**5**	**34**

Definitively shutdown reactors not participating in ISOE but included in the ISOE database						
Country	**PWR**	**BWR**	**PHWR**	**GCR**	**LWGR**	**Total**
Canada	–	–	1	–	–	1
Germany	5	3	–	–	–	8
United Kingdom	–	–	–	8	–	8
United States	6	2	–	–	–	8
Total	**11**	**5**	**1**	**8**	–	**25**

Total number of definitively shutdown reactors included in the ISOE database						
	PWR	**BWR**	**PHWR**	**GCR**	**LWGR**	**Total**
Total	**20**	**13**	**2**	**19**	**5**	**59**

Number of **Utilities** Officially Participating:	**68**
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 2002. 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 2002, the average collective dose per reactor for European PWRs remained quite stable compared to 2001, at around 0.8 man·Sv per reactor. In Germany, the main reason for an increase of the average collective dose per reactor was a major outage in Biblis, and the reduction of the number of operating nuclear power plants after the definitive shutdown of the Mülheim-Kärlich NPP which had low doses in recent years (13 operating reactors in 2002 instead of 14 reactors in 2001). The European BWRs have seen an increase of the average collective dose which is mainly due to the increase of the results in Sweden (performance of modernisation work at Oskarshamn 1 and Barsebäck 2) and in Cofrentes NPP of Spain.

In Japan, the fiscal year (FY) 2002 has resulted in the increase of the total collective dose for BWRs and decrease of total collective dose for PWRs. The increase in collective dose of BWRs for FY 2002 was due to many modification works of components such as PLR piping, CRD etc. In addition, during the periodical inspections, checks and repairs were performed at components with high dose rates such as shroud and PLR piping. The decrease in collective dose of PWRs for FY2002 was due to the reduction of the outage days for periodical inspection and to the absence of large modification work. The dosimetric trend at the Korean NPPs showed continuous reduction in both the average annual collective dose per reactor unit and average annual individual worker dose.

In countries participating through the IAEA Technical Centre, the PWR and the PHWR average collective dose per reactor continue to decrease. Although the two LWGR reactors in Lithuania show an increase in the collective dose in 2002, the actual collective dose was lower than planned. The average collective dose for these reactors is still higher than for other types of reactors. In Romania the slight upward trend was broken in 2002 and it could be noted that in 2002 only half of the annual collective dose was received during the outage.

In North America, the average 2002 PWR dose represents a 5% decrease from the 2001 value: the fourth time since the first commercial reactor commenced operations in 1969 that the average US PWR annual dose has been under 1.0 man·Sv/unit. The average collective dose per US BWRs in 2002 represents a 27% increase from the 2001 value. This is primarily due to extensive jet pump repairs and water chemistry challenges at one US BWR in 2002. The average BWR collective dose per reactor, without Quad Cities 1 and 2 included, was 1.31 man·Sv/BWR unit. Even with the Quad Cities high doses, the US BWR average collective dose for 2002 was the third lowest recorded average dose per unit for US BWRs since 1969.

More detailed analyses of dose trends in various countries can be found in Chapter 2.6 of this report.

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 2002 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 1992 to 2002 by reactor type. Figure 6 gives the average collective dose per LWGR for the years 1984-2002.

Table 2. **Evolution of average annual collective dose per unit, by country and reactor type, from 2000-2002 (man·Sv)**

	PWR			BWR			CANDU		
	2000	**2001**	**2002**	**2000**	**2001**	**2002**	**2000**	**2001**	**2002**
Armenia	0.96	0.66	0.95						
Belgium	0.35	0.56	0.47						
Brazil	1.35	0.58	0.68						
Bulgaria	1.03	0.93	0.62						
Canada[4]							0.72	0.78	0.90
China	0.59	0.50	0.65						
Czech Republic	0.25	0.29	0.20						
Finland	1.13	0.56	1.31	0.86	0.59	0.56			
France	1.08	1.02	0.97						
Germany	1.13	0.89	1.23	0.88	1.06	0.76			
Hungary	0.76	0.63	0.80						
Japan	1.03	1.27	1.00	1.96	1.68	2.10			
Korea	0.77	0.67	0.52				0.55	0.67	0.63
Mexico				2.83	3.29	1.89			
Netherlands	0.56	0.52	0.34						
Pakistan			0.33				4.46	3.2	2.52
Romania							0.47	0.58	0.55
Russian Fed.	1.24	1.41	1.24						
Slovakia	0.81	0.37	0.29						
Slovenia	2.60	1.13	0.58						
South Africa	0.42	1.15	0.83						
Spain	0.59	0.43	0.50	1.52	0.93	1.52			
Sweden	0.43	0.35	0.52	0.85	0.71	1.33			
Switzerland	0.69	0.48	0.51	0.89	0.97	0.69			
Ukraine	1.53	1.29	1.54						
United Kingdom	0.46	0.19	0.30						
United States	0.96	0.91	0.87	1.68	1.38	1.75			

	GCR			LWGR		
	2000	**2001**	**2002**	**2000**	**2001**	**2002**
Lithuania				5.35	3.14	4.4
Ukraine[5]				7.12		
United Kingdom[6]	0.17	0.13	0.11			

4. This average annual dose is calculated for 14 operating CANDU reactors. The reactors Bruce A2, A3, A4, and Pickering A1, A2, A3, A4 did not operate during 2002.
5. Chernobyl Nuclear Power Plant, Unit 3 was shutdown in 2001.
6. This average annual dose is calculated for 30 reactors in United Kingdom in 2000, for 28 reactors in 2001, and for 18 reactors in 2002.

Figure 1. **2002 PWR average collective dose per reactor by country**

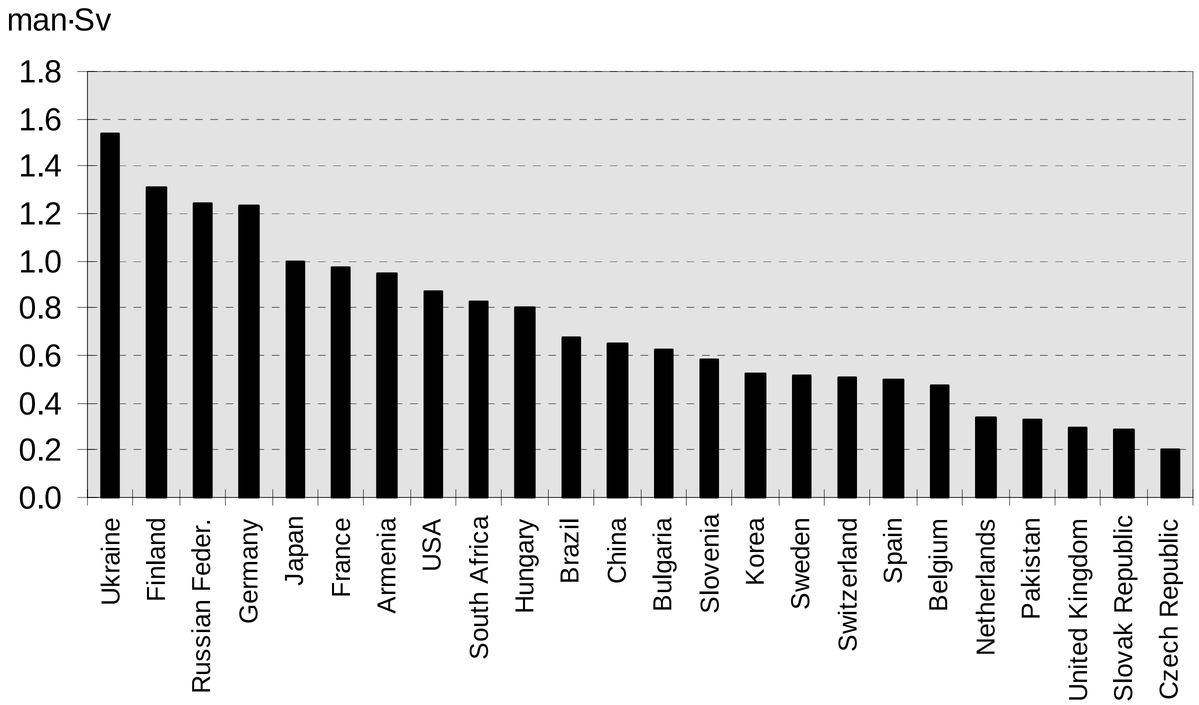


Figure 2. **2002 BWR average collective dose per reactor by country**

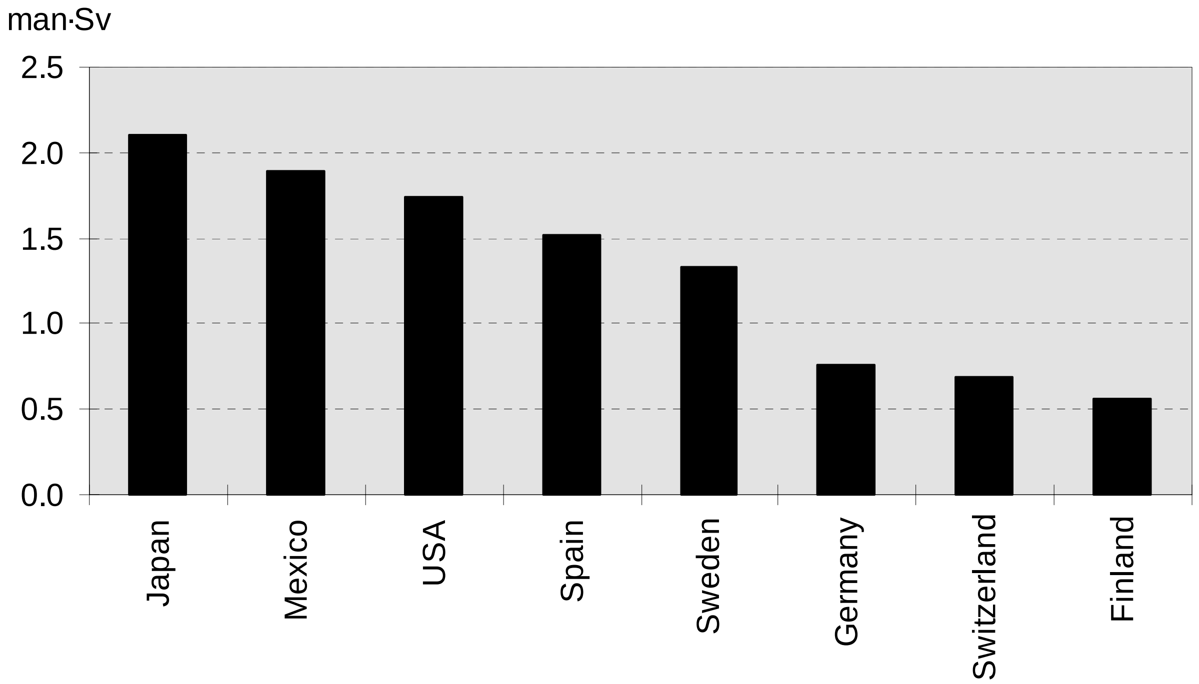


Figure 3. **2002 CANDU average collective dose per reactor by country**

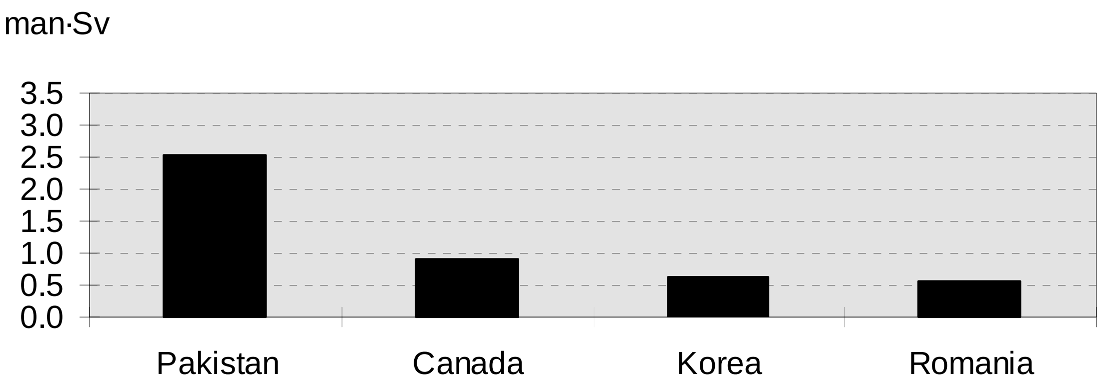


Figure 4. **2002 average collective dose per reactor type**

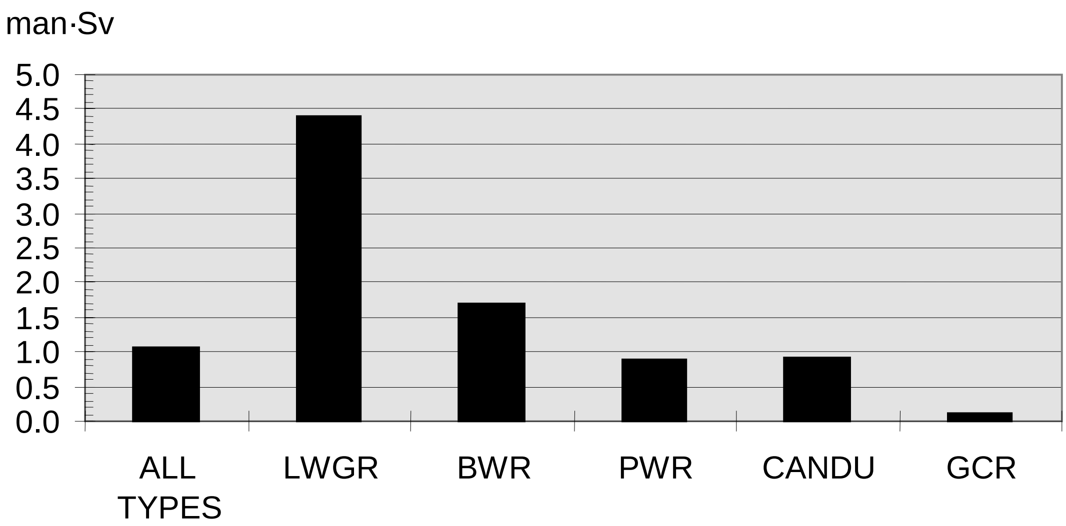


Figure 5. **Average collective dose per reactor for operating reactors included in ISOE by reactor type for the years 1992-2002**

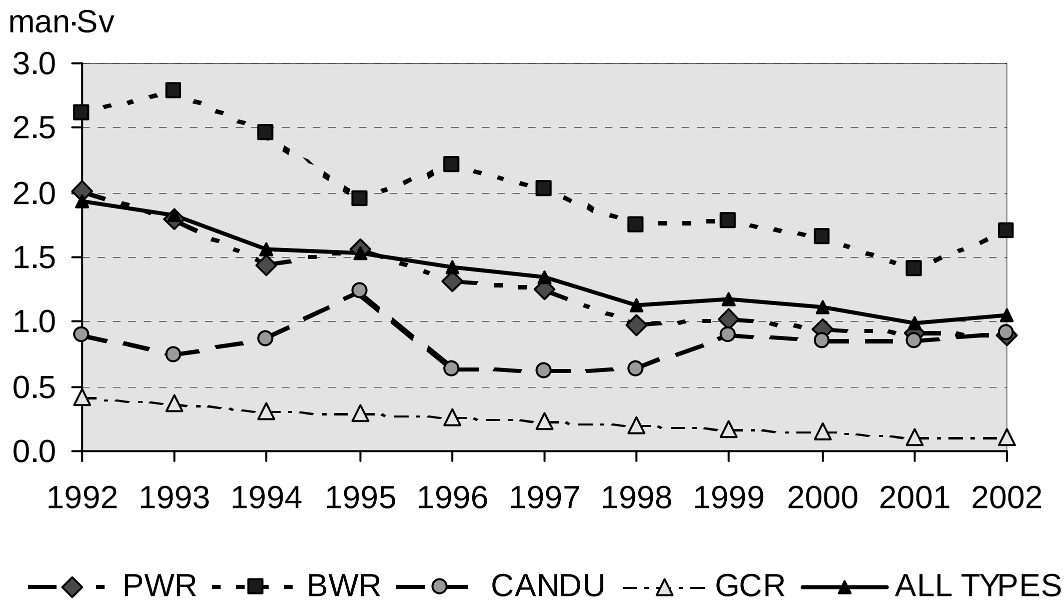
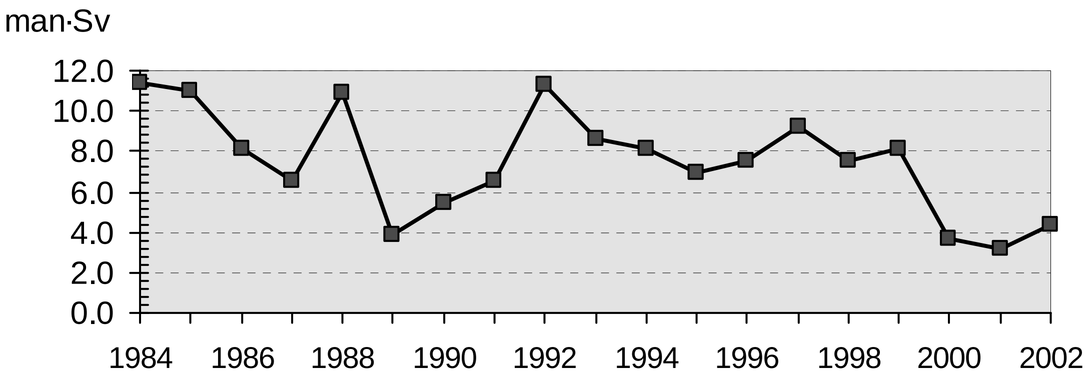


Figure 6. **Average collective dose per reactor for operating LWGRs included in ISOE**



2.2 Occupational exposure trends in reactors in cold shutdown or in decommissioning

The ISOE database contains dose data from 59 reactors which are shut-down or in some stage of decommissioning. The average collective dose per reactor for shutdown reactors saw a reduction over the years 1990 to 2002. However, the reactors represented in these figures are of different type and size, and are, in general, at different phases of their decommissioning programmes. For these reasons, and because these figures are based on a limited number of shutdown reactors, it is impossible to draw definitive conclusions.

Table 3 shows the average annual dose per unit by country and type of reactor for the years 2000 to 2002.

Table 3. **Average annual dose per unit by country and reactor type for the years 2000-2002**

PWR						
	2000		**2001**		**2002**	
	No.	man·mSv	No.	man·mSv	No.	man·mSv
France	1	14	1	7	1	12
Germany	6	47	6	46	1	66
Italy	1	7	1	4	1	5
United States	9	563	8	307	8	284

VVER						
	2000		**2001**		**2002**	
	No.	man·mSv	No.	man·mSv	No.	man·mSv
Germany	5	62	5	43	5	48
Russian Federation					2	313

BWR						
	2000		**2001**		**2002**	
	No.	man·mSv	No.	man·mSv	No.	man·mSv
Germany	4	256	4	269	1	816
Italy	2	34	2	38	2	20
Netherlands	1	318	1	95	1	22
Sweden	1	113	1	79	1	61
United States	4	403	4	164	5	120

Table 3. **Average annual dose per unit by country and reactor type for the years 2000-2002** (continued)

GCR						
	2000		**2001**		**2002**	
	No.	man·mSv	No.	man·mSv	No.	Man·mSv
France	5	35	5	13	6	7
Germany	1	34	1	19	1	33
Italy	1	8	1	44	1	43
Japan	1	280	1	20	1	178
Spain	1	87	1	197	1	33
United Kingdom	6	49	8	41		No data

CANDU						
	2000		**2001**		**2002**	
	No.	man·mSv	No.	man·mSv	No.	man·mSv
Canada	7	200		No data	8	609

LWGR						
	2000		**2001**		**2002**	
	No.	man·mSv	No.	man·mSv	No.	man·mSv
Ukraine			3	5078	3	4472

2.3 Operational views on the evolution of radiological protection

Operational radiological protection focuses very strongly on assuring that exposures to workers and the public are maintained As Low As Reasonably Achievable, or ALARA. While this concept is central to the day-to-day management of exposures, the complex nature of exposures and exposure situations mandates a flexible approach to the implementation of radiological protection actions. The increasing participation of various stakeholder groups in decision-making processes further suggests the need for flexibility to assure the appropriate incorporation of these views. Although philosophy, policy, regulations and guides are necessary as a framework for operational applications, these guiding tools should remain rather non-prescriptive to allow the radiological protection practitioner to appropriately find the optimum option for radiological protection on a case-by-case basis.

In this context, radiological protection professionals are very interested in the current development of new recommendations from the International Commission on Radiological Protection, ICRP. To assist in this development, the Information System on Occupational Exposure (ISOE) set up a Working Group on Operational Radiological Protection (WGOR). The objective of this work is to remind the international radiological protection community, and the ICRP, of the practical aspects of radiological protection that should be reinforced by any new ICRP recommendations, and to identify areas where further practical guidance would be useful. Several key messages, that are elaborated in the body of the report of WGOR and supported by practical examples in the report's annexes, have been developed.

The work of the WGOR has focused of seven topics, all within the broad context of optimisation. These are:

- Optimisation of public exposure.
- Optimisation of worker exposure.
- Empowerment of the workforce.
- The use of tools in optimisation.
- Old-plant ALARA versus new-plant ALARA: are they equal?
- Optimisation of decommissioning.
- International aspects of optimisation.

For each of these areas, the final report of the Group will address the key points from the perspective of the operator. The WGOR suggests that these points should be kept in mind by the ICRP in developing its new recommendations, and by national radiological protection authorities as they modify their regulations, as may be necessary, following the issuance of the new ICRP recommendations. The final report of the WGOR will be sent to the ISOE Steering Group for review, modification, and approval for publication.

2.4 Man-Sievert monetary value (2002) update

In order to balance the costs associated with radiological protection options and their benefits in terms of exposure reduction the ICRP has suggested the use of cost benefit or cost effectiveness analysis in which options' benefits or effectiveness are given a monetary value according to a monetary reference value of the avoided unit of exposure: the man-sievert value, often referred as "alpha value".

In 1997, the ISOE European Technical Centre performed an international survey among regulatory bodies and nuclear facilities to check the actual use of such a tool in various countries. Five years later, it appeared useful to check whether the values have changed or not. Therefore a second survey was performed in 2002 among all the ISOE participants.

Since 1997, additional countries introduced man-Sievert monetary value systems, both at regulatory body level (Romania, Slovakia) or utility level (Hungary). Most of the other regulatory bodies and utilities that had previously such systems have kept their 1997 values. Whenever alpha-values have been modified, the numerical values increased. Most of the modifications took account of the evolution of consumer prices (systems of the regulatory bodies from Slovakia, Sweden; utilities from Sweden). Some others changed the values, if they were previously too different from the world average (utilities from Slovenia, Romania, Spain, South Africa…).

In April 2000, Rosenergoatom in the Russian Federation introduced α-values for Russian NPPs. The weighted average single value for NPPs within Rosenergoatom is 20.0 US$/man·mSv. In addition, the following α-values are used for annual individual doses:

Individual dose [mSv per year]	**α-value [US$/man·mSv]**
0-1	0
1-5	20
5-15	100
15-30	500
30-50	1000

The following graphs present the 2002 values (the values from the Russian Federation are not included in the graphs).

Figure 7. **Alpha values adopted by the regulatory bodies as of 2002**

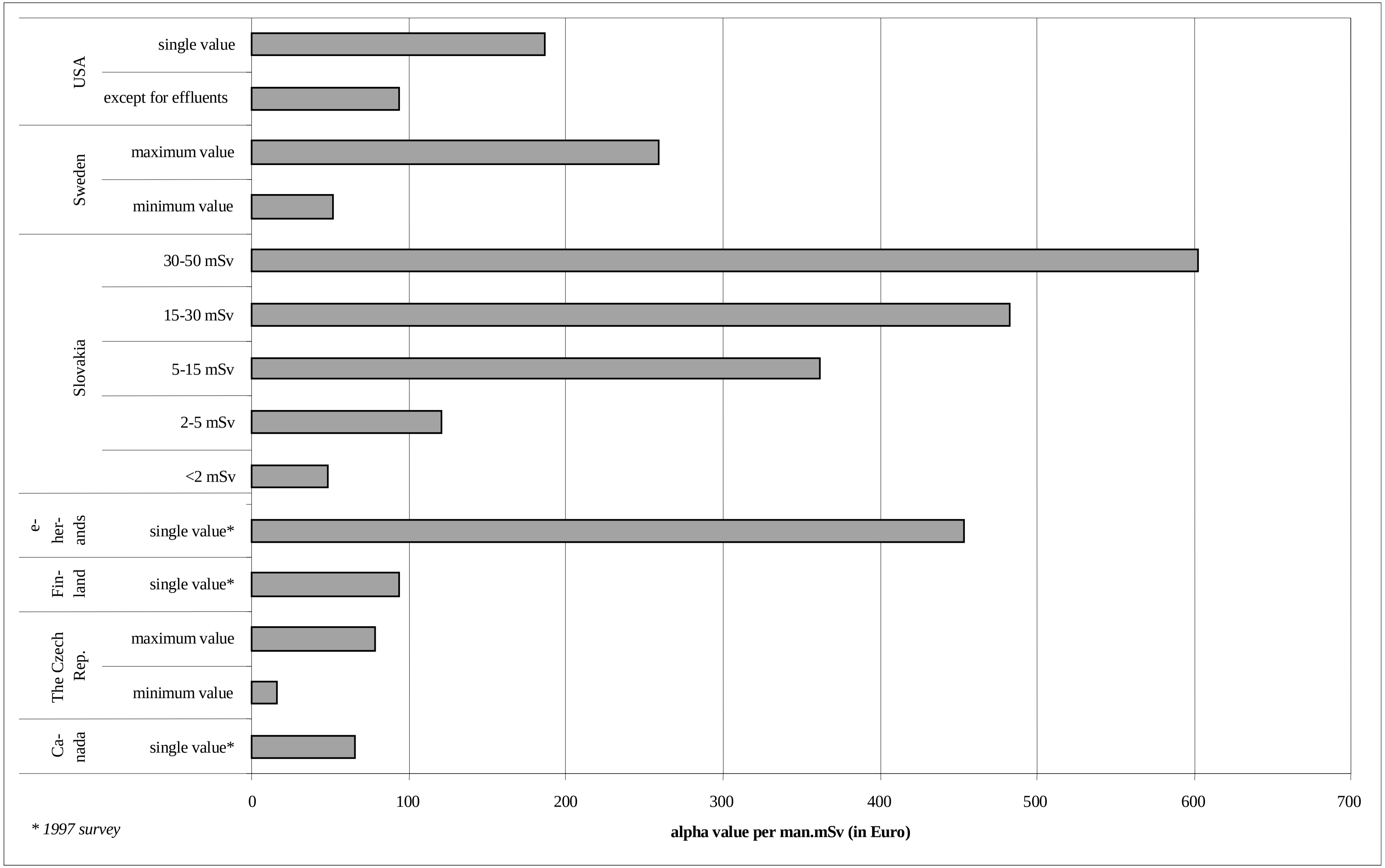


Figure 8. **Corporate or NPP alpha values for occupational exposure as of 2002: single value**

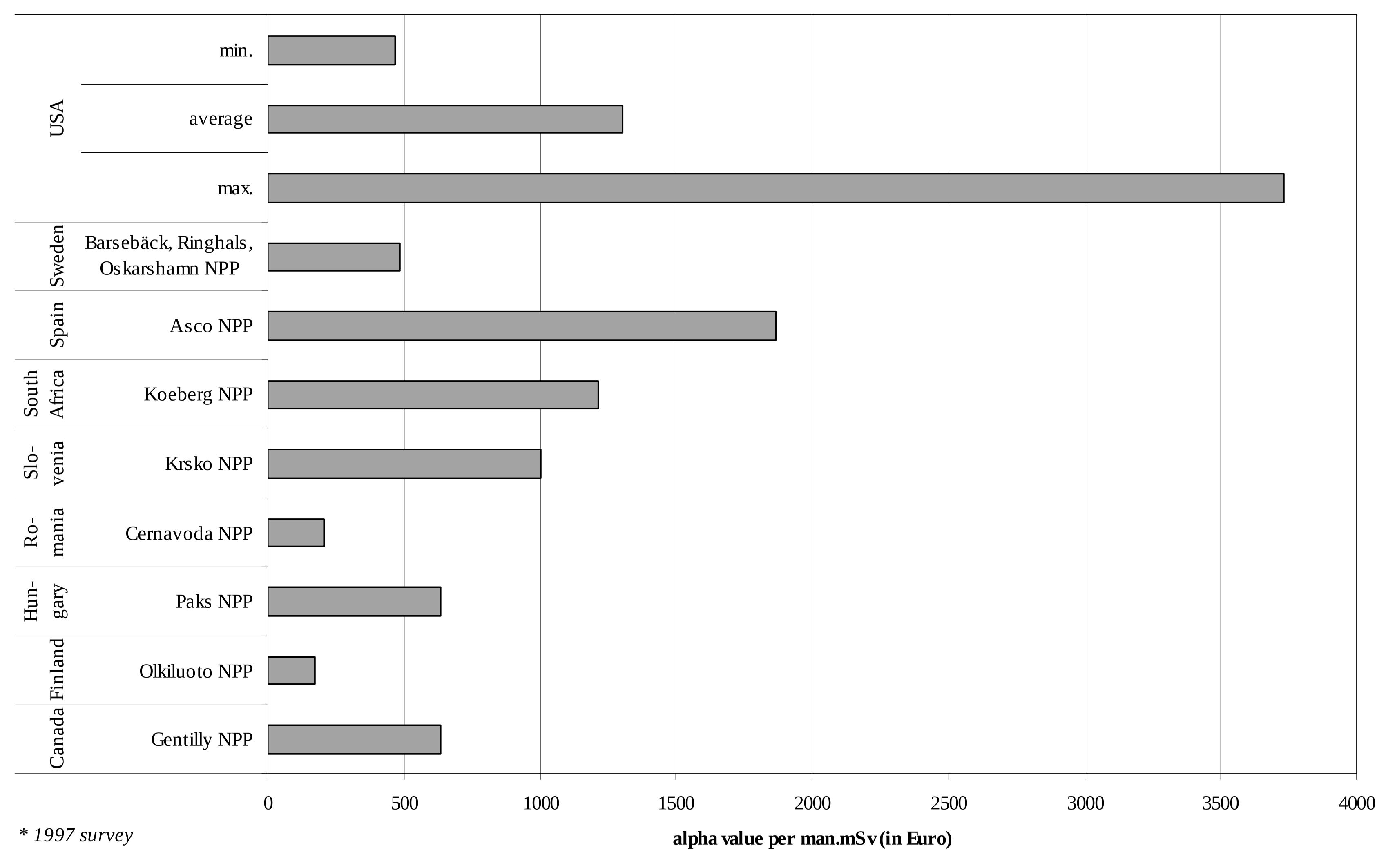
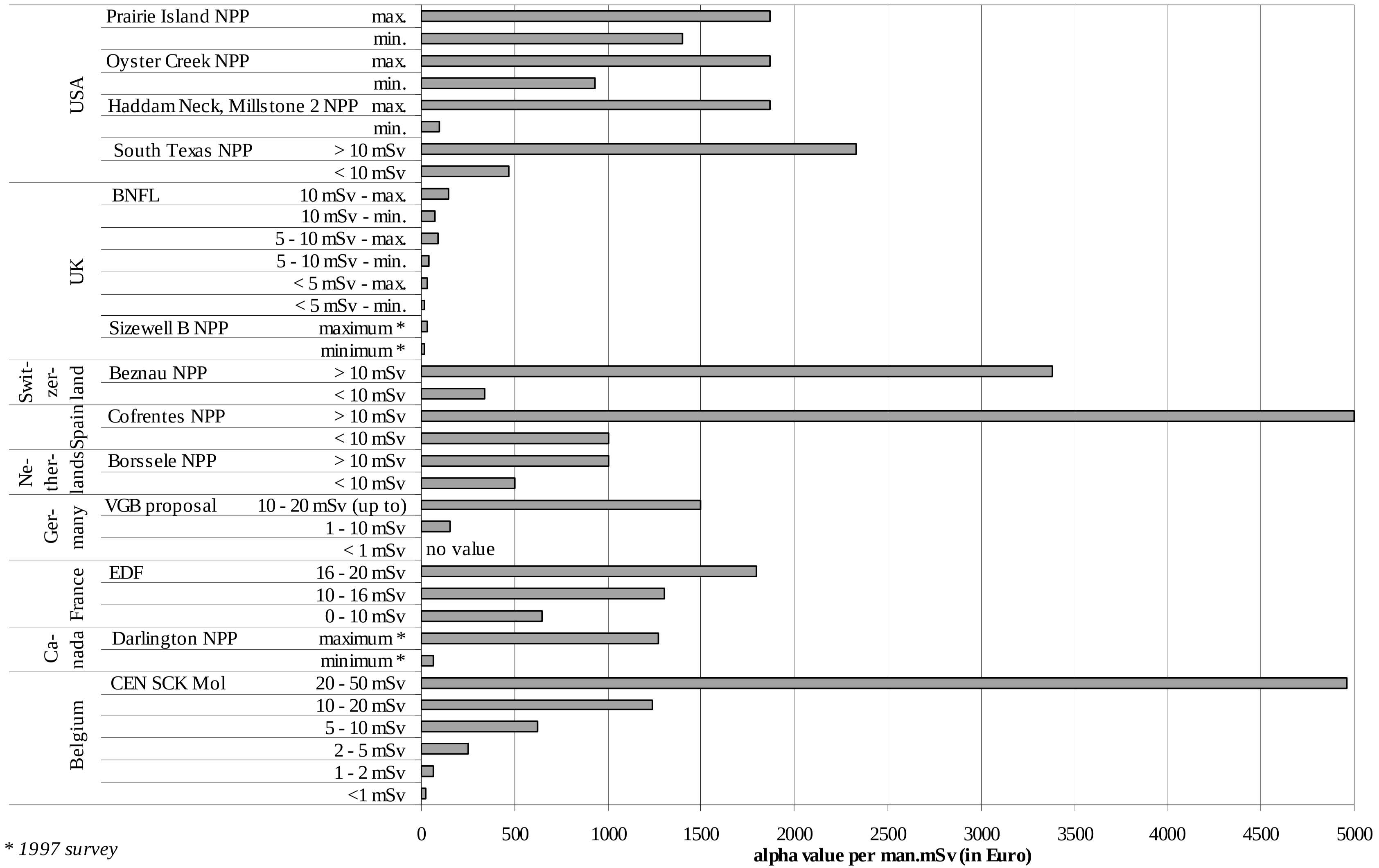


Figure 9. **Corporate or NPP alpha values for occupational exposure as of 2002: set of values**



** 1997 survey*

2.5 Summary of the 2003 International ALARA Symposium, Orlando, Florida (USA)

The 2003 International ALARA Symposium was held 12-15 January 2003 in Orlando, Florida (USA). The symposium with the theme “Radiological Work Management Techniques during Shortened Refuelling Outages” was organised by the North American Technical Centre in order 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)”. Over 150 individuals attended the symposium including 25 vendor exhibitions.

A CD Rom of the 42 technical papers and presentations was produced by the North American Technical Center. It is available to all ISOE members upon request. The Honorable Greta Joy Dicus, US Nuclear Regulatory Commissioner, was honored as “The Radiation Protection Professional of the Year” at the symposium. The special workshop was held with INPO on industry ALARA experience with PWR Reactor Head Replacement. EDF provided a plant manager to discuss the French experience on this topic which was well received by the participants.

The Byron nuclear power station was identified as a world class ALARA performer in 2002. The EDF Bugey nuclear power station was recognized for excellence in industry lessons learned based on the first PWR to undergo reactor head replacement in 1993. Plant site photos of the respective sites were shown on the symposium syllabus front and back covers.

The US Nuclear Regulatory Commission (NRC) Region III and IV Radiation Protection Managers (RPMs) meetings were held on the two days following the ISOE symposium. The format of the RPM meetings is a sharing of current radiological challenges and good practices at each plant on the first day. The second day is devoted to discussing radiological management issues with the US NRC regional managers and radiation safety inspectors. European RPMs also participated in the RPM meetings. The RPMs agreed to meet again in 2004 immediately after the ISOE ALARA Symposium.

The distinguished papers were selected by a European panel to include topics of tungsten shielding at Quad Cities, fuel cleaning at South Texas, and Decommissioning Results at San Onofre, Unit 1, to be presented at the 4th ISOE European Workshop on Occupational Exposure Management at NPPs, which will be held 24-26 March 2004 in Lyon, France.

The North American Technical Centre is currently preparing the 2004 North American Regional ISOE ALARA Symposium, which will be held 11-14 January 2004 in Miami, Florida, United States.

2.6 Principal events of 2002 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 2002. 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 2002 and which may have influenced the occupational exposure trends. These are presented by country.

ARMENIA

Summary of national dosimetric trends

For the year 2002, the collective dose at the Armenian NPP has increased due to specific work performed during the outage, in particular, transport-technological operations with spent fuel, non-destructive testing activities, isolation works.

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

Years	1995	1996	1997	1998	1999	2000	2001	2002
Collective dose	4.18	3.46	3.41	1.51	1.58	0.96	0.66	0.95

Events influencing dosimetric trends

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

Number and duration of outages

One outage (app. 90 days), without refuelling. Maintenance and repairing works in safety systems(in-service inspections and etc.) were performed. There was special influence of dosimetric trends on transferring of 7 casks with spent fuel from the NPP's water pools to dry storage.

The planned exposure doses were agreed with the regulatory body. The planned collective dose before outage was 1.66 man·Sv. The achieved collective dose was 0.74 man·Sv.

The maximum individual dose was 19.6 mSv.

2003 issues of concern

There are foreseen medium activity radioactive waste handling including drums replacement (part of these activities are transferred from the year 2002 to 2003), which can have an impact on dosimetric trends.

Regulatory plans

The revised regulations on radiation protection and safety are in the stage of approval in Government of Armenia.

BELGIUM

Summary of national dosimetric trends

Collective doses for the year 2002 (in man·mSv)

In Tihange	Tihange 1	Tihange 2	Tihange 3	Total
Plant Personnel	131.6	166.5	24.5	322.6
Contractor's Personnel	487.4	549.5	62.4	1099.3
Total	**619**	**716**	**86.9**	**1421.9**
In Doel	**Doel 1 + 2**	**Doel 3**	**Doel 4**	**Total**
Plant Personnel	127.5	117.3	62.2	307
Contractor's Personnel	461.4	490.4	258.2	1210
Total	**588.9**	**607.7**	**320.4**	**1517**

Collective doses in Tihange are decreasing compared to 2001. This is due to the number of outages: 2 in 2002 compared to the 3 outages with one steam generator replacement outages in 2001.

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.

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 47 days, No exceptional work	1014	571
Tihange 2	Outage duration 37 days, End of steam generator replacement	928	660
Tihange 3	No outage, No exceptional work	–	–
Doel 1	Outage duration 16 days, No exceptional work	653	218
Doel 2	Outage duration : 29 days No exceptional work	896	305
Doel 3	Outage duration : 45 days No exceptional work	–	562
Doel 4	Outage duration : 29 days No exceptional work	941	268

Major evolutions

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

Implementation in 2002:

- Reduction of the annual dose of the public from 5 mSv to 1 mSv.
- Reduction of the annual dose of the professional worker from 50 mSv to 20 mSv.
- Free release criteria (activity) for equipment leaving the controlled area: from 0.3 Bq/g to 0.1 Bq/g (Co60).

Programme for 2003:

- Implementation of the free release criteria (contamination) for equipment leaving the controlled area.

Component or system replacements

Tihange 3: Continuation of the replacement of BORAFLEX by BSS (Borated Stainless Steel) plates in the fuel racks of the spent fuel storage facility.Replacement of Boraflex (2^{nd} year).

Organisational evolutions

Organisation of the radioprotection personal has changed. Before there were three teams (one pro unit) of 7 persons on permanent base, now we have one team on permanent base for the whole plant and much more RP personal during working hours.

Plans for major work in the coming year

Tihange 1: No outage

Tihange 2: Special outage for intervention on the pressurizer; Normal outage;

Tihange 3: Normal outage; Replacement of Boraflex continues;

Doel 2: 2004 Special outage, steam generator replacement

BULGARIA

Summary of national dosimetric trends *(Utility report)*

Trends and data are presented on the following table and graphs. The average individual effective dose is 0.65 mSv. The maximum individual effective dose (a person from external organisation) for 2002 is 19.6 mSv, for the person from the plant – 12.9 mSv. Unit 4 has had no refuelling outage – some modernisation of Instrumentation and Control took place. The total effective collective dose for the site, including external organisations is 3.735 man·Sv.

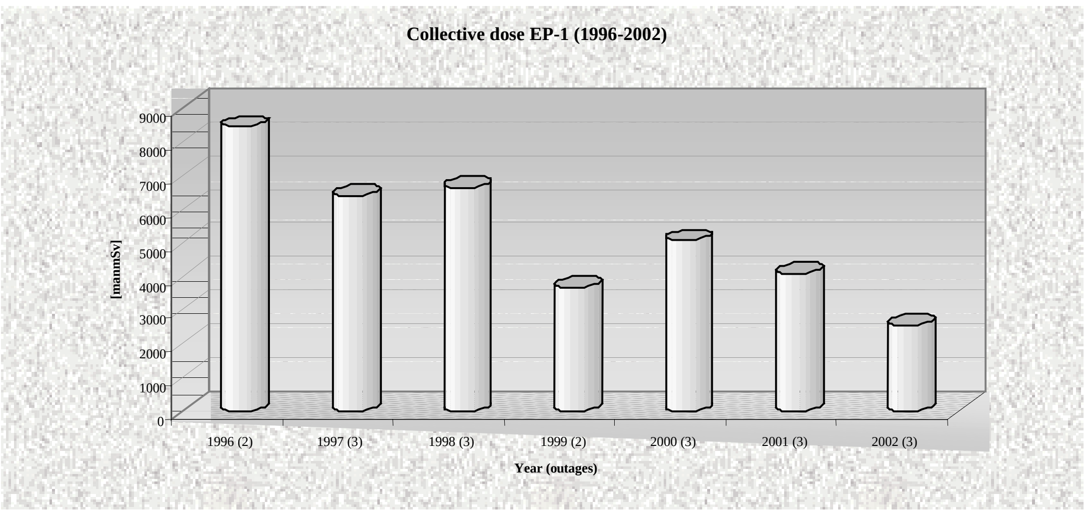
Collective doses per reactor for 2002 at Kozloduy NPP						
Site	**Reactor**	**Type**	**Outage duration [days]**	**Collective dose [man·mSv]**		**Comments**
				outage	**yearly**	
EP-1	Kozloduy 1	WWER 440	71	371.29	503.66	
	Kozloduy 2	WWER 440	78	388.27	520.64	
	Kozloduy 3	WWER 440	126	1259.44	1391.82	SLA
	Kozloduy 4	WWER 440	64	31.1	132.37	
EP-2	Kozloduy 5	WWER 1000	73	520.48	623.31	modernisation
	Kozloduy 6	WWER 1000	104	440.49	543.32	modernisation
Average/unit	**Kozloduy**				**622.5**	

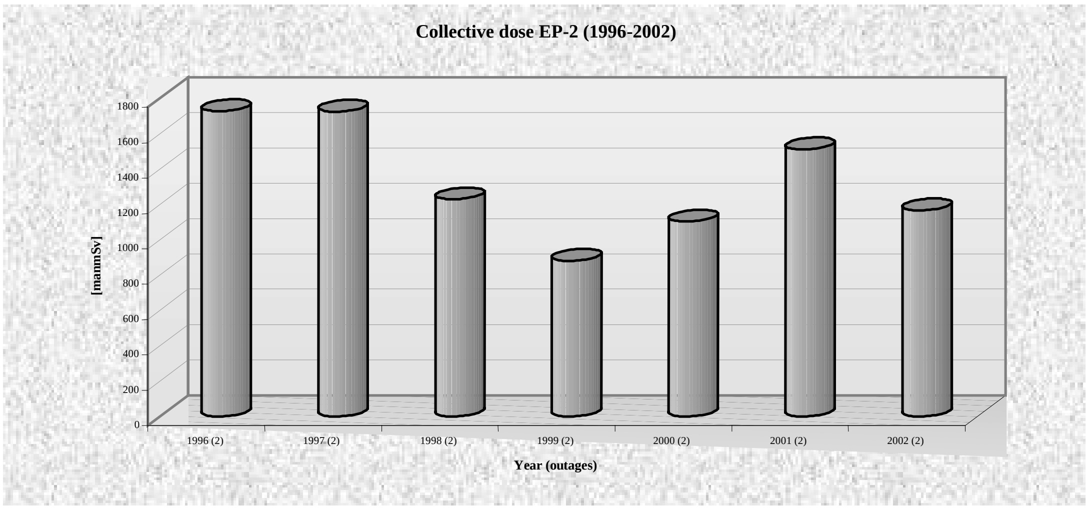
The prolonged outage duration is considered the only event influencing the collective dose. Also the ALARA implementation continued and was performed as described in IAEA Safety Reports Series No. 21.

A major modernisation concerned the Accident Localisation System (ALS) on unit 3. The main part of the system is the constructed Jet Vortex Condenser.

No unexpected events and/or safety related issues occurred.

In 2003, units 1 and 2 will be shut down for decommissioning.





CANADA

Canada's CANDU reactors have been focused on unit refurbishment projects in 2002 to achieve a "return to service" for up to seven CANDU units in the near future. Operations have continued strong at other CANDU units coupled with first time major maintenance outage work scope to assure continued reliable operation of the CANDU fleet of reactors in Canada. To assure that occupational doses are maintained ALARA, Canadian plants have focused on innovative and aggressive dose reduction measures to achieve site annual dose targets and support expanded plant maintenance work scope due to operating unit modernisation programs.

Highlights from the regulatory body – the CNSC

Subsequent to the new Nuclear Safety and Control Act and Regulations implemented in May 2000, the Canadian regulatory body has continued to monitor daily activities at all sites, and evaluate licensee radiation protection programs with its specialists. Some focus was on requirements of respiratory protection programs at Canadian sites and on quality assurance of the radiation protection programs to meet the expectations of the operational quality standard. It should be noted that the Canadian regulatory body requires formal ALARA programs.

Highlights of the Canadian reactor ALARA initiated by site are provided below

Ontario Power Generation ALARA highlights

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 near future.

Ontario Power Generation's Darlington 1-4

ALARA staff are reducing occupational dose through the implementation of a site-wide Dose Mitigation Plan. Key ALARA initiatives contained in the Dose Mitigation Plan include the following:

1. Implementation of tritium mitigation plan:
   - Implemented solutions to minimise closure plug leaks.
   - Improved dryer reliability dryer refurbishment, control and backup power.
   - Identified and contained sources of D_2O leaks, expand the use of CATS devices.
   - Reduce unplanned tritium uptakes through improved human performance.
2. Radiation source term reduction:
   - Increased purification flow.
   - Reduced filter pore size.
   - Hot spot tracking and removal.
   - Increased detritiation to outage units.
3. Expanded the use of teledosimetry.
4. Extensive use of temporary shielding, shielding curtains and mobile shielding structures.

Pickering 1-4

ALARA staff have developed major ALARA initiatives to support the extensive maintenance being performed on the units to bring the units back into service.

2002 occupational dose results are as follows:

Site dose by unit Whole body dose (includes tritium)	
Unit 1	855 man·mSv
Unit 2	138 man·mSv
Unit 3	172 man·mSv
Unit 4	1275 man·mSv
Total pickering	**2440 man·mSv**

Dose to badged workers Whole body dose (includes tritium)	
Maintenance	153man·mSv
Operators	138 man·mSv
Fuel handling	97 man·mSv
Construction (return to service)	806 man·mSv
Radiation protection	208 man·mSv

Specific ALARA initiatives at Pickering 1-4 in 2002 include:

5. Implementation of Tele-Dosimetry
   - Unit 4 100% complete

6. Implementation of Catch Containment Devices
   - Action Plan complete (100%)
   - Incorporating into REPs and Work Plans

7. Heat Transport Filtration
   - ECR approved for Unit 4
   - Will reduce filtration size from 2 microns to 0.5 microns following unit start up

8. Detritiation
   - Unit 4 Moderator and HT detritiated – 100% complete

9. Implementation of Mark 2 EPDs
   - RIS 4.5 R1 implemented
   - 1100 Mark 2 (v2.3) issued

Pickering 5-8

ALARA staff are implementing ALARA initiatives similar to Unit 1-4: Pickering 5-8 ALARA staff are tracking major ALARA initiatives to support the extensive maintenance being performed on the units. Some examples include the following:

1. Hot Spot and Temporary Shielding Programs are progressing well.
2. Heat Transport Filtration upgrades are scheduled to install 0.45 micron filters.
3. Teledosimetry installation is scheduled for the fall P361 outage 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 program, teledosimetry 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.
4. Vapor recovery drier maintenance is scheduled to replace the aged drier desiccant in order to improve drier efficiency.
5. Installation of a permanent tritium off-gassing facility is scheduled for the fall of 2003.

Dose results for 2002 (4 Units in operation during 2002):

Total station dose for 2002:	663 man·mSv / Unit
Total internal tritium dose:	196 man·mSv/ Unit
Total external dose:	467 man·mSv / Unit

Bruce Power ALARA Program

During the first part of 2002, Bruce Power continued to be operated Units 5-8 in 2002 under the management and 18-year lease of British Energy. Due to financial difficulties of the British Nuclear plants in the United Kingdom, Bruce Power was sold to a Canadian nuclear organisation in the fourth quarter of 2002.

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 (including 180 man·mSv for the 2002 outage carryover dose). Bruce B, Unit 6 completed a service outage from, April 2002 to August 2002. The outage dose was 1885 man·mSv including 440 man·mSv attributed top the unplanned replacement of pressure and calandria tubes. The Bruce B, Unit 7 planned maintenance outage in 2002 was completed for 1657 man·mSv .

The restart of Bruce A, Units 3 and 4 has been a major focus of management attention in 2002. There were several forced outages for the Bruce B operating units during 2002. The total electrical generation for Bruce B was 20.8 TwH. The total site dose for Bruce B was 1 228 man·mSv/unit.

A source term reduction initiative to reduce the tritium concentration in the moderator by 30-35% has significantly reduced the internal dose at Bruce (approximately 7% of the total whole body dose or 86 man·mSv/unit in 2002). A dedicated group to perform ALARA reviews of appropriate work packages is being formed to better integrate ALARA in the work planning process.

Point Lepreau ALARA Program

In 2002, Point Lepreau completed a maintenance outage with an outage dose of 1 060 man·mSv. The 2002 total site dose was 1 353.5 man·mSv that included an internal (tritium) dose of 185.2 man·mSv. The gross electricity generated in 2002 was 4 153 GWh with a 69% capacity factor.

In preparation for the 2002 maintenance outage, changes were made to the supervision of radiation work at Point Lepreau. Cameras were installed to monitor the passage of basic-qualification (in radiation protection) workers through radiation areas to get to their job site. Previously, this would have required a direct escort by an advanced-qualification person. Also, in low risk areas, one advanced-qualified person was allowed to supervise the radiation protection of several groups within an area rather than line-of-sight for just one group. New equipment and inspection technique reduced the time required to perform feeder tube inspections.

CHINA

Qinshan 1

For Qinshan 1 NPP, the annual collective dose for the year 2002 is 1 157.99 man·mSv, or 0.649 man·Sv/TWh.

Number and duration of outages

The 6th refuelling outage lasted took place from 7 April 2002 to 28 July 2002, with a total duration of 113 days.

Issues of concern for 2002

Dose reduction of In Service Inspection, ISI, scaffolding/insulation and the dose control of contractors.

Plans of major work in the coming year

The 7th refuelling outage will be performed in the coming year. Radiation protection personnel focus on the dose reduction and contamination control during the outage.

CZECH REPUBLIC

The licensing and control of NPP

New licensing process in accordance with the new legislation – concerns both NPP. During the years 2001 and 2002, a national inter-comparison was organised by SUJB for external gamma exposure evaluation. Both NPP were involved – very good results in accordance with uncertainties required. Control and modification of methods used for neutron and accidental dosimetry. The conception of metrological assurance requested for all personal dosimetry systems used in personal monitoring

Personal dose evaluation

First step for better evaluation of registered results in CROE – introduction of new indicator of dosimetric results validity “no access to controlled area” in given monitoring period. The statistical evaluation of personal doses could than be much precise and detailed.

Dukovany NPP

Summary of dosimetric trends

The total collective effective dose (CED) at Dukovany NPP in 2002 was 0.812 man·Sv. CED for utility employees was 0.089 man·Sv, respectively 0.723 man·Sv for contractors. The average collective effective dose per unit was 0.203 man·Sv (Dukovany NPP has installed four units of VVER-440, Model 213). The total number of exposed workers was 2 094 (746 utility employees and 1 348 contractors).

The total value of CED for 2002 is at all the lowest value under whole time operation Dukovany NPP.

The maximal individual effective dose was 13.7 mSv, which was reached by one of the contractor workers during performing the SG internal equipment fittings and inspections at all outages.

Events influencing dosimetric trends

The main contributions to the collective dose at Dukovany NPP were 4 planned outages. The total CED for four units from normal operation was 0.023 man·Sv and CED from outages was 0.789 man·Sv.

Number and duration of outages

Unit 1	34 days standard maintenance outage with refuelling; total CED during outage was 0.147 man·Sv
Unit 2	41 days standard maintenance outage with refuelling; total CED during outage was 0.145 man·Sv
Unit 3	36 days standard maintenance outage with refuelling; total CED during outage was 0.189 man·Sv
Unit 4	57 days major maintenance outage with refuelling; total CED during outage was 0.308 man·Sv

Major evolutions

Radiation contamination monitor of trucks on the main entrance/exit gate was replaced for the new generation monitor with plastic scintillators.

Temelín NPP

Summary of national dosimetric trends

The total collective effective dose (CED) at Temelín NPP in year 2002 reached value 0.0312 man·Sv. CED for utility employees was 0.0055 man·Sv, for contractor workers 0.0257 man·Sv.

The average CED per unit was 0.0197 man·Sv. There are two units of VVER1000 reactor, model 230 in Temelín NPP. The first unit is in a trial operation since June 2002, the second unit is in the commissioning (part of dynamic tests) since June 2002.

The maximal individual effective dose (IED) 1.21 mSv was determined for one contractor worker in March 2002 as a consequence of radiography works.

There was no any occurrence of internal personnel contamination in the year 2002, thus the internal contamination contribution to collective effective dose rate is Zero.

Major evolutions

Implementation of the electronically plant information system PassPort – Dosimetry module used for handling with radiation-permit documents. Implementation of computing code SEOD (electronically personal dosimetry system, having been used in NPP Dukovany for several years and implemented for NPP Temelin in late 2001).

Implementation of special ALARA computation program, used to choose the actual optimum methods to perform activities, improving the extended cost-benefit analysis.

Setting-up the ALARA committee as the executive body responsible for actual ALARA implementation from the senior management level down to the department level.

Installation of the “fast body scan” monitor for fast and operative measurement of internal contamination. All contractors workers have to measure on this equipment before starting and after ending of their works in the radiation controlled area.

FINLAND

Olkiluoto

Summary of national dosimetric trends

At Olkiluoto 1 unit the outage were refuelling and in Olkiluoto 2 outage service outage. The variation of dosetrends during three past years are implemented in the following Table.

Dosetrends at Olkiluoto NPP

	2002	2001	2000
Olkiluoto 1	0.809 man·Sv	0.367 man·Sv	0. 977 man·Sv
Olkiluoto 2	0.312 man·Sv	0.816 man·Sv	0.742 man·Sv
Average	0.560 man·Sv	0.592 man·Sv	0.859 man·Sv

Events influencing dosimetric trends

Replacement of the sealing ring in reactor water clean-up systems heat exhanger. This replacemet was made with a collective dose of 48 manmSv. An other work that increased collective dose 81 manmSv was NDT inspection in piping of reactor systems.

In 2002 OL1 outage lasted 13 days and OL2 7 days.

Major evolutions

Some collective doses decreases with the strict ALARA training in heat exchanging work. They had also in use electronic teledosimetry system.

Component or system replacements

Replacement of the sealing ring of heat exchanger in OL1.

Loviisa nuclear power plant

Summary of national dosimetric trends

At Loviisa 1 the outage was normal refuelling outage and Loviisa 2 had an extended inspection outage. The variation of dose trends during three past years are shown in the following Table.

Dosetrends at Loviisa NPP

	2002	2001	2000
Loviisa 1	1.041 man·Sv	0.760 man·Sv	1.728 man·Sv
Loviisa 2	1.573 man·Sv	0.367 man·Sv	0.537 man·Sv
Average	1.307 man·Sv	0.564 man·Sv	1.133 man·Sv

Events influencing dosimetric trends

Loviisa Unit 1: During the normal reloading outage about 1 100 people used personal dosimeter and the collective radiation dose was 0.985 man·Sv. The collective dose exceeded the estimated dose accrual by 185 mSv. The major part of this came from the extra decontamination work (asbestos cleaning) done in steam generation room. The highest personal dose was caused by the insulation work in the steam generator room.

Loviisa Unit 2: During the extended inspection outage about 1 180 people used personal dosimeter and the collective radiation dose was 1.503 mSv. The highest personal dose was caused by the insulation work in the steam generator room.

In 2002 at Unit 1 the outage took 27 days and 17 hours and the outage at Unit 2 took 49 days and 14 hours.

Component or system replacements

At Loviisa Unit 1

- Replacement of the radiation monitoring system.
- Replacement of two low-pressure emergency cooling pumps.
- Replacement of the excitation of generator one.

At Loviisa Unit 2

- Replacement of two low-pressure emergency cooling pumps.
- Replacement of the excitation of generator three.

Safety-related issues

At Loviisa Unit 1

- Improvement work related to the automatic isolation of leaks outside the containment and to decrease of the core damage risk in the so called bypass chains (VLOCA).

At Loviisa Unit 2

- Improvement work related to the automatic isolation of leaks outside the containment and to decrease of the core damage risk in the so called bypass chains (VLOCA).
- The following systems were installed: opening cylinders in the ice condenser doors, and neutron shield lowering mechanism and filters in the reactor pit for the management of severe reactor accidents (SAM-project).

New/experimental dose-reduction programmes

In year 2003 there will be new electronic dosimetry system in operation at Loviisa NPP. The ALARA committee will be working on to decrease doses caused by work in the steam generator rooms.

Other issues that are coming 2003

At Loviisa Unit 2 the replacement of the radiation monitoring system

FRANCE

Summary of dosimetric trends

Collective doses

The average 2002 collective dose for the 3loop reactors (34 reactors) was about 1.17 man·Sv. The average 2002 collective dose for the 4loop reactors (22 reactors) was about 0.66 man·Sv. The average collective dose is 0.97 man·Sv per reactor in 2002 for a target of 1 man·Sv. The number of short outages was 30 in 2002 and will be 20 in 2003. There were 8 ten yearly outages in 2002 and also 8 in 2003. The number of standard outages was 16 in 2002 and will be 22 in 2003.

Individual doses

In 2002, the average individual dose of all exposed workers (EDF and contractors) is about 2.1 mSv in 12 months. Since October 2001, nobody received an annual dose in excess of 20 mSv. In 2002, only 3 workers were recorded over 19 mSv in 12 months and less than 10 over 18 mSv.

Events influencing dosimetric trends, number of outages

EDF 3loop reactors

The lowest collective dose for a short outage in 2002 was CRUAS 2 with 0.48 man·Sv. The lowest dose for a standard outage in 2002 was DAMPIERRE 3 with 0.80 man·Sv. The highest outage dose in 2002 was BUGEY 2 with 3.33 man·Sv for a ten yearly outage. In 2003, the main contributors will be 15 standard outages, 10 short outages, 7 ten yearly outages, one Steam Generator Replacement in SAINT LAURENT B2

EDF 4loop reactors

The lowest collective dose for a short outage in 2002 was NOGENT 2 with 0.35 man·Sv. The lowest dose for a standard outage in 2002 was GOLFECH 1 with 0.37 man·Sv. The highest dose for an outage in 2002 was PALUEL 1 with 2.18 man·Sv for a standard outage. In 2002, 2 reactors had no outage and the lowest annual dose was GOLFECH 1 with 0.07 man·Sv. In 2003, the main dose contributors will be 7 standard outages, 10 short outages and 1 ten yearly outage.

Other activities

The new targets in the field of collective dosimetry are obtained with a yearly 5% decrease, i.e. 0.90 man·Sv per reactor in 2004, 0.85 in 2005 and 0.80 in 2006. In the field of individual dosimetry, the target is to reduce by 10% the number of workers exceeding 16 mSv in 12 months.

GERMANY

General information

Since the new German Radiation Protection Ordinance has been set into force in August 2001, the revision of subordinated regulations under the responsibility of regulators, and of instructions and recommendations for the use in the daily practice of NPPs is still an ongoing work in different organisations. The VGB Working Group up to now has revised the following papers:

- Method for an ALARA cost-benefit-analysis based on monetary values for pers.Sv.
- Procedure for the avoidance and control of contamination during actions for transportation of radioactive material to and from NPPs.

Further VGB-Papers will be revised in the near future:

- Control of incorporation in controlled areas of NPPs.
- Decision procedure for the use of respirators in controlled areas.

In parallel, the VGB-Organisation observes and accompanies regulator's work on following subjects:

- RP guideline for inspection and repair works in controlled areas. The guideline passed the German Health Physics Committee in February 2003.
- Guideline for physical RP control.
- Legal procedure guideline for the use of radiation passports.

Modernisation of personal dosimetry systems

The efforts of VGB in the field of modernisation of the system for personal dosimetry in NPPs are still continuing. Based on very good results in a pilot project in NPP Isar, the discussion with system suppliers, service companies, official supervisors and one local supervisory authority has reached a sufficient state. In the case of contractor companies, it is possible, that its personnel uses film badges and EPDs in parallel. However, official dosimetry during work in NPPs will be performed with EPDs handed out to contractor personnel with reference to the specific task.

To gain a broader practical experience additional pilot projects have been started with a large hospital and a second NPP. In the next step,

- the opinion has to be formed on a nationwide level (supreme authority and expert commission).
- the system suppliers have to be asked for bids.
- the investment costs have to be calculated under aspects of the technical and organisational concept.

Neutron dosimetry

In order to run an increasing number of dry flask storage facilities on German NPP sites in the near future, the knowledge about neutron dose rate measurements, neutron dosimetry (active/passive) and neutron spectra has to be raised especially in inhomogeneous neutron fields.

In a first step neutron spectra and directional distribution of neutron fluency at two working places inside a BWR (control rod driving chamber, high pressure turbine) have been measured (see publication in Nuclear Instruments and Methods in Physics Research A 476 (2002) 457-462: "Measurement of energy and directional distribution of neutron fluency inside a nuclear power plant").

In a second step the same measurement has been performed outside the plant. There was no influence of plant neutrons on the neutron dose rate in the planned onsite flask storage facility found.

A third step is the participation in the EU - founded research project EVIDOS for qualifying different neutron dosimeters (active/passive) at working places with different neutron spectra in NPPs and flask storage facilities. Measurements in a German BWR and in a defined neutron field of a research reactor will be performed in April 2003.

JAPAN

Summary of national dosimetric trends for the fiscal year 2002

Collective doses

The dosimetry level in the fiscal year 2002 increased by about 6 man·Sv from the previous year for all operating units. The average annual collective doses per unit for all operating units, BWRs, and PWRs were 1.61 man·Sv, 2.10 man·Sv, and 1.00 man·Sv respectively. The increase in dosimetry was mainly due to several modification works under high radiation dose rate during the periodical inspections for BWRs.

Individual doses

The annual average exposure of radiation workers was 1.3mSv, which was almost the same level as the previous year. The highest annual individual exposure per nuclear power station was 19.7mSv, which was well below the dose limit of 50mSv/y. Although annual individual exposures of 3 workers who worked at several nuclear power stations and other nuclear facilities exceeded 20mSv, their doses were well below the limit as well. The number of workers whose annual individual doses range from 15mSv to 20mSv was 955, which was about 330 more than the previous year.

Status of outage and periodical inspection

Periodical inspections were completed at 11 BWRs and 19 PWRs. The average duration for periodical inspection was 84 days for BWRs and 61 days for PWRs. The shortest one lasted 29 days for a PWR.

For the following years

The inspections and repairs of the PLR piping and the core shroud for BWRs, which will increase the collective dose significantly, are scheduled for the fiscal year 2003 as in 2002.

KOREA, REPUBLIC OF

Summary of national dosimetric trends

The dosimetric trend at the Korean NPPs showed continuous reduction in both the average annual collective dose per reactor unit and average annual individual worker dose.

For the year of 2002, 17 NPPs were in operation; 13 PWR units and 4 CANDU units. A new PWR (1,000 MWe), Yonggwang Unit 6 completed the test operation and started its commercial operation in 2002. The average collective dose per unit for the year 2002 was 0.55 man·Sv dropping from 0.67 man·Sv in 2001, 0.71 man·Sv in 2000.

As in previous years, the outages of units in 2002 contribute to the major part of the collective dose; 71.3% 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 2002 are shown in the following tables:

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

Year	1998	1999	2000	2001	2002
PWR (number of reactors)	1.04 (11)	0.84 (11)	0.77 (12)	0.67 (12)	0.52 (13)
CANDU (number of reactors)	1.01 (3)	0.85 (4)	0.55 (4)	0.67 (4)	0.63 (4)

Average annual collective and individual doses per unit for the year of 2002

NPP	Type	Outage duration (days)	Collective doses (man·Sv)	Average individual doses (mSv)
Kori 1	PWR	–	0.17	0.63
Kori 2	PWR	33	0.60	0.63
Kori 3	PWR	29	1.34	1.32
Kori 4	PWR	–	0.40	1.32
Yonggwang 1	PWR	37	0.82	0.91
Yonggwang 2	PWR	–	0.23	0.91
Yonggwang 3	PWR	39	0.45	0.82
Yonggwang 4	PWR	40	0.61	0.82
Yonggwang 5	PWR	–	0.05	0.06
Ulchin 1	PWR	–	0.14	1.18
Ulchin 2	PWR	76	1.22	1.18
Ulchin 3	PWR	39	0.37	0.53
Ulchin 4	PWR	53	0.35	0.53
Wolsong 1	CANDU	–	0.31	0.95
Wolsong 2	CANDU	34	0.78	0.95
Wolsong 3	CANDU	29	0.78	1.23
Wolsong 4	CANDU	33	0.66	1.23

In 2002, the number of people who were occupied in radiation works was 8 346 and the total collective dose was 9.32 man·Sv. The dose is lower than that of the year 2001(10.75 man·Sv) and this is due to the continuous efforts for ALARA and shortening of outage days.

Collective doses and outage duration in 2001/2002

Year	Number of reactors	Collective doses (man·Sv)		Outage duration	
		Total	Average doses per unit	Number of outage reactors	Duration days
2001	16	10.75	0.67	13	510
2002	17	9.32	0.55	11	438

Principal events

Staff of the Korea Institute of Nuclear Safety (KINS) worked on the ISOEDAT with the help of the CEPN in order to make the ISOEDAT run on the Asian operating systems (Korea, China, and Japan) that have a two-byte character system. After deletion of special characters from the ISOEDAT, the running of the ISOE software was verified under the environment of Windows XP (Korean and English version) as well as Windows ME (Japanese version).

LITHUANIA

Summary of national dosimetric trends

The average annual collective dose per unit for the year 2002 for the Ignalina nuclear power plant (INPP) (2 units with LWGR (RBMK) type reactors) was 4.40 man·Sv. The annual collective dose per unit was distributed as follows: for INPP personnel – 3.67 man·Sv, outside workers – 0.74 man·Sv.

The maximal individual dose of INPP personnel was 24.6 mSv, and for contractors – 19.1 mSv. Average effective individual dose was 1.97 mSv.

In 2002 the outage of Unit 1 took 100 days (22/06/02 – 09/29/02), the outage of Unit 2 lasted 66 days (06/04/02 – 10/06/02).

In 2002 collective dose was distributed as following: normal operation – 1.679 man·Sv (19% of the annual collective dose), outage of Unit 1 – 5.659 man·Sv (64% of the annual collective dose), outage of Unit 2 – 1.47 man·Sv (17% of the annual collective dose).

The following works contributed mostly to the annual collective dose during the outages of Units 1 and 2:

1. Reactor vessel: maintenance, repairs, inspection of the reactor fuel (technological) channels.
2. Main circulation circuit: Inspection and repairing of the primary system pipes d = 300 mm, d = 800 mm and pipeline valves.
3. Main circulation circuit: repairing of the bottoms of the group distribution collector.
4. Installation of the temporary shielding and insulation works.

In 2002 assessment of internal exposure for 1986 workers was carried out. There was no internal overexposure detected – maximal value of expected internal individual dose was below the registration level.

As compared to 2001, the annual collective dose increased during the year 2002. In total, 40 INPP workers received external individual dose exceeding 20 mSv. The main reasons for exceeding the 20 mSv individual dose limit was the replacement of reactor fuel channels with the aim to identify the gap between graphite and fuel (technological) channel (the collective dose after the implementation of this work was 1.145 man·Sv) and also repair of the bottoms of the Group Distribution Collector (collective dose was 0.626 man·Sv).

Defects of bottoms of Group Distribution Collector were identified after the operational control. The identification of defects has increased the contents of the inspection programme of the Group Distribution Collector. The control was performed for all welded joints of the Collector. In order to reduce dose rates, additional radiation protection measures were implemented: the washout of the blind zones of the Group Distribution Collector and the installation of additional temporary shielding was performed.

However, taking into account additional works performed during the outages, the annual collective dose for INPP personnel and contractors was below planned (4.58 man·Sv per Unit).

Goals for Ignalina Nuclear Power Plant for the year 2003:

- The maximal individual dose has to be below 20 mSv.
- The collective dose shall not exceed 10.15 man·Sv. The collective dose is determined in the dose plans for year 2003 and approved by the Radiation Protection Centre.
- Further implementation of the ALARA principle will be continued by conducting appropriate activities, such as: proper management of jobs, additional training of personnel, improving of working conditions, improving of technological processes, strengthening of quality assurance, safety culture, avoiding influence of human factor. The measures foreseen for implementation of ALARA principle are included in the Ignalina NPP ALARA Programme, which results showed it's effectiveness.

With regard to coming closure of the Unit 1 of the Ignalina NPP, new Lithuanian Hygiene Standard HN 87:2002 ,,Radiation Protection in Nuclear Facilities" has been prepared by the Radiation Protection Centre and approved by the Minister of Health at the end of 2002. This Hygiene Standard establishes radiation protection requirements for workers working in nuclear facilities and for general public during the operation and decommissioning of nuclear facilities.

For 2003, the main activities of the Radiation Protection Centre will be connected with taking part in the licensing of Ignalina NPP Unit 2, review of the Final Decommissioning Plan of Ignalina NPP, preparation and issue the information brochure for the general public on the decommissioning process, including radiation protection requirements. It is also foreseen to improve constantly the form and contents of performed inspections at the plant, the procedure of which will be set in the Quality Management Manual of the RPC. It is also planned to perform inspections in 2003 in order to control how the radiation protection requirements and exposure reduction measures are implemented for plant personnel and contractors during routine operation and outages of INPP, at the INPP spent nuclear fuel storage and during the management of radioactive waste.

MEXICO

2002 Collective dose

Laguna Verde NPP (LVNPP): Two BWR Units rated 684 MWe each		
Unit 1	Total dose	**3.33 man·Sv**
	Normal operations	0.66 man·Sv
	9th Refuelling outage	2.67 man·Sv
Unit 2	Total dose	**0.45 man·Sv**
	Normal operations	0.45 man·Sv
	Average Unit 1 and Unit 2	**1.89 man·Sv/Unit**

The collective dose reduction trend continues. The 2002 average collective dose, even having resulted higher than our proposed goal for that year (1.74 man·Sv / Unit), has been the lowest since 1991.

Main events influencing dosimetric trends /results

Unit 1 9th refuelling outage, top dose jobs

- In Service Inspection in the drywell: 0.38 man·Sv
- Control rod drives change/maintenance: 0.33 man·Sv
- Thermal insulation removal/replacement: 0.17 man·Sv
- Recirculation system drain valves replacement: 0.11 man·Sv
- Drywell ventilators maintenance: 0.10 man·Sv
- Safety relief valves tests/maintenance: 0.10 man·Sv

A scram occurred during the shutdown for this refueling outage, increasing the expected dose rate of the lower levels of the drywell by about 15%. Although the scram occurred at low power (around 2%) was enough to give that result. However same effect was not observed in the mid part of the drywell. On the other hand, the dose rate in the upper part was not just unaffected, but was even smaller than in the previous outages, due probably to the effect of the improved water chemistry, sustained during the normal operations, and to the fact that the scram produced crud movement limited to the lower part of the reactor vessel.

The duration of the outage (68 days) was longer than expected due mainly to the replacement of the jet pumps upper beams (all 20 of them) when an inspection revealed stress corrosion cracking in 6 of them.

Major evolutions

LVNPP has became one of the best performers among the BWRs GE fleet during the last two years regarding low cobalt concentration in reactor water. That explains also the radioactive source term reduction observed during the last years.

Component or systems replacement

As stated before, all the jet pumps upper beams (20 in total) were replaced after an inspection revealed stress corrosion cracking indications in 6 of them. The utility decided to substitute the whole set as a conservative measure. Contact dose rates up to about 5 000 mGy per hour were found in the removed components. Since the job was performed under water, the associated collective dose resulted in the order of 28 man·mSv.

Regulatory aspects for the year 2003

The Mexican Regulatory body has submitted a draft of a new national regulation on Radiation Protection based on ICRP 60; the new regulation is expected to be made official by the end of 2003 or early 2004. Current regulation is based in ICRP 26 being consistent with the American Regulation 10 CFR 20. Anyway, in advance of the change of regulation, the Utility is already adopting administrative limits consistent with ICRP 60.

NETHERLANDS

General

The Netherlands has two nuclear power plants. The Borssele NPP is a PWR (450 MWe) operated by the company NV EPZ. The plant is in operation since 1973. In 1997 a major backfitting programme in the plant was completed. The Dodewaard NPP is a BWR (57 MWe) operated by GKN and this plant was permanently shutdown in March 1997.

Regulatory

The radiation protection standards based, on the Euratom guidelines were implemented in the Netherlands in March 2002.

Nuclear power plant operation

Borssele NPP

Collective dose

The annual collective dose for Borssele NPP was 338 mSv (111 mSv for EPZ staff and 227 mSv for contractors). The availability of the plant in 2002 was 93.7%. The outage dose in 2002 was 257 mSv (10% less than planned in advance), while the outage duration was 18.4 days (4.5 days more than planned).

Due to fuel leakages in the last cycle the shutdown phase lasted longer, because more time was needed for the purification of the primary system. In the outage 4 fuel elements were found to have defects. Two elements were repaired in which 7 tubes were found to have leakages due to fretting, these tubes were replaced by dummy-tubes. After repair the elements appeared to be leakfree (wetsipping test) and were then loaded again into the core for the next cycle. Extensive search actions and inspections were carried out to find any foreign loose parts in the primary systems. Four loose parts were found and removed from the system. A modification is in preparation to install debris filters in the foot of future fuel elements to avoid fuel leakages in the future.

The doserate on the primary system again was 10% lower than last year.

Individual dose (mSv)

	Average individual dose (mSv)	**Maximum individual dose (mSv)**
EPZ-staff	0.40	5.09
Contractors	0.60	5.46

98.2% of all the workers received an individual dose lower then 3 mSv. The plant policy to reduce the individual dose is successful and will be continued.

Developments

The 10 yearly periodic safety review of Borssele NPP is in progress and will be finished in 2003. In the scope of this project a review of the radiation protection programme is included.

Dodewaard NPP

The post operation activities and the project to realise a safe enclosure for the plant are in progress. Several transports of fuel elements toke place last year. The last transport of fuel to Sellafield is planned in April 2003. The fuel racks from the dry storage for new elements were removed.

The annual collective dose in 2002 was 22 mSv.

Developments

Several decommissioning activities (emptying the fuel storage pool, decontamination of primary systems, fuel pool and buildings, radioactive waste treatment of core components, fuel racks and other types of waste) are planned for 2003.

The collective dose for these activities is planned to amount a few hundred mSv.

PAKISTAN

The collective dose at the nuclear power plants KANUPP and CNPP for the year 2002 are as follows:

Year	**Plant**	**Reactor type**	**Collective dose minus outage doses**	**Outage dose**	**Total dose**
2002	KANUPP	CANDU			2.52 man·Sv
2002	CNPP	PWR	32.5 man·mSv	299.4 man·mSv	331.9 man·mSv

ROMANIA

SNN-CNE PROD CERNAVODA operates a single Nuclear Power Plant of CANDU-600 type. The year of 2002 is the sixth full year of commercial operation.

In 2002 the collective dose was 550 man·mSv; this is below the 2001 value.

Occupational exposure at Cernavoda NPP (February 1996 - December 2002)

	Internal effective dose man·mSv	**External effective dose man·mSv**	**Total effective dose man·mSv**
1996	0.6	31.7	32.3
1997	3.81	244.48	248.28
1998	54.37	203.25	257.62
1999	85.42	371.11	469.89
2000	110.81	355.39	466.2
2001	141.42	433.44	574.86
2002	206.43	344.04	550.48

Events influencing dosimetric trends

In 2002 the planned outage was short having a 49% contribution to the collective dose, lower than previous years, which made the previous years' dose-increasing trend to stop.

During 2002 there were:

1. one 15.5 days forced outage between 18 February and 5 March, without radiological impact;
2. one 30 days planned outage, between 11 May and 11 June.

Major evolutions

In 2002 CNCAN continued to issue new regulations. Till now, the following norms related to NPPs were issued:

- Radiological Safety Fundamental Norms/2000 (transposing the Council Directive 96/29/EURATOM – the Romanian regulation has a supplementary chapter on the transfer in environment of the radioactive waste).
- Radiological Safety Norms on Operational Protection of Outside Workers/2001.
- Radiological Safety Norms – Procedures for Agreement of External Undertaking/2002.
- Radiological Safety Norms – Authorization Procedures/2001.
- Norms for Designation of Notified Bodies in Nuclear Field/2000.
- Norms for Authorization of the Work with Radiation Sources Outside the Special Designated Precinct/2002.

- Individual Dosimetry Norms/2002.
- Norms for Issuing the Work Permits for Nuclear Activities and Designation of Radiological Protection Qualified Experts/2002.
- Fundamental Norms for Safe Transport of Radioactive Materials/2002.
- Norms for International Shipments of Radioactive Materials Involving Romanian Territory/2002.
- Norms for International Shipments of Radioactive Wastes Involving Romanian Territory/2002.
- Norms for Transport of Radioactive Material – Authorization Procedures/2002.
- Safeguards Norms for Nuclear Field/2001.
- Detailed List of Materials, Devices, Equipment and Information Relevant for the Proliferation of Nuclear Weapons and Other Explosive Nuclear Devices/2002.
- Norms for Physical Protection in Nuclear Field/2001.
- Norms on Requirements for Qualification of the Personnel that Ensures the Guarding and the Protection of Protected Materials and Installations in Nuclear Field/2002.
- Norms on Radiation Protection of the Persons in Case of Medical Exposures/2002.
- Norms on Radioactively Contaminated Foodstuff and Feeding stuff after a Nuclear Accident or other Radiological Emergency/2002 (issued together with the Ministry of Health and Family).

Organisational evolutions

A new organisational structure of the Radiation Protection Department of NPP was established during 2002, in order to flatten the organisation chart. The Radiation protection manager co-ordinates four groups – Radiation Protection Technical Service, Radiation Control Service, Dosimetry Laboratory and Environmental Control Laboratory – to meet all the requirements related to the radiation protection of professionally exposed workers, population and environment.

Relevant issues for the year 2003

Issues of concern

- Special measures for radiation protection are necessary, as tritium build-up in the moderator and primary circuits will increase the tritium dose to workers.
- Measures to ensure safe storage of the degradable radwaste before treatment and conditioning, as the pressure in the storage drums is increasing.

Technical plans for major work in 2003

- The major activities planned for 2003 outage having a potential impact on the collective dose are: fuel channel inspection, primary circuit pump replacement, feeders' inspection, fuel handling machine inspection. Permanent metallic platforms will be installed next to the steam generators in order to reduce/eliminate doses associated with installing/disassembling operations each time steam generators are inspected.

- Spent fuel transfer will start during 2003 from Spent Fuel Pool Storage to the new Intermediate Spent Fuel Dry Storage (MAXTOR) under construction since 2002.

Regulatory plans for major work in 2003

- The reauthorization of operation of Unit 1 of CNE-PROD Cernavoda, the commissioning authorisation and probatory operation authorisation of the Intermediate Spent Fuel Dry Storage are scheduled for 2003.
- For 2003 CNCAN will continue to issue regulations related to radiation protection in NPPs. The Radiological Safety Norms – Procedures for Acceptance of External Undertaking are scheduled to be issued in January 2003. The set of radioactive waste management regulations is scheduled to be issued in 2003-2004.
- CNE-PROD ALARA committee(s) will also be established during 2003.

RUSSIAN FEDERATION

Main data from Russian NPPs type WWER

The average annual collective dose (personnel & contractors) per unit for WWER type reactors was 1.24 man·Sv in 2002. The authorised individual control was based on thermoluminescent dosimeters.

Nuclear power plant	**Annual collective dose [man·Sv/unit]**								
	1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Balakovo 4 units with WWER-1000	0.62	1.21	0.92	0.94	1.03	0.92	0.67	0.68	0.66
Kalinin 2 units with WWER-1000	2.77	2.22	1.83	1.77	1.52	1.46	1.49	1.24	0.94
Kola 4 units with WWER-440	2.21	1.56	1.76	0.89	1.02	1.71	1.02	1.10	1.07
Novovoronezh Units 3&4 – WWER-440 Unit 5 – WWER-1000	4.00	4.63	2.58	2.20	2.07	3.47	2.13	3.36	2.81
Volgodonsk 1unit with WWER-1000								0.03	0.16
Average	**2.22**	**2.26**	**1.70**	**1.34**	**1.34**	**1.83**	**1.24**	**1.41**	**1.24**

Shutdown WWER reactors

There are two shutdown WWER units in Russia. Novovoronezh 1 was shut down in 1984, Novovoronezh 2 – in 1990. The shutdown annual collective dose (personnel and contractors) in 2002 was 626.6 man·mSv.

Number and duration of outages

Name of reactor unit	Since (date)	Duration (days)	Type of outage
Balakovo 1	06.01.02	49	Standard maintenance
Balakovo 2	02.04.02	48	Standard maintenance
Balakovo 3	14.08.02	54	Standard maintenance
Balakovo 4	12.05.02	82	Major maintenance
Kalinin 1	15.06.02	51	Standard maintenance
Kalinin 2	16.03.02	49	Standard maintenance
Kola 1	15.06.02	109	Specific modification & modernisation aimed at unit life extension
Kola 2	19.03.02	52	Standard maintenance
Kola 3	17.08.02	29	Standard maintenance
Kola 4	14.05.02	60	Major maintenance
Novovoronezh 3	29.05.02	62	Standard maintenance
Novovoronezh 4	01.08.02	113	Specific modification & modernisation aimed at unit life extension
Novovoronezh 5	29.08.02	54	Standard maintenance
Volgodonsk 1	11.05.02	47	Standard maintenance

Component or system replacements

The most important activity performed during modification and modernisation at Kola 1 and Novovoronezh 4 were:

- Modernisation of the Accident Localisation System with construction of jet-vortex condenser instead of the relief valves.
- Modernisation of the Reliable Power Supply System aimed at creation of two independent power supply channels.
- Modernisation of the Service Water System which include additional water supply pumps and secure each unit independently.
- Construction of the system for additional steam generator emergency make-up.

The total collective dose during Kola 1 outage was 631.5 man·mSv (plant personnel – 239.4 man·mSv, contractors – 338.1 man·mSv). One of the most significant part to the outage collective dose gave the construction of jet-vortex condenser (collective – 147.9 man·mSv, max. individual – 4.8 mSv). The ALARA approach was used during planning, preparation and implementation of construction.

New dose-reduction programmes

In 2002, the following programmes took place:

- Electronic personnel dosimeters (EPD) of Rados Technology were implemented at Kalinin NPP (completely) and Novovoronezh, Volgodonsk NPPs (partly).
- Experimental approval of EPDs produced in the Russian Federation were carried out at Balakovo and Kola NPPs.
- The new general programmes of external and internal dosimetry control at NPPs were developed.
- The Methodical Recommendations "Development and application ALARA certificates during high radiation work preparation and implementation" were prepared, published and distributed at all Russian NPPs.

Issues of concern for 2003

First part delivery of EPDs produced in the Russian Federation at NPPs. It is planned to deliver in total 3 600 EPDs in 2003-2005 and 1 200 EPDs in 2003.

Implementation of personnel dosimetry control computer based system at NPPs.

SLOVAK REPUBLIC

The average annual collective dose per unit and reactor type PWR – VVER in Slovak republic for 2002 is 284.55 man·mSv.

Bohunice nuclear power plant (4 Units)

The total annual effective dose in Bohunice NPP in 2002 calculated from legal film dosimeters was 1 299.72 man·mSv (employees 809.16 man·mSv, outside workers 490.56 man·mSv). The maximum individual dose was 16.44 mSv (contractor).

Events influencing dosimetric trends in 2002

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. The main reasons of the higher exposures at Unit 1 and 2 were the higher radiation fields than at Unit 3 and 4 due to the historical higher contamination of the primary loops and due to the leakage of the fuel element indicated at Unit 2. All activities performed in radiation controlled zones had been optimised.

Number and duration of outages

Unit 1 – 42 days standard maintenance outage. Total collective dose was 430.16 man·mSv.
Unit 2 – 43 days standard maintenance outage. Total collective dose was 359.09 man·mSv.
Unit 3 – 44 days standard maintenance outage. Total collective dose was 174.20 man·mSv.
Unit 4 – 43 days standard maintenance outage. Total collective dose was 156.78 man·mSv.

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

Major evolutions

Bohunice NPP renewed all licensees in the field of radiation protection having validity for five years.

Component and system replacement

The installation of N16 monitors for Unit 3 and 4 as well the installation of spectrometry system for monitoring of noble gas releases in all ventilation stacks had been finished.

The modification of the plant calibration facility for RP instrumentation was postponed and the finishing of the works is planned for April 2003.

Safety-related issues

After the exchanging of the instrumentation and improving of the personal contamination and small items measurements at the exit from the RCA there was no person found contaminated outside the radiation controlled area in 2002. Nevertheless the WANO Follow Up mission held at Unit 1 and 2 showed the place for the further improvement.

New / experimental dose – reduction programmes

Several works were submitted to the ALARA committee. The cost benefit and sensitive analyses were applied to the “repair of the upper feedwater distribution pipes in SG” at Unit 1.

Unexpected events

The fuel leakage at Unit 2 caused the high concentration of the noble gases and iodine in primary circuit. To protect the workers against the internal contamination the corrective measures were elaborated and accepted. The situation was consulted with the regulatory body – State Health Institute.

The second event was combined with the high surface contamination of the outer site of the steam generator after its decontamination from primary site (Unit 1).

Both events were analysed and corrective measures were suggested at the Plant Event Commission.

Due to the good co-operation between the plant employees and RP staff both events had only negligible influence to the occupational exposure.

Organisational evolutions

Lowering of the number of NPP RP employees by 14 persons.

Expected principal events for the year 2003

Unit 1 – 43 days standard maintenance outage.
Unit 2 – 76 days major maintenance outage.
Unit 3 – 78 days major maintenance outage.
Unit 4 – 46 days standard maintenance outage.

Note: large modification works are planned to start at Unit 3 and 4 due to the process of modernisation of V2 NPP.

Technical issues of concern from radiation protection point of view

Following events in the field of modernisation of radiation instrumentation are expected:

- continuing in improving of contamination measurement at all exit points from RCA for women;
- installation of new particulate, iodine and gas accident monitoring system in ventilation stack at Unit 3 and 4;
- installation of accident monitors on live steam pipelines from steam generators at Unit 3 and 4;
- modernisation of the main radiation control room at Unit 3 and 4;
- modernisation of release counting and spectrometry laboratory as well as the environmental laboratory;
- finishing of the calibration facility.

Mochovce nuclear power plant (2 Units)

Total collective effective dose (CED) for the two units was 407.55 man·mSv (CED was evaluated from legal film badge and TLD neutron personal dosimeters), maximum individual effective dose was 4.49 mSv (contractor).

Events influencing dosimetric trends in 2002

The main contributors to the total CED at Mochovce NPP were planned outages at Units 1 and 2. The total CED for both units from normal operation was 60.188 man·mSv and CED from outages was 402.311 man·mSv (CED were evaluated on a base of results of operational electronic personal dosimeters).

Unit 1 – 47 days long planned standard outage. Total CED was 274.196 man·mSv (plant personnel 131.837 man·mSv, contractors 142.359 man·mSv).

Unit 2 – 78 days long planned major outage. Total CED was 128.145 man·mSv (plant personnel 60.545 man·mSv, contractors 67.600 man·mSv).

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

Component and system replacement

Teledosimetry system in vicinity of the NPP.

Expected principal events for the year 2003

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

Unit 2 – 47 days standard maintenance outage combined with safety measures implementation.

Technical issues of concern from radiation protection point of view

Following events are expected in 2003 – finalising of installation of new radiation measurements – stack instrumentation and final testing of central radiation monitoring computer system.

Regulatory plans for major work in the coming year

- Assessment of the improvements (modernisation measures) on unit 3 and 4 in Bohunice NPP.
- Inspections of outages in all operated units.
- Application of recommendations and suggestions of 2002 IAEA IRRT Mission in Slovakia.

SLOVENIA

Radiological performance indicators of Krško nuclear power plant (PWR) for the year 2002

Collective radiation exposure was 0.58 man·Sv (0.109 man·mSv per GWh electrical output). Maximum individual dose was 8.15 mSv, average dose per person was 0.71 mSv.

Planned outage (11.5.02-5.6.02), 25 days: Outage collective dose was 0.53 man·Sv.

Main additional activities planned according to ALARA and their collective doses (in man·mSv) were: Ex-core detectors replacement (12), installation of fatigue monitoring (12), inspection of reactor lower internals (5), testing of hangers (73), inspection of reactor vessel head (32) and of piping welds (37).

Collective dose of re-racking of spent fuel pool was 18 mSv.

Major evolution

In year 2002 the new Law on protection against ionising radiation and nuclear safety was introduced. The Law is based on the safety standards and other relevant directives and regulations of Euratom. It gives basics rules for the control of the occupationally exposed workers, radiation safety, licensing, nuclear and waste safety, and radiation protection of people and patients. The Law corresponds to previous acts introducing the Convention on nuclear safety and Joint convention on the safety of spent fuel and radioactive waste management, and to other acts related to environmental protection, construction and mining, transport of dangerous goods, civil defence, and to internal affairs.

Considering the outside workers the Law requires an agreement on radiation protection between nuclear power plant operator and a contractor and regulatory approval of the contractors who are engaged in activities in radiation controlled area.

It is required that the complete change of radiation protection regulation will be performed during the years 2003-2004.

Reviews

In year 2003 the IAEA OSART mission will be at Krško.

SPAIN

In the year 2002 the average dose per outage has been 0.569 man·Sv for PWR (5 units) and 2.154 man·Sv for BWR (1 unit). Per plant, the annual and outage collective doses are shown in the following table:

NPP	Type	Outage coll. doses (man·Sv)	No. days	Annual coll. doses (man·Sv)	Comments
J. Cabrera	PWR	0.650	53	0.845	
Almaraz I	PWR	0.594	24	0.698	
Almaraz II	PWR	–	–	0.105	No outage
Ascó I	PWR	–	–	0.028	No outage
Ascó II	PWR	0.464	23	0.512	
Vandellos II	PWR	0.863	34	0.964	
Trillo	PWR	0.273	37	0.327	
S.M Garoña	BWR	–	–	0.249	No outage
Cofrentes	BWR	2.154	30	2.795	

Regarding the total annual collective dose, the PWR average for this year is 0.497 man·Sv (and the 3 year rolling average is 0.51 man·Sv.).

For BWR the total collective dose average for this year is 1.52 man·Sv (and the three-year rolling average is 1.32 man·Sv).

	PWR			BWR		
Year	**Outages**	**Collective doses (man·Sv)**	**3 year rolling average**	**Outages**	**Collective doses (man·Sv)**	**3 year rolling average**
1997	5	1.35		1	2.39	
1998	4	0.54		0	0.58	
1999	5	0.71	0.87	2	2.45	1.81
2000	6	0.59	0.61	1	1.52	1.52
2001	5	0.43	0.58	1	0.93	1.63
2002	5	0.50	0.51	1	1.52	1.32

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 increased a bit compared with the result of 2001, which was the lowest of the last 5 years. For BWR, the yearly value is higher than in 2001, with also an unique refuelling outage in Cofrentes that will be commented later on. However, the value is lower than in 2000, the previous year with only one outage in Cofrentes. Differences between the two BWR plants outages can be seen looking at the figures. Even though, the three year rolling average has decreased in 0.31 man·Sv because this time all the three years considered within the average have had only one outage.

Regarding the Cofrentes outage, one of the main task carried out has been the chemical decontamination of the Reactor Coolant System (B33), with worse results than expected. It has been only possible to decontaminate the lower part, leaving without decontaminating the upper part: suction and discharge pipe, collectors, risers, and suction and impelling nozzle. The dose reduction factor in the inferior part of the drywell has been lower than expected. For this reason, most of the jobs programmed to be performed after the chemical decontamination have had a higher radiological cost than previously estimated.

Relating Ascó II, this last outage of 23 days has been the shortest one in the history of Ascó I and II. The old radiological Monitoring System was changed to a modern digital system (MGP).

In Vandellós II an increase of the dose rates in the cavity has been registered, affecting to the refueling tasks (133.19 man·mSv). There has been also an increase in the doses associated to the valve tasks (86.33 man·mSv), which has been linked to the increase of the plant doses.

The collective dose during the outage of Almaraz I is the lowest dose received in the history of this Unit Plant, a 25% lower than the lowest registered dose. The main non routine task carried out was the inspection of the vessel nozzles, producing a total collective dose of 55.12 man·mSv. These numbers confirm the decreasing evolution of the radiation levels in the Plant, although the remaining antimonium delivered in 1999 due to the breakage of a secondary source is still affecting these radiation levels.

Jose Cabrera has had a quite long outage, 53 days due to a problem occurred when extracting the upper internals. During this task performance, three pins of the fuel elements bent and had to be cut. The Spanish Regulatory Body had to licensee this operation, which delayed even more the outage completion. During this year, this Plant has renewed his Operating Permit until 30th April 2006, when the plant will stop definitely its operation. José Cabrera NPP was in 1968 the first nuclear power plant to go into operation in Spain. It is a PWR type designed by Westinghouse with an electrical power of 160 MW.

In Trillo NPP, the new interim storage building constructed to contain the dry spent fuel cask contains at this moment the two first containers filled and stored after this year outage.

The main decommissioning labours under the radiological point of view carried out in Vandellós I have been the dismantling and scarifying of the Graphite Silos, clearance material expeditions to El Cabril, clearance of different materials, the finalisation of the dismantling and disassembling of the spent fuel pool building, dismantling of the reactor box external structure, and the dismantling of the store wells for irradiating waste and of the radioactive liquid effluent tanks. The official collective dose accumulated during 2002 was 33.01 man·mSv.

The new Regulation on Sanitary Protection against Ionising Radiation (Royal Decree 783/01 based on the European Directive 96/29/Euratom) issued on July 6th 2001 came into force in January 2002. The working group with representatives from the utilities the and the regulatory body created with the objective of developing a “Generic Radiation Protection Plan” successfully completed this task by December 2001, Limiting values and reference levels for radiological zones in terms of dose rate, airborne contamination and surface contamination.

SWEDEN

Summary

The total collective dose 2002 at the Swedish NPPs was 13.0 man·Sv, which is very much higher than previous years. Thus the down going trend during the five last years was cut. The reason to this was the performance of modernisation work of Oskarshamn 1 and Barsebäck 2. The collective dose for the modernisation of Oskarshamn1 and Barsebäck 2 was 5.5 man·Sv respectively 1.2 man·Sv. The rest of the Swedish total collective dose (6 man·Sv) is about the level of the yearly collective dose during the last years.

The dose rate levels of the most of the reactors are fairly low mostly due to dose rate reduction measures performed during the past years. Very low collective doses of the outage (0.1-0.2 man·Sv) at Forsmark 3 and Oskarshamn 3 were results of earlier performed system decontamination.

Collective dose and dosimetric trends

Barsebäck

The total collective dose was 2.1 man·Sv.

Unit 1 has been in service operation since the final shut down at the first of December 1999. All fuel is transported away and planning for decommissioning is ongoing.

At unit 2 a modernisation of the primary systems were performed during the outage of totally 81 days. Pipes and components were replaced in order to reduce the risk for IGSCC and to reduce the amount of inspections. Initially a system decontamination was successfully performed resulting in a decontamination factor of 22. The total collective dose for the outage was 1.9 man·Sv of which 1.2 man·Sv due to the modernisation work.

Forsmark

The total collective dose was only 1.3 man·Sv, the lowest ever with all three units in operation.

Unit 1 stopped twice for replacing damaged fuel due to fuel failure. These were short outage periods and very low collective doses.

At Forsmark 3 the outage lasted only 12 days and the outage dose was only 0.1 man·Sv, the lowest ever in Sweden. The low collective dose was a result of a small amount of performed jobs and low dose rates, as a result of the system decontamination carried out the year before.

Oskarshamn

The total collective dose was 7.0 man·Sv of which modernisation of Oskarshamn 1 was 5.5 man·Sv. The modernisation was ongoing during all the year and included replacement of the 4 main circulation pump housing, modifications of the main cooling system and replacement of the turbine. The dose rate levels were higher than expected and this was the main reason to a higher outage dose than planned. Before the replacement of the main circulation pump housing a system decontamination was performed.

At unit 2 there were a normal outage. Several activities were postponed to 2003 when a system decontamination will be carried out. A primary fuel failure occurred in September but has so far not developed into a secondary fuel failure.

At unit 3 there occurred also a small primary fuel failure in March but it was stable until the outage period. The dose rates and contamination levels are about the same since the system decontamination performed in 1999.

Ringhals

The total collective dose was 2.6 man·Sv.

At unit 1 outage collective dose was 0.7 man·Sv, which is the lowest ever. The dose rates were about the same as after a system decontamination in 1997.

At unit 2 and 3 the dose rates were at the same or increasing levels as compared to last year.

At unit 4 the reactor vessel outlet nozzles (safe ends) were repaired due to cracks. The repair was performed with newly developed equipment from inside the emptied reactor vessel. About 6 km new weld were applied by remote controlled equipment.

A general explanation for the still favourable dose rate trend at Ringhals 2, 3 and 4 (PWR) is a strong focus on the primary chemistry.

Number and duration of outages

Plant	Type of reactor	Length of outage (days)	Collective dose (man·Sv)	Comments
Barsebäck 2	BWR	82	1.86	Upgrading project 1.2 man·Sv
Forsmark 1	BWR	19	0.37	
Forsmark 2	BWR	21	0.35	
Forsmark 3	BWR	12	0.09	
Oskarshamn 1	BWR	365	5.49	Upgrading during all the year
Oskarshamn 2	BWR	25	0.57	
Oskarshamn 3	BWR	19	0.24	
Ringhals 1	BWR	36	0.71	
Ringhals 2	PWR	25	0.42	
Rinhals 3	PWR	31	0.23	
Ringhals 4	PWR	*69*	0.80	Repair of reactor vessel outlet nozzles
Total		**739**	**11.13**	

Authority

The Swedish Radiation Protection Authority finds the present situation of radiation protection satisfying. It is anyhow important in the future that there are resources available, both economical and personnel, to retain and develop good conditions from the radiation protection point of view. The authority foresees that further efforts are needed in order to maintain the technical quality and safety at the Swedish NPPs. During the next coming years there will be further modernisation and repair work leading to higher collective doses during the outages. The authority will therefore focus on dose rates levels in the plants, personnel dosimetry and systems for exchange of experience and quality assurance in the area of radiation protection.

Issues of concern

The Swedish ICRP Project, initiated in the end of 2000, has studied the available material from the ongoing international debate on the ICRP risk model, to describe the present situation and analyse different concrete results and their consequences. The project has published both its main report and six case studies, used as an important vehicle for the analysis.

Plans for 2003

The upgrading of Oskarshamn 2 starts in 2003. Pipes and valves will be replaced in the main circulation system and in the spray system for the reactor vessel head, because of IGSCC.

At Ringhals 3 repair work of cracks in the reactor vessel outlet nozzles will be performed in 2003. The same repair work that was performed at Ringhals 4 this year.

Zinc injection will be started in Oskarshamn 1 and 2 during 2003.

SWITZERLAND

Summary of dosimetric trends

Facility	Number of monitored workers	Years' collective dose (man·mSv)	
		2002	**2001**
KKB Beznau I + II	778	595.3	907
KKG Gösgen	841	931.4	540
KKM Mühleberg	888	944.5	922
KKL Leibstadt	1009	428.2	1010

Events influencing dosimetric trends

KKB Beznau I + II

In both units the Co-58 contamination of components outside the reactor core was significantly decreased compared with the situation in 2001 as a result of different chemistry in the primary circuit at normal operation and an improved cleaning process before starting the outages. Therefore the dose rates decayed in some parts of the containment below the values of the last years. Because of leakages in both units the duration of outages took longer as they were planned.

KKG Gösgen

Because of a leakage which was found after the outage while start up the reactor another break of about 7 days was needed to repair. The leakage didn't led to any release of radioactivity outside the primary system. The repair of the sealing resulted in an additional 150 man·mSv.

KKL Leibstadt

Despite of the increase of thermal and electrical power dose rates were identical to those of last years. Especially on the recycle pumps the dose rate decreased by 10%.

KKM Mühleberg

Despite of an identical Noble Metal Chemical Addition (NMCA) and Hydrogen Water Chemistry (HWC) as compared with 2001 there was a slightly increase of the average dose rate on the components in the primary circuit in 2002. The cleaning of the torus was performed with optimised tools which had a positive influence on the collective dose for the workers as well as on the time needed for this job.

Number and duration of outages

KKB I 1 outage, 31 days (planned 26 days, last year 11 days)

KKB II 1 outage, 18 days (planned 11 days, last year 68 days)

KKG 1 outage, 29 days (planned 20 days, last year 22 days)

KKL 1 outage, 17 days (last year 24 days)

KKM 1 outage, 19 days (last year 24 days)

New plants on line/plants shutdown

The old incinerator for radioactive waste at the Paul Scherrer Institut was closed down definitively end of 2002. In the last three decades the combustible waste from all Swiss NPP was conditioned there. The new incinerator at ZWILAG got no permission to operate with radioactive material up to now.

Safety-related issues

KKL

The uncontrolled release of condense water from an air cooling system inside the controlled zone via rainwater pathway was reported to the Swiss Federal Nuclear Safety Inspectorate. Fortunately there exsist a monitoring of the rainwater. No excitation of any release limits were found.

New/experimental dose-reduction programmes

KKM

New equipment was used to clean up the torus resulting in a reduced dose rate and exposure time for the workers. The process was tested before on a mock up and optimised additionally. It benefits on shorter outage duration and lower collective dose.

Regulatory issues in 2003

Due to the revised guideline R-11 on "general aims of radiation protection in nuclear facilities" the licence holders have to build up a quality assurance system for radiation protection wherein the process of planning and optimisation of outages has to be described.

UKRAINE

Summary of national dosimetric trends

In 2002 the collective occupational exposure dose of NNEGC “EnergoAtom” NPP personnel was equal to 20.0 man·Sv, that is ~ 3 man·Sv more in comparison with 2001.

In 2002 total collective doses per NPP unit were equal to: Zaporizhzhe NPP – 6.76 man·Sv (1.13 man·Sv/ unit); Rivno NPP – 5.97 man·Sv (1.99 man·Sv/unit); South Ukraine NPP – 5.85 man·Sv (1.95 man·Sv/ unit); Khmelnitsky NPP – 1.42 m Sv (1.42 man·Sv /unit).

To perform operational tasks an NPP invites outside personnel. The outside personnel dose contribution into the NPP annual collective dose was equal to: ZNPP – 3%; RNPP – 1%; SU NPP – 23%; KhNPP – 14%.

Events influencing dosimetric trends

It is worthwhile mentioning that in 2001 NNEGC “EnergoAtom” annual collective occupational doses were the lowest with regard to the whole period of operation.

Annual collective occupational doses increased in 2002 in comparison with 2001 at ZNPP by 156%; at RNPP by 115%. Collective occupational exposure doses at SU NPP and KhNPP remained at the last year level.

Such increase is caused by the increased volume of radiation dangerous activities during overhauls at ZNPP units 2 and 5 and RNPP unit 1. Overhauls of steam generators were also performed at all three units of RNPP.

Number and duration of outages

Planned unit outages took place at all NPP units in 2002.

NPP	Duration of the outage [days]	Annual collective dose [mSv]
Zaporizhzhe NPP	390	4429
Rivno NPP	179	2887
South Ukraine NPP	217	3350
Khmelnitsky NPP	69	830

The analysis shows that with every subsequent unit outage the tendency to ionising radiation dose capacity increase from the main equipment is observed.

The greatest dose expenditure is observed for such activities as inspection and maintenance of the reactor, steam generators and main circulation pumps; moreover, the tendency of radiation sedimentation growth at inner surfaces of the above equipment is observed.

Since the year 1999 the outage dose level decreased, and during the recent three years has not changed sufficiently. This factor increased by approximately 3.5% during the period under review with the total duration of NNEGC “EnergoAtom” unit outage reduction by 4 days.

Major evolution

In 2002 for the first time NNEGC “EnergoAtom” has not recorded any case of personnel individual exposure dose limit exceeding – 20 mSv/year (allowable limit is equal to 100 mSv per 5 years)

During the year under review NPPs developed ALARA implementation principle programs. ALARA engineering working groups were created at the NPPs with the purpose of planning and analysing the collective doses for each department during normal operation and outage. The groups meet 2-4 times per year and according to the results of their meetings, the measures for decreasing the exposure of workers from “radiation dangerous activities” are developing. Besides, the ALARA Groups hold unplanned meetings in case of emergency.

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

Component and system replacement

In 2002-03 over the plan steam generator outage was performed the duration of which in the year 2002 was equal to 54 days. During the reactor shut down the maintenance activities involved radiation dangerous equipment. The collective exposure dose of the personnel participating in it was equal to 1 004 mSv.

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Issues for the year following the year of the Annual Report (2003)

In 2003 two steam generators at SU NPP are planned to be replaced that has to lead to NPP collective dose increase.

Currently there are common problems for all NPPs connected with personnel exposure control. Thus lack of modern electronic dosimeters leads to additional mistakes in exposure dose definition and defining work expenditure for individual radiation dangerous activities.

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.

UNITED KINGDOM

The average collective doses for operational reactors in 2002 are as follows:

Reactor type	Number of units	Collective dose/unit (man·mSv)
PWR	1	296
AGR	14	103
Magnox	8	88.5

Summary of national dosimetry trends

Doses accrued at AGRs were similar to that for 2001. Collective doses ranged from 26 to 695 man·mSv for a 2 unit station.

Doses accrued at Magnox units were lower than that for 2001. Collective doses ranged from 102 to 315 man·mSv for a 2 unit station.

The PWR (Sizewell B NPS) collective dose was 10% higher than 2001.

Events influencing dosimetry trends

Sizewell B undertook a short refuelling outage without any need for steam generator primary side access.

The difference between AGR units is the need for man access for pressure vessel inspections and repairs. Thus a different unit (Hinkley Point B) had the highest collective dose whereas it was Hunterston B the previous year. These 2 sites have undergone a series of planned and unplanned outages to repair boiler components.

Bradwell, a 2 unit Magnox site, ceased generation on 31 March 2002. Other Magnox units underwent a programme of statutory inspections and maintenance.

Major evolutions and system upgrades

The Electronic Personal Dosimeter (EPD mark 1) is now the regulatory dosimeter used at 15 out of 23 units. The remainder use the film badge (6 units) and TLD (2 unit site). Units using the EPD do not use a secondary control dosimeter.

A "work management system" was installed at all PWR and AGR sites. This system included a "Total Exposure Module" designed to integrate radiological planning with the production of Radiological Work Permits.

On all reactor systems the pressure is to operate and maintain systems with less staff and to reduce outage times to a minimum.

Unexpected events

At the PWR focus was to prevent further significant atmospheric halogen discharges during refuelling outages. This area caused serious regulatory concern in 2000/2001 and plant modifications are planned for 2003 to mitigate further such events.

Torness (AGR) experienced a catastrophic gas circulator failure on one unit, that resulted in significant downtime and in-vessel work although this work did not result in increased collective dose compared with the previous year.

Plans for 2003

Three plants (Sizewell B, Hinkley Point B and Hartlepool) will experience a WANO inspection this year and in each case radiological protection will be one of the tracks reviewed.

Corporate radiological protection will be reorganised in a new Nuclear Oversight Department. This is as a result of an earlier Corporate WANO inspection.

UNITED STATES

Summary of USA occupational dose trends

The USA PWR and BWR occupational dose averages for 2002continued a downward trend for the 104 commercial reactors:

Reactor type	Number of units	Total collective dose	Dose per reactor
PWR	69	61.08 man·Sv	0.87 man·Sv/unit
BWR	35	61.18 man·Sv	1.75 man·Sv/unit

The total collective dose for the 104 reactors in 2002 was 121.26 man·Sv, a increase of 9% from the 2001 total. The resulting average collective dose per reactor for USA LWR was 1.17 man·Sv/unit: the second lowest average collective dose ever recorded for US light water reactors.

US PWRs

The total collective dose for US PWRs in 2002 was 60.18 man·Sv for 69 operating PWR units. The 2002 average collective dose per reactor was 0.87 man·Sv/ PWR unit. The average 2002 PWR dose represents a 5% decrease from the 2001 value: the fourth time since the first commercial reactor commenced operations in 1969 that the average US PWR annual dose has been under 1.00 man·Sv/unit.

US BWRs

The total collective dose for US BWRs in 2002 was 61.08 man·Sv for 35 operating BWR units. The 2002 average collective dose per reactor was 1.75 man·Sv/BWR unit.

The average 2002 BWR dose represents a 27% increase from the 2001 value. This is primarily due to extensive jet pump repairs and water chemistry challenges at one US BWR in 2002 (17.86 man·Sv at Quad Cities, Unit 1 and 2).

The average BWR collective dose per reactor, without Quad Cities 1 and 2 included, was 1.31 man·Sv/BWR unit. Even with the Quad Cities high doses, the US BWR average collective dose for 2002 was the third lowest recorded average dose per unit for US BWRs since 1969.

Regulatory issues (Nuclear Regulatory Commission)

All commercial nuclear power reactors operating in the United States must be licensed and monitored by the Nuclear Regulatory Commission (NRC). Nuclear Plant operators are subject to continual inspections by the NRC inspectors permanently stationed at each facility. Regional inspectors also make several visits annually to conduct routine inspections.

NRC reactor oversight

The improvements in plant performance can be attributed both to efforts within the nuclear industry and to successful regulatory oversight. Despite this success, the NRC has noted that previous processes for inspection, assessment, and enforcement were not always focused on the most important safety issues. In some situations regulatory activities have been redundant or inefficient and, at times, overly objective. The NRC has addressed these concerns.

The new oversight program calls for:

- Focusing inspections on activities where the potential risks are greater.
- Applying greater regulatory attention to nuclear power plants with performance problems, while maintaining a normal level of regulatory attention on facilities that perform well.
- Using objective measurements of the performance of nuclear power plants.
- Giving both the public and the nuclear industry timely and understandable assessments of plant performance.
- Reducing unnecessary regulatory burden on nuclear facilities.
- Responding to violations of regulations in a predictable and consistent manner that reflects the potential safety impact of the violations.

NRC scope of inspections

The inspections are performed by NRC resident inspectors who monitor plant activities. The inspections are performed by NRC resident inspectors stationed at each nuclear power plant and by inspectors based in one of the NRC regional offices or in NRC headquarters in Rockville, MD.

The revised process includes baseline inspections common to all nuclear plants. The baseline inspection program, based on the “cornerstone” areas, focuses on activities and systems that are ”risk significant.”

The inspection program also reviews the “crosscutting issues” of human performance, the “safety-conscious work environment,” and how utilities find and fix problems. Additional inspections may also be performed in response to a specific event or problem which may arise at the plant. The new inspection program uses a “risk informed” approach to select areas to inspect within each cornerstone. The inspection areas were chosen because of their importance from the point of view of potential risk, past operational experience, and regulatory requirements. Inspection reports are issued for all inspections just as under the previous inspection program.

NRC performance indicators

The performance indicator data are evaluated and integrated with findings of the NRC inspection program. Each of the performance indicators has criteria for measuring acceptable performance. These objective criteria are designed to reflect risk according to established safety margins, as indicated by a colour coding system.

A “green” coding indicates performance within an expected performance level in which the related cornerstone objectives are met. “White indicates performance outside an expected range of nominal utility performance but related cornerstone objectives are still being met. “Yellow” indicates related cornerstone objectives are being met, but with a minimal reduction in safety margin. “Red” indicates a significant reduction in safety margin in the area measured by that performance indicator. The performance indicators are reported to the NRC on a quarterly basis by each utility.

Advance NRC reactor research plan

In 2001, the NRC staff has developed and issued a report, “Future Licensing and Inspection Readiness Assessment (FLIRA).” The FLIRA report committed the NRC staff to the development of an advanced reactor research plan. The scope of the plan included both confirmatory and anticipatory research, as it applies to four reactors identified in the FLIRA report. These reactors included the Pebble Bed Modular Reactor (PBMR), Gas Turbine-Modular Helium Reactor (GT-MHR), Westinghouse advanced pressurised water reactor AP-1000, and International Reactor Innovative and Secure (IRIS). The plan originated from a technology-neutral perspective. Discrimination between technologies was required, however, once design-specific safety issues needed to be considered, or when modifications to existing analytical codes for specific applications needed to be addressed.

Many of these reactor designs will propose features very different than current reactor designs. Since safety and licensing are major considerations, NRC will have early interactions with the designers and developers. It is a possibility that in the next five to 10 years orders for new nuclear power plants will become reality.

3. ISOE PROGRAMME OF WORK

3.1 Achievements of the ISOE Programme in 2002

The Information System on Occupational Exposure made the following achievements in the year 2002:

Data collection and management

Collection of ISOE 1 data

ISOE participants provided their 2001 data using the ISOE Software under Microsoft ACCESS. Data from ATC member utilities were collected and transferred to ETC for integration. All IAEATC participants, except the Russian Federation, provided data. NATC provided data for reactors in Canada, Mexico and the United States. ETC integrated all data received into the ISOE database.

Collection of ISOE 2 data

Collection of ISOE 2 data started – for the first time – in the beginning of 2003.

Collection of ISOE 3 reports

Since the release of the input module to collect ISOE 3 reports February 2002, collection of ISOE 3 reports has started. Historical ISOE 3 (NEA 3) reports have been included in the ISOE database.

Data release

The first release of the ISOEDAT database with data from 1969 to 2001 was made available to the European Utilities and to the Technical Centres for distribution on password protected ETC FTP server in July. Since then, several updates have been performed.

The database and the ISOE Software has been provided on CD-ROM to all participants at the end of 2002.

Documents and reports

ISOE Annual Report 2001 – The report was published and distributed in November 2002.

ISOE – Information System on Occupational Exposure, Ten Years of Experience – Report: 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. It was presented at the 3rd ISOE European Workshop on Occupational Exposure Management in Nuclear Power Plants, which was also the Tenth anniversary of the ISOE System, and at the International Conference on Occupational Radiation Protection, held in Geneva in August 2002. As of September 2002, more than 1400 reports have been distributed.

Information Sheets issued in 2002: The ISOE Technical Centres performed in 2002 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 Third ISOE European Workshop on "Occupational Exposure Management at Nuclear Power Plants", Portoroz, Slovenia, 17-19 April 2002

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.

The proceedings of the workshop: *Occupational Exposure Management at Nuclear Power Plants: Third ISOE European Workshop, Portoroz, Slovenia, 17-19 April 2002,* OECD 2003 are available from NEA Publications or from the ISOE Technical Centres. In addition, individual papers can be downloaded from the ETC web site at http://isoe.cepn.asso.fr.

Organisation of the 2003 International ALARA Symposium, 12-15 January 2003 in Orlando, Florida (USA)

The North American Technical Centre held the 2003 International ALARA Symposium, 12-15 January 2003 in Orlando, Florida (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 "Radiological Work Management Techniques during Shortened Refuelling Outages" and the symposium was sponsored by the North American Technical Centre (NATC), the OECD/NEA and the IAEA.

Individual papers can be downloaded from the NATC web site at http://www.natcisoe.org

Data analysis

The Working Group on Data Analysis (WGDA) reviewed and proposed the structure and content of the ISOE Annual Report 2001.

The Working Group on Data Analysis was supervising the preparation of the ISOE report ***ISOE – Information System on Occupational Exposure, Ten Years of Experience, OECD, 2002*** which was published in March 2002.

Software development

General

With the implementation of ISOE 2 in the ISOE Software under Microsoft ACCESS, the software development for ISOE nears its completion. Future work will include the translation of the software in various languages, including Japanese, Korean and Russian, and the preparation of a User Manual.

ISOE 2 Software development

The input module to implement ISOE 2 data into the ISOE database has been developed and undergoes currently final testing. The complete ISOE Software under Microsoft ACCESS was distributed in the beginning of 2003.

ISOE 3 Software development

The input module to collect ISOE 3 reports has been developed and was distributed to all ISOE participants in February 2002. The collection of ISOE 3 reports has started. Historical ISOE 3 (NEA 3) reports have been included in the ISOE database.

Distribution of a new ISOE 3 report

After writing a new ISOE 3 report, the author of the ISOE 3 report 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, in case prepare and amend the retrieval lists, and will then distribute the file via the NEA e-mail remailing system to all ISOE participants.

Launching of a new ISOE Working Group for interaction with ICRP

At its 2001 meeting, the ISOE Steering Group decided to launch an ***ISOE Working Group on Operational Radiation Protection (WGOR)*** 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. The Joint Secretariat prepared a draft Terms of Reference and a Work Plan for the Group, which was adopted by the ISOE Bureau. The WGOR held its first meeting on 22 November 2002 in Malmö, Sweden.

Contact with WANO

In order to improve collaboration and synergy with WANO, the ISOE Steering Group agreed during its meeting in 2000 to send a letter to WANO, suggesting a close co-operation in the field of occupational exposure at nuclear power plants (letter was sent 28 November 2000). WANO's co-ordinating centre replied that they are considering the proposal, but that it will take some time to discuss it within WANO.

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.jnes.go.jp/isoe/
ETC	http://isoe.cepn.asso.fr
IAEATC	http://www-rasanet.iaea.org/programme/rmps/isoe-tech.htm
NATC	http://www.natcisoe.org
NEA	http://www.nea.fr/html/jointproj/isoe.html

3.2 Proposed programme of work for 2003

The Information System on Occupational Exposure programme for the year 2003 includes:

General promotion of the ISOE System

Letter to top-level management: Information on ISOE and the importance of a practicable experience exchange system. The letter should be translated into several languages and sent to regulators and utilities. In order to achieve this ISOE members should send their vice Presidents or Plant managers' name and address.

Data collection and management

- Collection of ISOE 1 data for the year 2002.
- Collection of ISOE 2 data, using the ISOE data input module (static data and dynamic data for 2002).
- Organisation of national training courses on the use of the ISOE system, especially with a view to use the ISOE 3 reporting system (Commitment from national co-ordinators).
- 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.
- Award best ISOE 3 reports each year at the annual ISOE ALARA Workshop or Symposium.

- Issuance of several updates of the ISOEDAT database on the ETC server and distribution of a CD-ROM in June 2003 and September 2003.
- Korea will use, for the first time, the ISOE Software under Microsoft ACCESS which had been modified to accept Asian software requirements (e.g. Korean and Japanese characters) to collect ISOE data.

Data analysis (under the auspices of the ISOE Working Group on Data Analysis)

Promotion of the preparation of the ISOE 3 reports.

Initiation of the new ISOE data display to clearly show what data there is.

Documents and Reports (under the auspices of the ISOE Working Group on Data Analysis)

ISOE Annual Report 2002 – Objective to publish the report in September 2003.

Information sheets planned for 2003

Yearly analyses		**Technical centre**
1.	Japanese dosimetric results: FY2002 data and trends	ATC
2.	Korea, Republic of; Summary of national dosimetric trends	ATC
3.	Preliminary European Dosimetric Results for the year 2002	ETC
4.	Annual outage duration and doses in European reactors (update)	ETC
5.	Information on exposure data collected for the year 2002	IAEATC
6.	3-year rolling average annual dose comparisons US PWR, 2000-2002	NATC
7.	3-year rolling average annual dose comparisons US BWR, 2000-2002	NATC
8.	3-year rolling average annual dose comparisons Canadian CANDU, 2000-2002	NATC
9.	US PWR refuelling outage duration and dose trends	NATC
10.	US BWR refuelling outage duration and dose trends	NATC
11.	Dollars per man·Sv saved	NATC
Special analyses		
1.	Analysis of the vessel head replacement - update	ETC
2.	Partial replacements of the Residual Heat Removal system piping in France	ETC
3.	Radiation Protection during industrial radiography in NPPs	ETC
4.	Status of decommissioning data in the ISOEDAT database	ETC and NEA
5.	Standardisation of dose rate measurements in WWER reactors	IAEATC
6.	North American experience with reactor head inspections	NATC
7.	Summary of 2003 International ALARA Symposium, Orlando United States	NATC

International ISOE Workshop on occupational exposure in nuclear power plants

Organisation and follow-up of the 2003 International ALARA Symposium, 12-15 January 2003 in Orlando, Florida (USA).

Preparation of the 4th ISOE European Workshop on Occupational Exposure Management at NPPs, which will be held 24-26 March 2004 in Lyon, France.

Interaction with the International Organisations

International Commission on Radiological Protection (ICRP) (under the auspices of the ISOE Working Group on Operational Radiation Protection)

Preparation of the occupational radiation protection specialists' views on the development of new ICRP recommendations.

European Commission

Establish close links to the European Commission occupational exposure programme; harmonise occupational exposure data collection programme.

WANO/INPO

Intensify the co-operation between WANO and the ISOE System especially in the domain of ISOE 3 reporting system.

Software maintenance

To further enhance the usefulness of the ISOE software, the following items remain to be developed in 2003:

- Implementation of the modified structure of data codification (task list for ISOE 1 data).
- Translation of the software in other languages, especially in Japanese, Korean and Russian.
- 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 on request in order to meet the user's needs.

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)
Multidisciplinary workers in nuclear installations: Radiation protection and Welding

Annex 1

LIST OF ISOE PUBLICATIONS

Reports

1. *Occupational Exposure Management at Nuclear Power Plants: Third ISOE European Workshop, Portoroz, Slovenia, 17-19 April 2002,* OECD 2003.

2. *ISOE – Information Leaflet,* OECD 2003.

3. *Occupational Exposures at Nuclear Power Plants: Eleventh Annual Report of the ISOE Programme, 2001*, OECD, 2002.

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

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

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

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

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

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

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

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

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

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

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

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

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
No. 17, 2002	Japanese dosimetric results: FY2001 data and trends
No. 18, 2002	Japanese occupational exposure during periodic inspection at PWRs and BWRs ended in FY 2001
No. 19, 2002	Korea, Republic of; Summary of national dosimetric trends
European technical centre	
No. 1, April 1994	Occupational Exposure and Steam Generator Replacement
No. 2, May 1994	The influence of reactor age and installed power on collective dose: 1992 data
No. 3, June 1994	First European Dosimetric Results: 1993 data
No. 4, June 1995	Preliminary European Dosimetric Results for 1994
No. 6, April 1996	Overview of the first three Full System Decontamination
No. 7, June 1996	Preliminary European Dosimetric Results for 1995
No. 9, December 1996	Reactor Vessel Closure Head Replacement
No. 10, June 1997	Preliminary European Dosimetric Results for 1996
No. 11, September 1997	Annual individual doses distributions: data available and statistical biases
No. 12, September 1997	Occupational exposure and reactor vessel annealing
No. 14, July 1998	PWR collective dose per job 1994-1995-1996 data (restricted distribution)

European technical centre (cont'd)	
No. 15, September 1998	PWR collective dose per job 1994-1995-1996 data (general distribution)
No. 16, July 1998	Preliminary European Dosimetric Results for 1997 (general distribution)
No. 17, December 1998	Occupational Exposure and Steam Generator Replacements, update (general distribution)
No. 18, September 1998	The Use of the man-Sievert monetary value in 1997 (general distribution)
No. 19, October 1998	ISOE 3 data base – New ISOE 3 Questionnaires received (since September 1998) (restricted distribution)
No. 20, April 1999	Preliminary European Dosimetric Results 1998
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
No. 30, April 2002	Occupational exposure and steam generator replacements – update
No. 31, July 2002	Preliminary European Dosimetric Results for the year 2001
No. 32, November 2002	Conclusions and Recommendations from the 3rd European ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants
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
No. 7, October 2002	Information on exposure data collected for the year 2001
No.8, November 2002	Conclusions and Recommendations from the 3rd European ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants

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
No. 02-1, November 2002	3-year rolling average annual dose comparisons US PWR, 1999-2001
No. 02-2, July 2002	3-year rolling average annual dose comparisons US BWR, 1999-2001
No. 02-4, July 2002	US PWR 2001 Occupational Dose Benchmarking Chart
No. 02-5, July 2002	US BWR 2001 Occupational Dose Benchmarking Chart
No. 02-6, 2002	Monetary value of person-rem avoided

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	2001 International ALARA Symposium
February 2002, Orlando, Florida, USA	North-American National ALARA Symposium
January 2003, Orlando, Florida, USA	2003 International 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 2002

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 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
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
	Vattenfall Europe/Hamburgische Elektrizitäts-Werke AG (HEW)	Brunsbüttel
	Vattenfall Europe/HEW and E.ON	Krümmel
	RWE Power	Biblis A, B 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, 5
Lithuania	Ignalina Nuclear Power Plant	Ignalina 1, 2
Mexico	Comisiòn Federal de Electricidad	Laguna Verde 1, 2
Netherlands	N.V. EPZ	Borssele
Pakistan	Pakistan Atomic Energy Commission	Chasnupp 1 Kanupp
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	Slovenske Electrarne	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 Fuel and 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
United States	Amergen Energy Company	Clinton 1 Oyster Creek 1 TMI 1
	American Electric Power	D.C. Cook 1, 2 South Texas 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 2, 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
	First Energy Corporation	Beaver Valley 1, 2 Davis Besse 1 Perry 1
	Nuclear Management Company	Duane Arnold 1 Kewaunee 1 Monticello 1 Palisades 1 Point Beach 1, 2 Prairie Island 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
Canada	Bruce Power	Bruce A1
France	Électricité de France	Bugey 1 Chinon A1, A2, A3 Chooz A St. Laurent A1, A2
Germany	E.ON Arbeitsgemeinschaft Versuchsreaktor AVR RWE Power	Würgassen Jülich Mülheim-Kärlich
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 1, 2, 3
United States	Amergen Energy Company Nuclear Management 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	Bulgarian Nuclear Regulatory Agency
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 (until September 2003) Japan Nuclear Energy Safety Organisation(JNES),Tokyo, Japan (since October 2003)
	http://www.jnes.go.jp/isoe/
IAEA Region (IAEATC)	International Atomic Energy Agency (IAEA), Vienna, Austria Agence Internationale de l'Energie Atomique (AIEA), Vienne, Autriche
	http://www-rasanet.iaea.org/programme/rmps/isoe-tech.htm
North American Region (NATC)	University of Illinois, Champagne-Urbana, Illinois, U.S.A.
	http://www.natcisoe.org

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

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