OECD Nuclear Energy Agency
International Atomic Energy Agency

ISOE

INFORMATION SYSTEM ON OCCUPATIONAL EXPOSURE

Tenth Annual Report

OCCUPATIONAL EXPOSURES AT NUCLEAR POWER PLANTS

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NEA

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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

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

The original Member countries of the OECD are Austria, Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The following countries became Members subsequently through accession at the dates indicated hereafter: Japan (28th April 1964), Finland (28th January 1969), Australia (7th June 1971), New Zealand (29th May 1973), Mexico (18th May 1994), the Czech Republic (21st December 1995), Hungary (7th May 1996), Poland (22nd November 1996), 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 27 OECD Member countries: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, the Netherlands, Norway, Portugal, Republic of Korea, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The Commission of the European Communities also takes part in the work of the Agency.

The mission of the NEA is:

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

Specific areas of competence of the NEA include safety and regulation of nuclear activities, radioactive waste management, radiological protection, nuclear science, economic and technical analyses of the nuclear fuel cycle, nuclear law and liability, and public information. The NEA Data Bank provides nuclear data and computer program services for participating countries.

In these and related tasks, the NEA works in close collaboration with the International Atomic Energy Agency in Vienna, with which it has a Co-operation Agreement, as well as with other international organisations in the nuclear field.

FOREWORD

Throughout the world, occupational exposures at nuclear power plants have been steadily decreasing for over a decade. Regulatory pressures, particularly after the issuance of ICRP Publication 60 in 1990, technological advances, improved plant designs, and improved water chemistry and plant operational procedures have contributed to this downward trend. However, with the ageing of the world's nuclear power plants the task of maintaining occupational exposures at low levels has become increasingly difficult. In addition, economic pressures have led plant operation managers to streamline refuelling and maintenance operations as much as possible, thus adding scheduling and budgetary pressure to the task of reducing operational exposures.

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

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

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EXECUTIVE SUMMARY

The Tenth Annual Report of the ISOE Programme, 2000, as it is given here, represents the status of the ISOE Programme at the end of December 2000.

As of December 2000, the ISOE database includes occupational exposure data from a total of 452 reactors from 28 countries representing 72 utilities. Some 92% of the world's operating commercial nuclear reactors participate in the ISOE programme (398 from a total of 433), as well as the regulatory authorities of 25 countries. During 2000, Russia joined the ISOE Programme with 14 operating reactors (13 VVER and one fast breeder reactor) and 4 reactors in cold-shutdown or some stage of decommissioning. In addition, the Slovakian nuclear power plant Mochovce joined the ISOE programme with 2 units. The regulatory authorities from Lithuania and South Africa now also participate in ISOE.

Since the beginning of the ISOE programme, the annual average dose per reactor has undergone a remarkable downward trend, which can be explained by improved communication and experience exchange between radiation protection managers of nuclear power plants world wide as well as by improved work management procedures prepared and published through the ISOE system. Although the data show some annual fluctuations, the average annual dose is still decreasing, for pressurised water reactors (PWR) from 1.00 man·Sv in the year 1999 to 0.96 man·Sv in 2000, for boiling water reactors (BWR) from 1.77 man·Sv in 1999 to 1.62 man·Sv in 2000. For CANDU reactors the dose increased slightly from 0.85 man·Sv in 1999 to 0.92 man·Sv in 2000. The average collective dose per reactor for LWGRs (RBMK), represented in the database by only three units, decreased from 8.09 man·Sv in 1999 to 5.94 man·Sv in 2000, a value still higher than for all other types of reactors.

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

In 2000, the Technical Centres published a number of ISOE information sheets in order to exchange experience between ISOE participants. To further promote the preparation and distribution of such information sheets, this Annual Report contains short abstracts of recent interesting information sheets such as the annual outage duration and doses and the access and dosimetric follow-up rules in nuclear power plants for foreign workers.

Deregulation and its implications on radiation protection is an emerging issue which is of interest for the ISOE members. First discussions took place at the international ISOE workshop in Tarragona as well as at the last ISOE Steering Group meeting.

The Health Physics Groups of VVER and RBMK reactors launched in 1998 a standardised dose rate measuring programme which allows a comparative analysis of dose rates at predefined measuring points in VVER reactors. First results are available for the years 1999 and 2000.

In April 2000, the second EC/ISOE Workshop on Occupational Exposure at Nuclear Power Plants was held in Tarragona, Spain, followed, in February 2001, by the International ALARA Symposium in Anaheim, California. The common objective of these workshops was to communicate experience in ALARA implementation and occupational exposure issues, and to share lessons learned. The international and broad participation in these workshops shows the interest in ALARA and occupational exposure issues.

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

Finally, the ISOE Programme made significant progress during 2000, particularly in terms of data analysis and output. The software to run the ISOE database was extended by a new input module and additional predefined analyses in the MADRAS module. Details of this progress as well as the programme of work for 2001 are provided in Chapter 3.

SYNTHÈSE DU RAPPORT

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

À cette date la base de données ISOE comportait les données concernant les expositions professionnelles dans 452 réacteurs nucléaires situés dans 28 pays et appartenant à 72 exploitants. Près de 92% des réacteurs commerciaux en fonctionnement dans le monde (398 réacteurs sur un total de 433), ainsi que les autorités de 25 pays, participent au programme ISOE. Durant l'année 2000, la Russie a rejoint le Programme ISOE avec 14 réacteurs en exploitation (13 VVER et un à neutrons rapides) et 4 réacteurs en arrêt à froid ou en phase de démantèlement. En outre, les deux réacteurs de la centrale nucléaire de Mochovce en Slovaquie ont rejoint le programme ISOE. Les autorités de Lituanie et d'Afrique du Sud participent également maintenant à ISOE.

Depuis le début du programme ISOE, la dose collective moyenne par réacteur a diminué de façon notable, ce qui peut pour partie s'expliquer par l'impact du système ISOE en termes d'amélioration de la communication et des échanges de retour d'expérience entre les *responsables* de la radioprotection des centrales nucléaires du monde entier ainsi que par l'amélioration des procédures de travail suite aux publications du système ISOE.

Bien que les données montrent quelques fluctuations annuelles, la dose collective moyenne diminue toujours, pour les réacteurs à eau pressurisée (REP) passant de 1,00 homme.Sv en 1999 à 0,96 homme.Sv en 2000, pour les réacteurs à eau bouillante (REB) passant de 1,77 homme.Sv en 1999 à 1,62 homme.Sv en 2000. Pour des réacteurs CANDU la dose a augmenté légèrement de 0,85 homme.Sv en 1999 à 0,92 homme.Sv en 2000. La dose collective moyenne par réacteur pour LWGRs (RBMK), représenté dans la base de données par seulement trois réacteurs, a diminué de 8,09 homme.Sv en 1999 à 5,94 homme.Sv en 2000, valeur qui reste plus élevée que celles des autres types de réacteurs.

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

En 2000, les centres techniques ont publié plusieurs « ISOE information sheets » pour faciliter les échanges de retour d'expérience entre les participants ISOE. Afin de favoriser la préparation et la distribution de ces « ISOE information sheets », ce rapport présente les résumés des plus récentes telles que celle sur « la durée des arrêts de tranche et les doses annuelles correspondantes » et celle sur « les procédures d'accès et de suivi dosimétrique des centrales nucléaires pour les travailleurs étrangers ».

La déréglementation et ses implications sur la radioprotection représentent un sujet de préoccupation pour l'ensemble des membres ISOE. Les premières discussions ont eu lieu lors du Séminaire international ISOE à Tarragona et lors du dernier comité de direction ISOE.

Le groupe de « radioprotectionnistes des réacteurs VVER et RBMK » a lancé en 1998 un programme de relevés standardisés des débits de dose qui permettent une analyse comparative des débits de dose à des postes de mesure prédéfinis dans les réacteurs VVER. Les premiers résultats sont disponibles pour les années 1999 et 2000.

En avril 2000, le deuxième Séminaire EC/ISOE sur la gestion des expositions professionnelles dans les centrales nucléaires s'est tenu à Tarragona, en Espagne, suivi, en février 2001, du colloque ALARA international à Anaheim, en Californie. L'objectif commun à ces Séminaires était de favoriser les échanges sur la mise en œuvre d'ALARA et des problèmes liés aux expositions professionnelles, et de partager les leçons tirées du retour d'expérience. La large participation internationale à ces séminaires montre l'intérêt porté aux problèmes de radioprotection et à ALARA.

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

En conclusion, le programme ISOE a fait des progrès significatifs en 2000, en particulier en ce qui concerne l'analyse des données et les publications. Le logiciel permettant la consultation de la base de données ISOE a bénéficié d'un nouveau module de saisie des données et a été agrémenté par de nouvelles analyses prédéfinies dans le module de MADRAS. Des détails sur ces progrès ainsi que sur le programme de travail pour l'an 2001 sont fournis dans le chapitre 3.

ZUSAMMENFASSENDE ÜBERSICHT

Der vorliegende zehnte ISOE Jahresbericht 2000 gibt den Stand des ISOE Programms Ende Dezember 2000 wieder.

Die ISOE Datenbank umfaßte Ende 2000 Daten zur beruflichen Strahlenexposition in insgesamt 452 Kernkraftwerken von 72 Energieversorgungsunternehmen aus 28 Ländern. Damit nehmen etwa 92% der weltweit in Betrieb befindlichen kommerziellen Kernkraftwerke (398 von insgesamt 433), sowie die Genehmigungs- und Aufsichtsbehörden aus 25 Ländern am ISOE Programm teil. Im Jahre 2000 trat Russland dem ISOE Programm, mit 14 in Betrieb befindlichen Reaktoren (13 WWER und ein schneller Brüter) und vier stillgelegten Reaktoren, bei. Zudem hat sich das Slowakische Kernkraftwerk Mohovce mit zwei Reaktoren ISOE angeschlossen. Schliesslich nehmen nun auch die Genehmigungs- und Aufsichtsbehörden von Litauen und Südafrika teil.

Seit Anbeginn des ISOE Programms zeigte die mittlere jährliche Kollektivdosis pro Reaktor einen bemerkenswerten Abwärtstrend, der durch eine verbesserte Kommunikation und Erfahrungsaustausch zwischen Strahlenschutzexperten der Kernkraftwerke weltweit sowie durch ein, mit Hilfe des ISOE Systems, vorbereitetes und veröffentlichtes, verbessertes Arbeitsmanagement erklärt werden kann. Obwohl die Daten jährlichen Schwankungen unterworfen sind, nimmt die mittlere jährliche Kollektivdosis pro Reaktor ab, für Druckwasserreaktoren (DWR) von 1,00 man·Sv im Jahre 1999 auf 0,96 man·Sv im Jahre 2000, für Siedewasserreaktoren (SWR) von 1,77 man·Sv (1999) auf 1,62 man·Sv (2000). Die mittlere jährliche Kollektivdosis für CANDU Reaktoren stieg von 0,85 man·Sv (1999) auf 0,92 man·Sv (2000). Die mittlere jährliche Kollektivdosis für Leichtwassergekühlte Graphitmoderierte Reaktoren (LWGR bzw. RBMK Reaktoren), in der Datenbank mit derzeit drei Reaktoren vertreten, fiel von 8,09 man·Sv im Jahre 1999 auf 5,94 man·Sv im Jahre 2000, ein Wert, der deutlich über den gemittelten Werten aller anderen Reaktortypen liegt.

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

Die ISOE Technischen Zentren veröffentlichten im Jahre 2000 eine Reihe von ISOE Informationsblättern, um Erfahrungen zwischen ISOE Teilnehmern auszutauschen. Um die Vorbereitung und Verteilung weiterer ISOE Informationsblättern anzuregen, enthält dieser Jahresbericht kurze Zusammenfassungen von kürzlich erschienenen, interessanten Informationsblättern. Es wird über die Dauer und Dosis der Jahresrevision sowie über Zugangs- und Dosiserfassungsregeln für Fremdarbeiter in Kernkraftwerken berichtet.

Die Deregulierung des Elektrizitätsmarktes und ihre Auswirkungen auf den Strahlenschutz ist ein neu auftretendes Problem von Interesse für ISOE Teilnehmer. Erste Diskussionen wurden im Rahmen des internationalen ISOE Workshops in Tarragona sowie während des letzten ISOE Treffens geführt.

Die Strahlenschutzarbeitsgruppe der WWER und RBMK Reaktoren hat im Jahre 1998 ein standardisiertes Dosismessprogramm eingeführt, dass einen Vergleich der Dosisleistung an definierten Messpunkten in WWER Rektoren ermöglicht. Erste Vergleichsmessungen wurden in den Jahren 1999 und 2000 durchgeführt.

Im April 2000 wurde der zweite EC/ISOE Workshop zum Thema “Berufliche Strahlenexposition in Kernkraftwerken” in Tarragona (Spanien) gehalten. Im Februar 2001 fand das internationale ALARA Symposium in Anaheim (Kalifornien, USA) statt. Diese Treffen haben das gemeinsame Ziel, Erfahrungen und gelernte Lektionen bei der Durchführung von ALARA Programmen sowie bei der Lösung anderer Probleme der beruflichen Strahlenexposition auszutauschen sowie über die gezogenen Schlussfolgerungen zu berichten.

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

Kapitel 3 faßt die im Jahre 2000 erzielten Fortschritte im ISOE Arbeitsprogramm, insbesondere in den Bereichen Datenanalyse und Datendarstellung, sowie das ISOE Arbeitsprogramm 2001 zusammen. Die Software zur Bearbeitung der ISOE Daten wurde um ein neues Eingabemodul und zusätzliche vorgefertigte Analysen im MADRAS Modul erweitert.

正文摘要

本文提供的ISOE计划第十个年度报告（ 2000年 ）介绍2000年12月底ISOE计划的状况。

截至2000年12月，ISOE数据库包括取自28个国家72个电力公司的总计452座反应堆的职业照射数据。全世界约92%的运行中商业核反应堆（ 总计433座反应堆中的398座反应堆 ）以及25个国家的监管当局参加了ISOE计划。在2000年期间，俄罗斯14座运行中反应堆（ 13座VVER和1座快增殖堆 ）和4座处于冷停堆状态或某个退役阶段的反应堆参加了ISOE计划。此外，斯洛伐克Mochovce核动力厂的2个机组也参加了ISOE计划。现在立陶宛和南非的监管当局也参加了ISOE。

自ISOE计划开始以来，每座反应堆的年均剂量有明显下降的趋势，不仅通过ISOE系统改进了已编写和出版的工作管理程序而且还加强了世界范围核动力厂辐射防护管理人员之间的联络和经验交流即可说明这一点。虽然数据表明每年有些波动，但年均剂量仍在下降，就压水堆（ PWR ）而言，从1999年的1.00人·希沃特降至2000年的0.96人·希沃特，就沸水堆（ BWR ）而言，从1999年的1.77人·希沃特降至2000年的1.62人·希沃特。对于CANDU反应堆，该剂量从1999年的0.85人·希沃特略增至2000年的0.92人·希沃特。对于LWGR（ RBMK ），每座反应堆的平均集体剂量（ 在数据库中只用3个机组代表 ）从1999年的8.09人·希沃特降至2000年的5.94人·希沃特，数值仍高于所有其他类型的反应堆。

ISOE数据库还载有关于已关闭或处于某个退役阶段的反应堆的剂量数据。鉴于数据库中代表的反应堆的类型和规模不同，而且总体上处于其退役计划的不同阶段，因此很难确定明确的剂量趋势，也很难得出确切的结论。

技术中心在2000年发表了若干ISOE信息记录单，以供在ISOE参与者之间交流经验。为进一步促进这类信息记录单的编写和分发，本年度报告载有关于最近令人感兴趣的信息记录单的简短摘要，例如每年停堆持续时间和剂量以及核动力厂关于外来工作人员进入和剂量跟踪的规则。

解除对辐射防护的管制及所造成的影响是一个令ISOE成员感兴趣的新问题。在塔拉戈纳举办的国际ISOE讲习班和最近举行的ISOE指导小组会议上进行了初步讨论。

VVER和RBMK反应堆保健物理小组在1998年启动了一项标准剂量率测定计划，该计划允许对VVER反应堆中预定测定点的剂量率进行比较分析。可提供关于1999年和2000年的首批结果。

2000年4月，在西班牙塔拉戈纳举办了第二期关于核动力厂职业照射的EC/ISOE讲习班，随后于2001年2月在加里福尼亚的阿纳海姆举办了国际ALARA专题讨论会。上述讲习班的共同目的是交流有关ALARA执行和职业照射问题的经验和分享所吸取的教训。国际上对这些讲习班的广泛参与表明了对ALARA和职业照射问题的兴趣。

扩编的一章中总结了ISOE参与国的最新进展和主要活动。

最后，ISOE计划在2000年取得了重大进展，尤其是在数据分析和产出方面。通过新的输入模板和对MADRAS模板的附加预定分析扩充了运行ISOE数据库的软件。有关进展的详细情况以及2001年的工作计划见第3章。

要　約

この第 10 年次総括報告書は、2000 年 12 月末における ISOE プログラムの状況をまとめたものである。

2000 年 12 月末現在、ISOE 1 データベースには 28 ヶ国から 72 の電気事業者の合計 452 基の原子力発電所に関する職業被ばくデータが含まれている。そして、ISOE に参加している運転中商用炉 398 基は、全世界の運転中商用炉（総計 433 基）の 92%を占めており、また、25 ヶ国からの規制当局が参加している。2000 年には、ロシアが運転中原子炉 14 基（VVER13 基と fast breeder 炉 1 基）と冷温停止または廃止措置の異なった段階にある原子炉 4 基と共に ISOE に新規参加した。更に、スロバキアの Mochovce 原子力発電所の 2 基、リトアニアと南アフリカの規制当局が ISOE プログラムに参加した。

ISOE プログラム開始以来、原子炉 1 基当たりの年間平均線量は顕著な減少傾向で推移してきている。これは、世界中の原子力発電所の放射線防護管理者間における連絡体系が確立され、経験を交換できるようになったこと、また、ISOE システムを通して作成・発行された作業管理手順の改善の成果と言える。データは年度により変動はあるものの、年間平均線量は依然として減少し続けている。2000 年及び前年 1999 年の線量実績を各炉型別にみると、原子力発電所 1 基当たりの 2000 年の平均線量当量は前年の値に対し、PWR で 1.00 人･Sv から 0.96 人･Sv、BWR で 1.77 人･Sv から 1.62 人･Sv といずれも減少している。CANDU 炉では 0.85 人･Sv から 0.92 人･Sv と僅かな増加となっている。ISOE データベースには 3 基のみが登録されている LWGR 軽水冷却黒鉛炉（RBMK）は、8.09 人･Sv から 5.94 人･Sv に増加し、他の炉型の原子力発電所よりも依然として高い値を示している。

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

2000 年に技術センターは ISOE 参加者間で被ばくに関する経験を交換するために、数多くの Information Sheet を発行した。Information Sheet の作成と配布を更に促進するために、この年次報告書では「年間の運転停止期間と線量」、「原子力発電所における海外からの作業員に対する入所管理及び線量管理ルール」といった、最近の興味深い Information Sheet の概要を掲載している。

ISOE メンバーが関心を寄せる課題として、放射線防護に関する規制緩和及びその実施が挙げられる。その最初の話し合いが、スペインのタラゴナで開催された国際 ISOE ワークショップにおいて、前回 ISOE 運営会合と同様に行われた。

VVER 炉及び RBMK 炉の保健物理グループは、1998 年に基準線量率測定プログラムを発足した。これにより、VVER 炉では、あらかじめ定められた測定ポイントにおける線量率の比較分析が出来るようになった。第 1 回目の結果として、1999 年及び 2000 年のデータが入手可能である。

2000 年 4 月のスペインのタラゴナにおける原子力発電所における職業被ばくに関する第 2 回 EC/ISOE ワークショップに引き続いて、2001 年 2 月にカリフォルニアのアナハイムにて 国際 ALARA シンポジウムが開催された。これらワークショップは ALARA の実施と職業被ばくの問題における経験を伝え合い、学んだ教訓を分かち合うことを共通の目的に開催

された。ワークショップへの参加者が国際的で広範に渡ることから、ALARA と職業被ばくの問題に対する関心がうかがえる。

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

最後に、ISOE プログラムは 2000 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、ISOE データベースを運用するためのソフトウェアに関しては、データ入力ソフトが改良され、また、MADRAS ソフトでは分析項目が追加された。この進展の詳細は 2001 年の作業プログラムと共に第 3 章に記されている。

ОСНОВНЫЕ ИТОГИ

Десятый ежегодный доклад программы ИСПО – за 2000 год, – являющийся предметом настоящего документа, отражает положение дел с осуществлением программы ИСПО на конец декабря 2000 года.

По состоянию на декабрь 2000 года база данных ИСПО включает данные о профессиональном облучении, получаемом в общей сложности от 452 реакторов в 28 странах, принадлежащих 72 энергопредприятиям. В программе ИСПО участвуют приблизительно 92% действующих коммерческих ядерных реакторов мира (398 из общего количества 433), а также регулирующие органы 25 стран. В течение 2000 года к программе ИСПО присоединилась Россия с 14 действующими реакторами (13 ВВЭР и один быстрый реактор-размножитель) и 4 реакторами, находящимися в состоянии холодного останова или на какой-либо стадии снятия с эксплуатации. Кроме того, к программе ИСПО присоединилась словацкая АЭС “Моховице”, имеющая 2 блока. В работе ИСПО теперь участвуют также регулирующие органы Литвы и Южной Африки.

С начала осуществления программы ИСПО наблюдается устойчивая тенденция к снижению средней годовой дозы в расчете на реактор, что можно объяснить улучшенной связью и обменом опытом между руководителями служб радиационной защиты на атомных электростанциях во всем мире, а также улучшенными процедурами управления работами, которые были подготовлены и опубликованы через систему ИСПО. Хотя данные свидетельствуют о некоторых ежегодных колебаниях, средняя годовая доза по-прежнему снижается: для реакторов с водой под давлением (PWR) – с 1,00 чел.-Зв в 1999 году до 0,96 чел.-Зв в 2000 году, для реакторов с кипящей водой (BWR) – с 1,77 чел.-Зв в 1999 году до 1,62 чел.-Зв в 2000 году. Для реакторов CANDU доза несколько возросла – с 0,85 чел.-Зв в 1999 до 0,92 чел.-Зв в 2000 году. Средняя коллективная доза в расчете на реактор для LWGR (РБМК), которые в базе данных представлены только тремя блоками, снизилась с 8,09 чел.-Зв в 1999 году до 5,94 чел.-Зв в 2000 году, однако эта величина все еще выше, чем по всем другим типам реакторов.

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

В 2000 году в целях обмена опытом между участниками ИСПО технические центры опубликовали ряд информационных бюллетеней ИСПО. В интересах дальнейшего содействия подготовке и распространению таких информационных бюллетеней в данном Ежегодном докладе содержатся краткие рефераты недавних интересных информационных бюллетеней, например, по таким вопросам, как ежегодная продолжительность останова и дозы и правила доступа и последующего дозиметрического контроля на атомных электростанциях для иностранных рабочих.

Дерегулирование энергетического рынка и его последствия для радиационной защиты – это одна из новых проблем, представляющих интерес для членов ИСПО. Первые ее обсуждения проходили на международном практикуме ИСПО в Таррагоне, а также на последнем заседании Руководящей группы ИСПО.

В 1998 году группы дозиметрии реакторов ВВЭР и РБМК начали осуществление программы стандартизированных измерений мощности дозы, которая позволяет проводить сравнительный анализ мощностей дозы в предварительно определенных точках измерений на реакторах ВВЭР. Имеются первые результаты за 1999 и 2000 годы.

В апреле 2000 года в Таррагоне, Испания, был проведен второй Практикум ЕК/ИСПО по профессиональному облучению на АЭС, а после него, в феврале 2001 года, в Анахайме, Калифорния, был проведен Международный симпозиум по ALARA. Общая цель этих практикумов состояла в том, чтобы передать опыт решения вопросов осуществления принципов ALARA и проблем профессионального облучения, а также обменяться информацией об извлеченных уроках. Широкое международное участие в этих практикумах свидетельствует об интересе к проблемам ALARA и профессионального облучения.

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

Таким образом, в течение 2000 года программа ИСПО добилась существенного прогресса, особенно в сфере анализа и подготовки данных. Программное обеспечение для управления базой данных ИСПО было расширено благодаря внедрению нового модуля ввода и дополнительных предварительно определенных аналитических функций в модуле MADRAS. Подробная информация об этих достижениях, а также программы работы на 2001 год предоставлены в главе 3.

RESUMEN EJECUTIVO

El décimo Informe Anual del Programa ISOE, 2000, presenta la situación del Programa a final de Diciembre del año 2000.

En Diciembre del 2000, la base de datos de ISOE incluía datos de exposiciones ocupacionales de un total de 452 reactores de 28 países pertenecientes a 72 empresas eléctricas. Aproximadamente el 92% de los reactores comerciales en operación en el mundo participan en le programa ISOE (298 de un total de 433), así como Organismos Reguladores de 25 países. En al año 2000 Rusia se incorporó al programa ISOE con 14 reactores en operación (13 de diseño VVER y un reactor rápido reproductor) y 4 reactores en parada fría o en alguna fase de desmantelamiento. Adicionalmente, la central nuclear eslovaca de Mochovce también se unió al programa ISOE con dos unidades. Las Autoridades Reguladoras de Lituania y Sudáfrica también participan actualmente en el ISOE.

Desde el principio del programa ISOE, la dosis media anual por reactor ha experimentado una notable tendencia decreciente, que puede ser explicada por la mejora de la comunicación y el intercambio de experiencias entre los responsables de Protección Radiológica de las centrales nucleares en todo el mundo, así como por la mejora de los procedimientos de gestión de los trabajos propuestos y publicados por el sistema ISOE. Aunque los datos muestran algunas fluctuaciones anuales, la dosis media anual sigue decreciendo: para reactores PWR de 1,00 Sv.persona en 1999 a 0,96 Sv.persona en el 2000; y para reactores BWR de 1,77 Sv.persona en 1999 a 1,62 Sv.persona en el 2000. Para reactores CANDU la dosis ha aumentado ligeramente pasando de 0,85 Sv.persona en 1999 a 0,92 Sv.persona en el 2000. La dosis colectiva media por reactor para LWGR (RBMK), representada en la base de datos sólo por tres unidades, disminuyó de 8,09 Sv.persona en 199 a 5,94 Sv.persona en el año 2000, valor todavía superior al de los otros tipos de reactores.

La base de datos de ISOE también contiene datos dosimétricos de reactores en parada o en alguna etapa de desmantelamiento. Como los reactores recogidos en la base de datos son de diferentes tipos y tamaños, y están, en general, en diferentes fases de su programa de desmantelamiento, es muy difícil identificar tendencias dosimétricas claras y extraer conclusiones definitivas.

En el año 2000 los Centros Técnicos publicaron una serie de Hojas informativas ISOE, con objeto de intercambiar experiencias entre los participantes en ISOE. Para promocionar la preparación y distribución de estas Hojas informativas, este Informe Anual incluye unos resúmenes de las Hojas informativas de más interés publicadas recientemente, tales como “Duración de recargas y dosis” o “Normas de acceso y de seguimiento dosimétrico para trabajadores extranjeros en centrales nucleares”.

La desregulación y sus implicaciones en la Protección Radiológica es un tema emergente de interés para los miembros de ISOE. Discusiones acerca del mismo tuvieron lugar en el Seminario Internacional de Tarragona, así como en la última reunión del Comité de Dirección.

Los Grupos de Protección Radiológica de reactores VVER y RBMK lanzaron en 1998 un programa para la medida de tasa de dosis estandarizadas que permite el análisis comparativo de las tasas de dosis en puntos de medida prefijados de los reactores VVER. Los primeros resultados están disponibles para los años 1999 y 2000.

En abril del 2000, el segundo Seminario internacional EC/ISOE sobre Exposiciones Ocupacionales en Centrales Nucleares tuvo lugar en Tarragona (España), seguido del Simposio Internacional ALARA que tuvo lugar en Anaheim, California (EE.UU) en febrero del 2001. El objetivo común de estos seminarios era intercambiar experiencias en la implantación del criterio ALARA y en temas relacionados con las exposiciones ocupacionales, así como compartir lecciones aprendidas. La amplia participación internacional en ambos seminarios muestra el interés en estos temas.

Un extenso capitulo resume los desarrollos recientes y los acontecimientos más relevantes en países participantes en ISOE.

Finalmente, el programa ISOE ha avanzado significativamente en al año 2000 en lo que se refiere a análisis de datos y salida de resultados. Al software que gestiona la base de datos ISOE se le incorporó un nuevo modulo de entrada de datos y otro de realización de análisis prefijados. Detalles de estos progresos, así como del programa de trabajo para el año 2001 se indican en el capitulo 3.

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

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

As of December 2000, the ISOEDAT database includes occupational exposure data from a total of 452 reactors (398 operating and 54 in cold-shutdown or some stage of decommissioning) from 28 countries representing 72 utilities. In addition, regulatory authorities from 25 countries participate in the ISOE Programme. The participation of 398 operating commercial nuclear reactors in the ISOE programme represents some 92% of the World's operating commercial nuclear reactors (total of 433). 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 2000, Russia joined the ISOE Programme with 14 operating reactors (13 VVER and one fast breeder reactor) and 4 reactors in cold-shutdown or some stage of decommissioning. In addition, the Slovakian nuclear power plant Mochovce joined the ISOE programme with 2 units. The regulatory authorities from Lithuania and South Africa now also participate in ISOE.

Table 1. **Participation summary**

Operating reactors participating in ISOE							
Country	**PWR**	**BWR**	**PHWR**	**GCR**	**LWGR**	**FBR**	**Total**
Armenia	1	–	–	–	–	–	1
Belgium	7	–	–	–	–	–	7
Brazil	1	–	–	–	–	–	1
Canada	–	–	21	–	–	–	21
China	3	–	–	–	–	–	3
Czech Republic	4	–	–	–	–	–	4
Finland	2	2	–	–	–	–	4
France	57*	–	–	–	–	–	57
Germany	14	6	–	–	–	–	20
Hungary	4	–	–	–	–	–	4
Japan	23	28	1	–	–	–	52
Korea	11	–	4	–	–	–	15
Lithuania	–	–	–	–	2	–	2
Mexico	–	2	–	–	–	–	2
Netherlands	1	–	–	–	–	–	1
Pakistan	–	–	1	–	–	–	1
Romania	–	–	1	–	–	–	1
Russian Federation	13	–	–	–	–	1	14
Slovakia	6	–	–	–	–	–	6
Slovenia	1	–	–	–	–	–	1
South Africa	2	–	–	–	–	–	2
Spain	7	2	–	–	–	–	9
Sweden	3	8	–	–	–	–	11
Switzerland	3	2	–	–	–	–	5
Ukraine	13	–	–	–	1	–	14
United Kingdom	1	–	–	–	–	–	1
United States	27	16	–	–	–	–	43
Total	**204**	**66**	**28**	**–**	**3**	**1**	**302**

Operating reactors not participating in ISOE, but included in the ISOE database							
Country	**PWR**	**BWR**	**PHWR**	**GCR**	**LWGR**	**FBR**	**Total**
United Kingdom	–	–	–	34	–	–	34
United States	42	20	–	–	–	–	62
Total	**42**	**20**	**–**	**34**	**–**	**–**	**96**

Total number of operating reactors included in the ISOE database							
	PWR	**BWR**	**PHWR**	**GCR**	**LWGR**	**FBR**	**Total**
Total	**246**	**86**	**28**	**34**	**3**	**1**	**398**

* Three of these 57 reactors (Chooz B1, Chooz B2 and Civeaux 1) are still in the pre-operational phase.

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

Definitively shutdown reactors participating in ISOE						
Country	**PWR**	**BWR**	**PHWR**	**GCR**	**LWGR**	**Total**
France	1	–	–	6	–	7
Germany	–	1	–	1	–	2
Italy	1	2	–	1	–	4
Japan	–	–	–	1	–	1
Netherlands	–	1	–	–	–	1
Russian Federation	2	–	–	–	2	4
Spain	–	–	–	1	–	1
Sweden	–	1	–	–	–	1
United States	4	3	–	1	–	8
Total	**8**	**8**	**–**	**11**	**2**	**29**

Definitively shutdown reactors not participating in ISOE but included in the ISOE database						
Country	**PWR**	**BWR**	**PHWR**	**GCR**	**LWGR**	**Total**
Canada	–	–	2	–	–	2
Germany	6	3	–	–	–	9
United Kingdom	–	–	–	6	–	6
United States	6	2	–	–	–	8
Total	**12**	**5**	**2**	**6**	–	**25**

Total number of definitively shutdown reactors included in the ISOE database						
	PWR	**BWR**	**PHWR**	**GCR**	**LWGR**	**Total**
Total	**20**	**13**	**2**	**17**	**2**	**54**

Number of **Utilities** Officially Participating:	**72**
Number of **Countries** Officially Participating:	**28**
Number of **Authorities** Officially Participating:	**25**

2. THE EVOLUTION OF COLLECTIVE DOSE IN ISOE MEMBER COUNTRIES

One of the most important aspects of the ISOE Programme is the tracking of annual occupational exposure trends. Using the ISOE 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 2000. Yearly variations around these low levels of doses can be made responsible for slight increases in dose, however, in general, a downward dose trend can still be observed.

In most ISOE participating countries, the average dose per unit for PWRs could be slightly reduced, in 2000, or stayed fairly constant. As can be seen in section 2.9, part of this reduction is due to the implementation of work management principles and the reduction in outage duration.

In 2000, the average annual doses for BWRs saw a reduction for most of the countries. These reductions are in part due to the positive effect of major plant modification works performed in previous years, and the result of extensive ALARA and work management programmes.

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

Table 2 summarises the average annual exposure trends for participating countries over the past three years. Figures 1 to 4 show this tabular data in a bar-chart format, for 2000 only, ranked from highest to lowest average dose. Please note that due to the complex parameters driving the collective doses and the varieties of the contributing plants, these figures do not allow to derive any conclusions on the quality of radiation protection performance in the countries addressed. Figures 5, 6 and 7 show the trends in average collective dose per reactor for the years 1990 to 2000 by reactor type.

Table 2. **Evolution of average annual dose per unit, by country and reactor type, from 1998-2000 (man·Sv)**

	PWR			BWR			CANDU		
	1998	1999	2000	1998	1999	2000	1998	1999	2000
Armenia	1.51	1.58	0.96						
Belgium	0.70	0.40	0.35						
Brazil	1.26	0.15	1.35						
Canada							0.52	0.82	0.81
China	0.71	0.55	0.59						
Czech Republic	0.34	0.28	0.25						
Finland	1.04	0.68	1.13	1.01	0.47	0.86			
France	1.21	1.17	1.08						
Germany	1.01	1.23	1.13	1.56	0.81	0.88			
Hungary	0.76	0.53	0.76						
Japan	0.96	1.02	1.03	1.78	2.14	1.96			
Korea	1.04	0.84	0.77				1.01	0.85	0.55
Mexico				4.77	3.67	2.83			
Netherlands	0.68	0.30	0.56						
Pakistan							2.49	2.05	4.46
Romania							0.26	0.46	0.47
Slovakia	0.98	0.59	0.81						
Slovenia	1.16	1.65	2.60						
South Africa	0.65	0.86	0.42						
Spain	0.55	0.71	0.59	0.53	2.45	1.47			
Sweden	0.59	0.43	0.43	1.52	1.12	0.85			
Switzerland	0.46	0.77	0.43	1.19	1.10	0.89			
Ukraine	1.89	1.37	1.53						
United Kingdom	0.04	0.66	0.46						
United States	0.92	1.05	0.96	1.90	1.84	1.68			

	GCR			LWGR		
	1998	1999	2000	1998	1999	2000
Lithuania				7.53	6.40	5.35
Ukraine					11.47	7.12
United Kingdom	0.21	0.17*	**			

* This is the average annual dose for 26 AGR in United Kingdom.
** Data not available.

Figure 1

2000 PWR Average collective dose per reactor by country

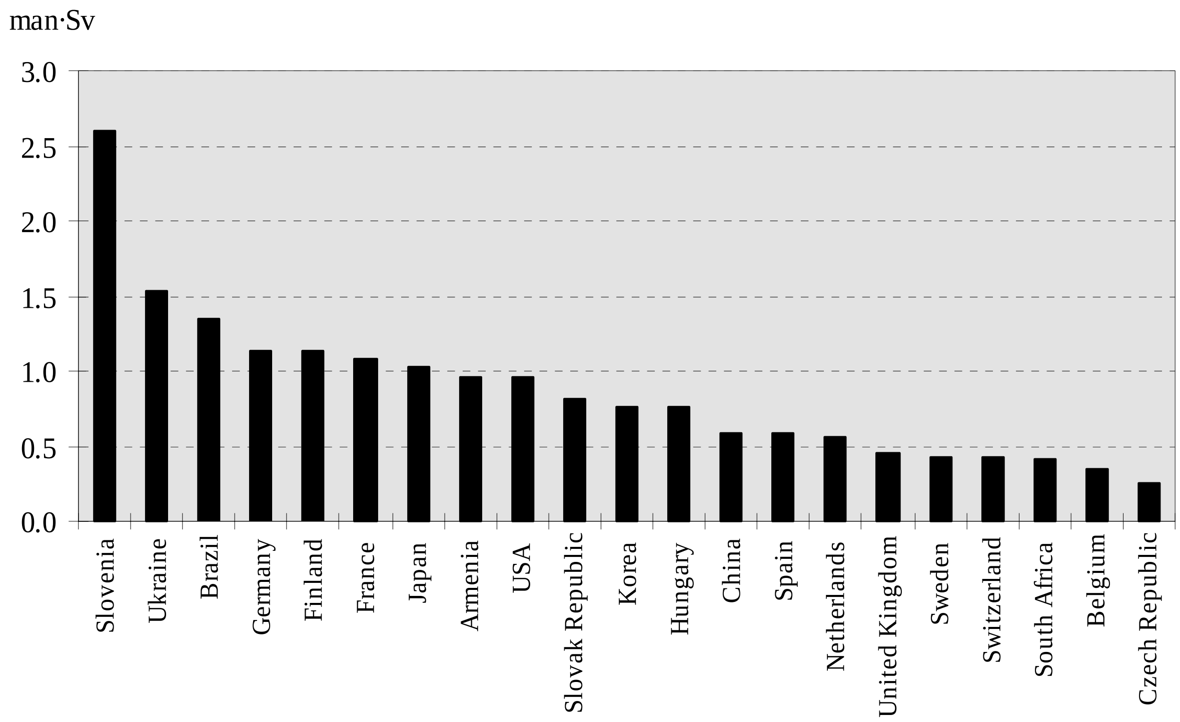


Figure 2

2000 BWR Average collective dose per reactor by country

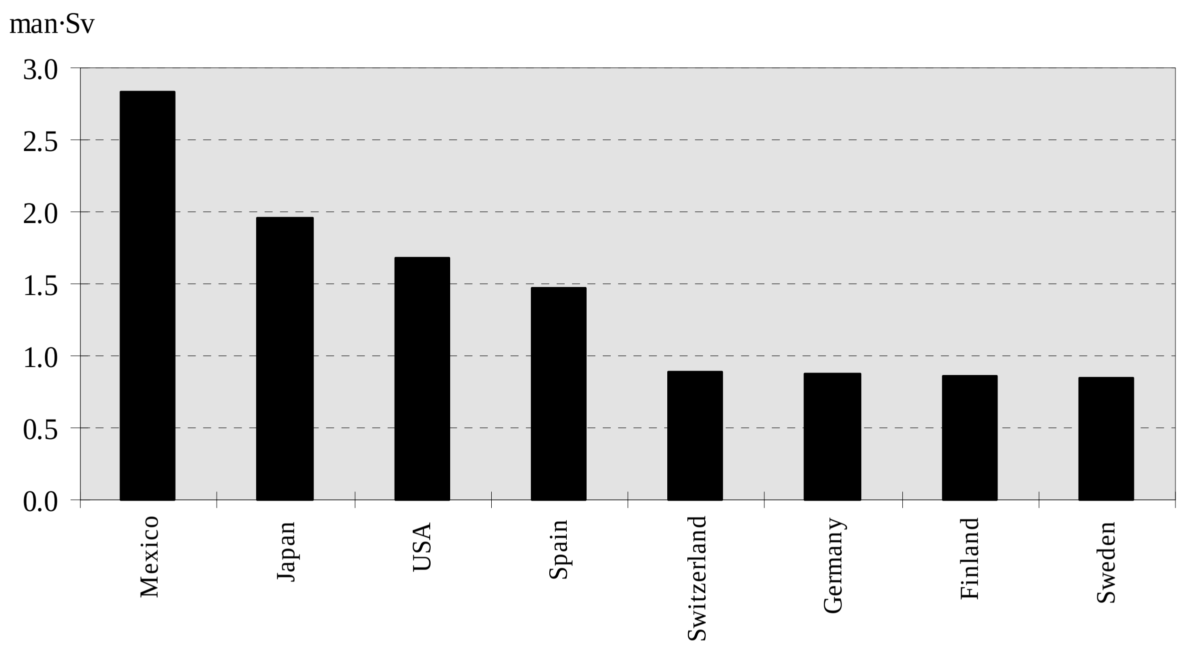


Figure 3

2000 CANDU Average collective dose per reactor by country

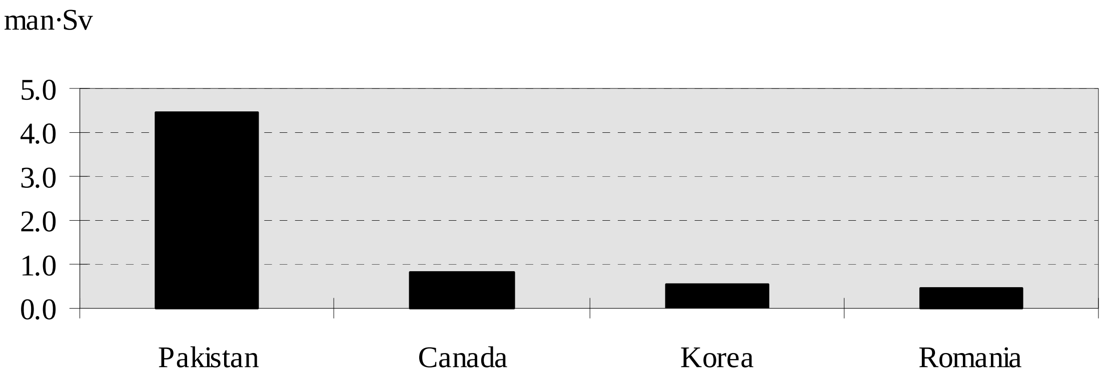


Figure 4

2000 Average collective dose per reactor type

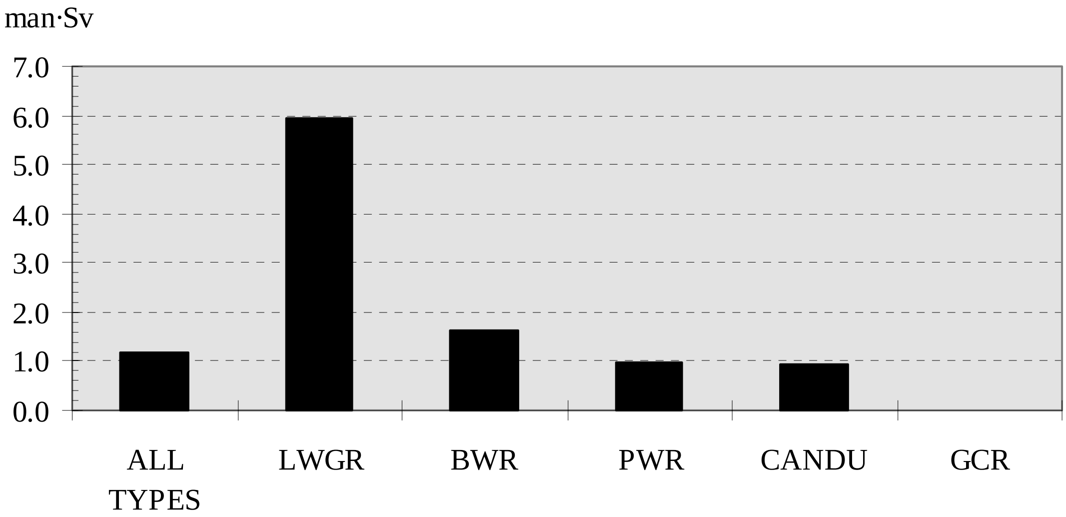


Figure 5

Average collective dose per reactor for operating reactors included in ISOE by reactor type for the years 1990-2000

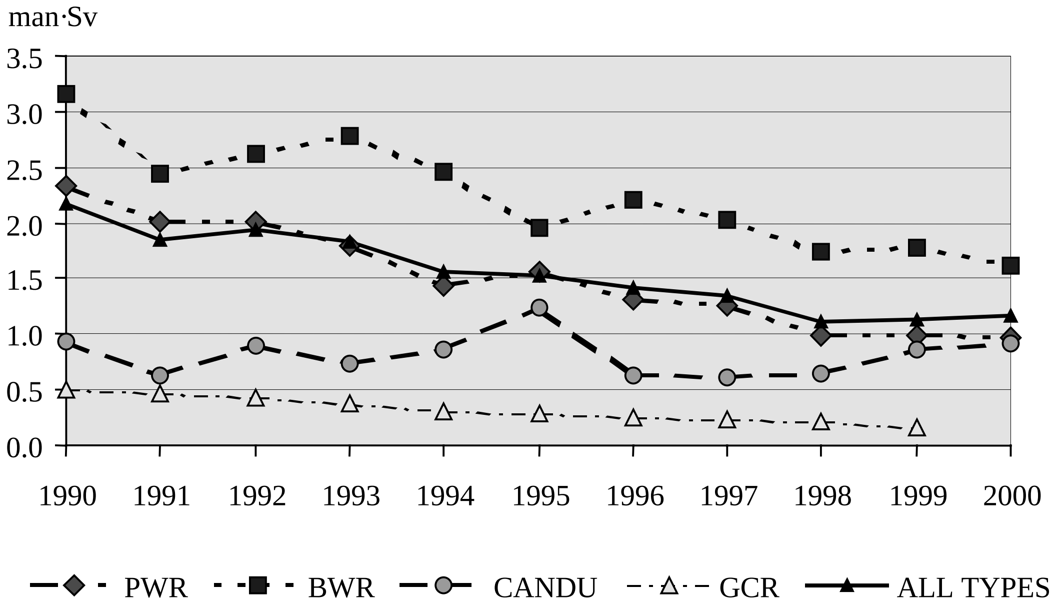


Figure 6

Average collective dose per reactor for operating reactors included in ISOE by reactor type for the years 1980-2000

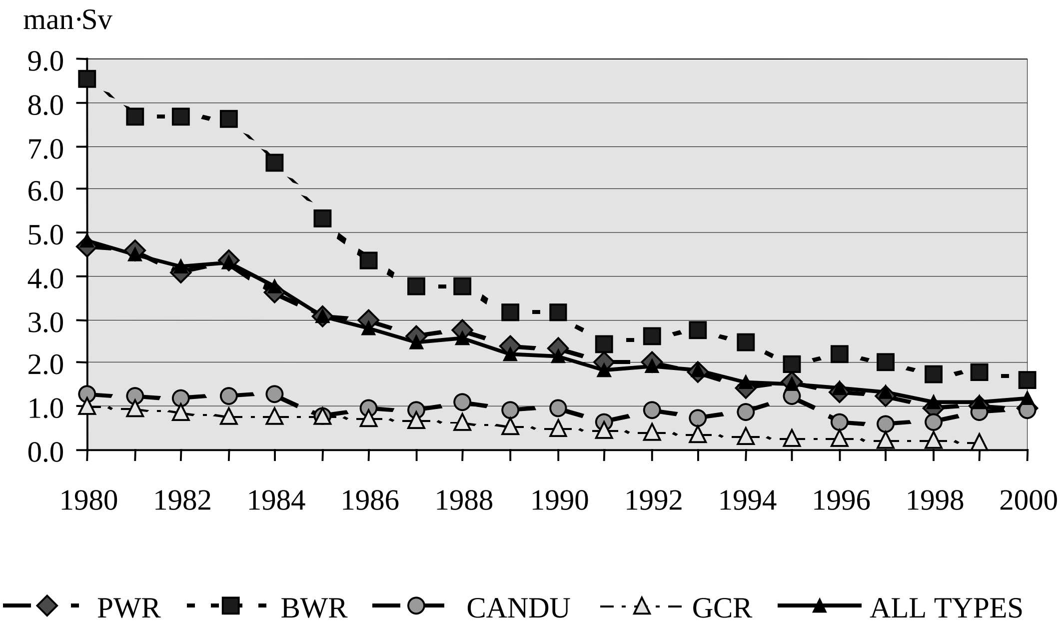
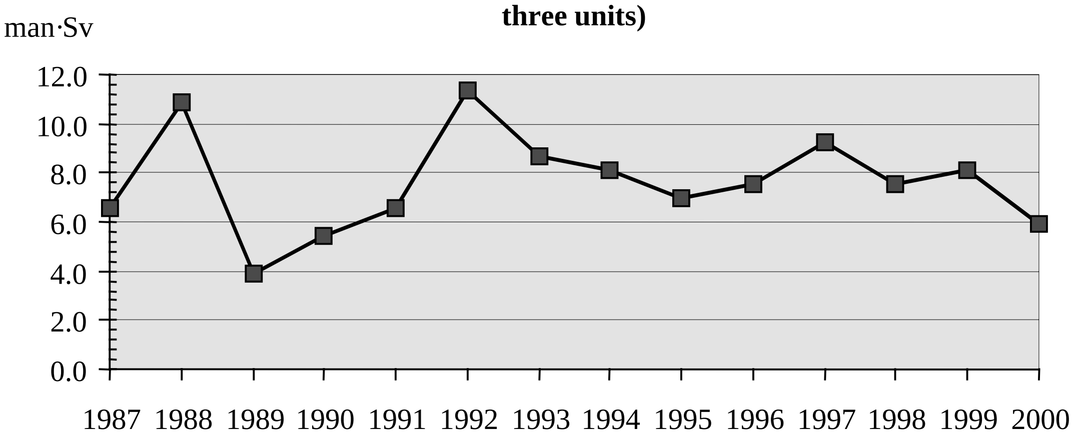


Figure 7

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



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

The average collective dose per reactor for shutdown reactors saw a reduction over the years 1990 to 2000. 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 1998 to 2000. Figures 8 to 11 summarise the average collective dose per reactor for shutdown reactors and the number of shutdown reactors for the years 1990 to 2000 for PWRs, BWRs, GCRs and for all types.

Table 3. **Average annual dose per unit by country and reactor type for the years 1998-2000**

PWR						
	1998		**1999**		**2000**	
	No.	man·mSv	No.	man·mSv	No.	man·mSv
France	1	120	1	91	1	14
Germany	6	96	6	79	6	47
Italy	1	14	1	19	1	7
United States	8	404	9	366	8	630

BWR						
	1998		**1999**		**2000**	
	No.	man·mSv	No.	man·mSv	No.	man·mSv
Germany	4	386	4	317	4	256
Italy	2	56	2	53	2	34
Netherlands	1	158	1	217	1	318
Sweden					1	113
United States	3	350	4	252	4	403

GCR						
	1998		**1999**		**2000**	
	No.	man·mSv	No.	man·mSv	No.	man·mSv
France	6	81	6	40	6	209
Germany	1	44	1	30	1	34
Italy	1	43	1	42	1	8
Japan	1	130	1	170	1	280
Spain	1	50	1	39	1	87
United Kingdom	6	78	6	70		No data

Figure 8

Average collective dose per reactor for shutdown PWRs included in ISOE

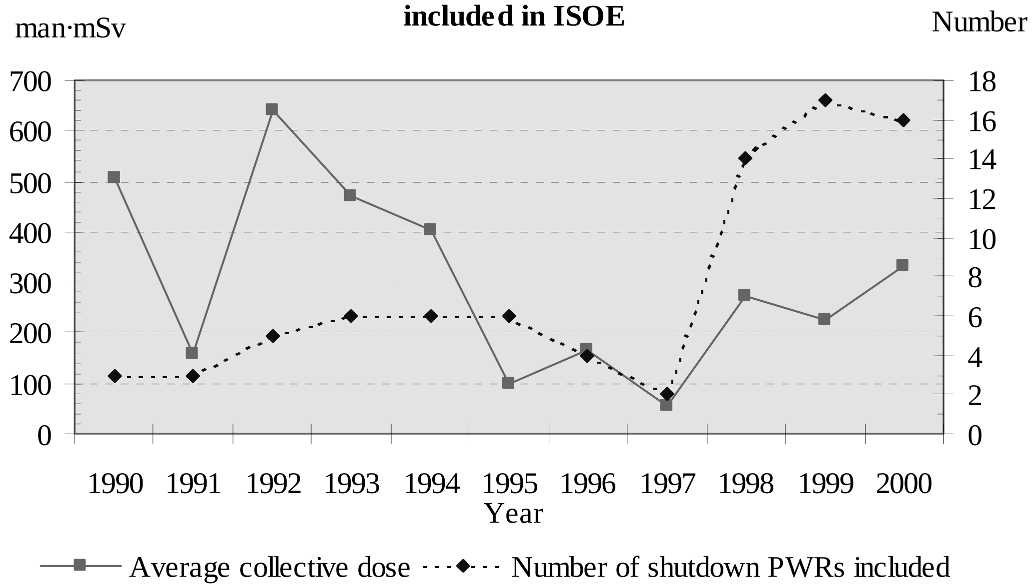


Figure 9

Average collective dose per reactor for shutdown BWRs included in ISOE

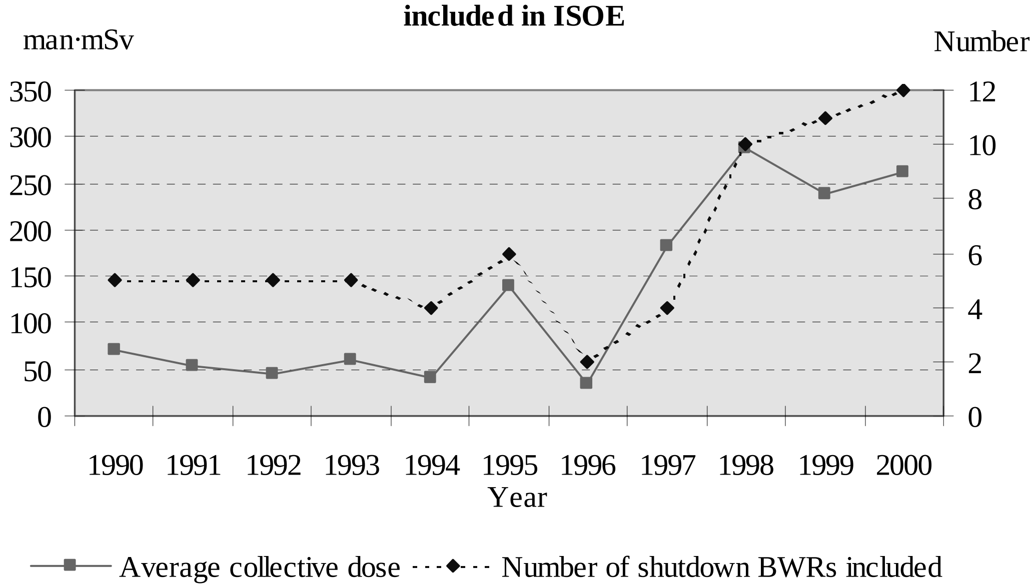


Figure 10

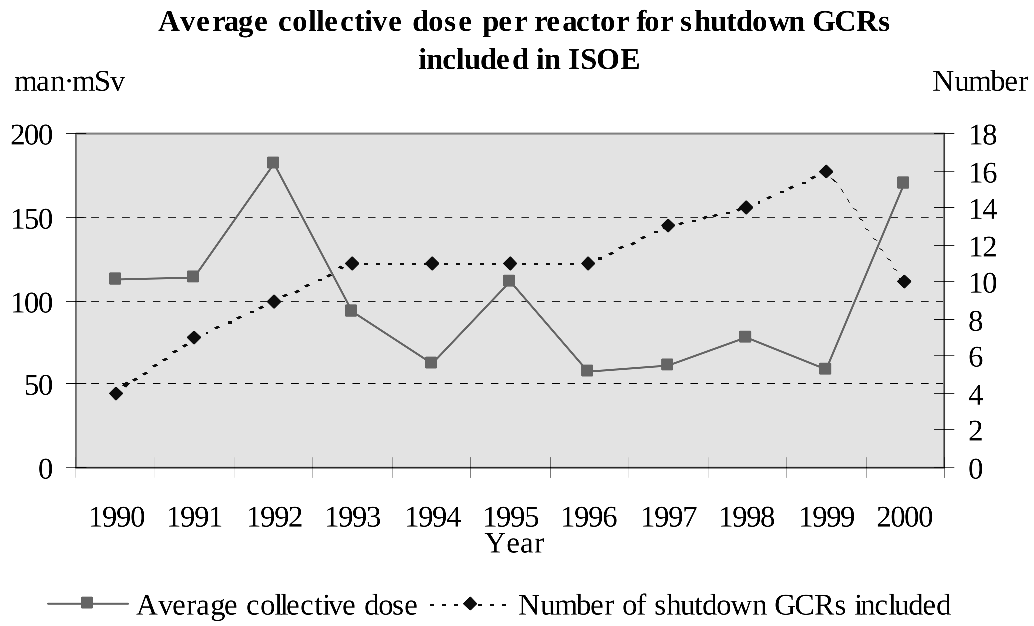
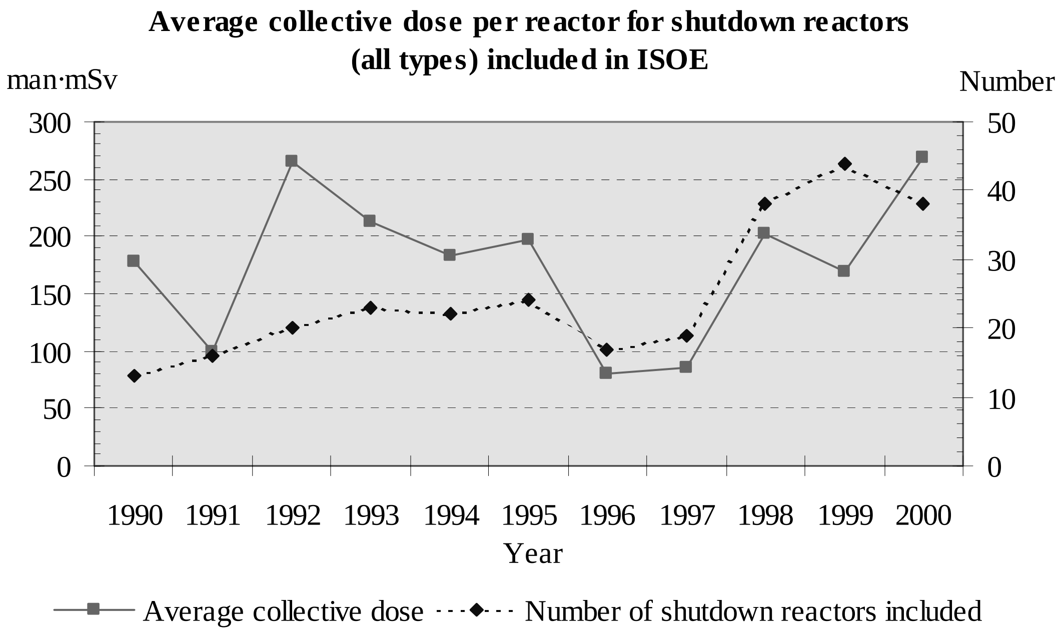


Figure 11



2.3 Annual outage duration and doses in European reactors

Annual outage duration and doses* have been analysed based on three year rolling averages in the time period 1993-1999.

Table 4. **Three year rolling average of total outage dose, outage duration and outage dose per day**

	Years	BWR	PWR	VVER
Average outage dose (man·mSv)	1993-95	1449.70	1600.19	472.91
	1994-96	1385.40	1444.23	495.44
	1995-97	1515.95	1347.92	510.23
	1996-98	1539.03	1206.02	608.07
	1997-99	1302.89	1096.92	548.73
Average outage duration (No. of days)	1993-95	43.75	54.96	44.74
	1994-96	42.76	50.94	44.78
	1995-97	44.47	51.56	47.15
	1996-98	48.45	50.79	51.52
	1997-99	46.19	53.45	49.36
Average outage dose/day (man·mSv/day)	1993-95	33.13	29.12	10.57
	1994-96	32.40	28.35	11.07
	1995-97	34.09	26.14	10.82
	1996-98	31.77	23.75	11.80
	1997-99	28.21	20.52	11.12
Total number of outages	1993-95	57	230	38
	1994-96	59	234	40
	1995-97	58	237	41
	1996-98	60	229	42
	1997-99	57	230	42

For PWRs, the outage dose shows a clear decreasing trend from 1993 to 1999 (decreasing by 30% over the period). During the same period, the average outage duration has fluctuated around 53 days (±5%). Therefore, the dose decrease can not be explained by the evolution of the outage length. On the contrary, there has been a continuous decrease of the outage dose per day (-30% for the whole period). This finding might be explained by the application of work management approaches that allowed the reduction in number of workers, and the workload in high dose areas. Improvements in dose rate reduction may also have contributed to the reduction.

No clear trend can be found for BWRs: after a slight decrease, the dose increased by 11% from 1994 to 1998, followed by a 15% decrease in the last period. The same evolution is observed for the outage duration indicating an influence of the duration on the outage dose.

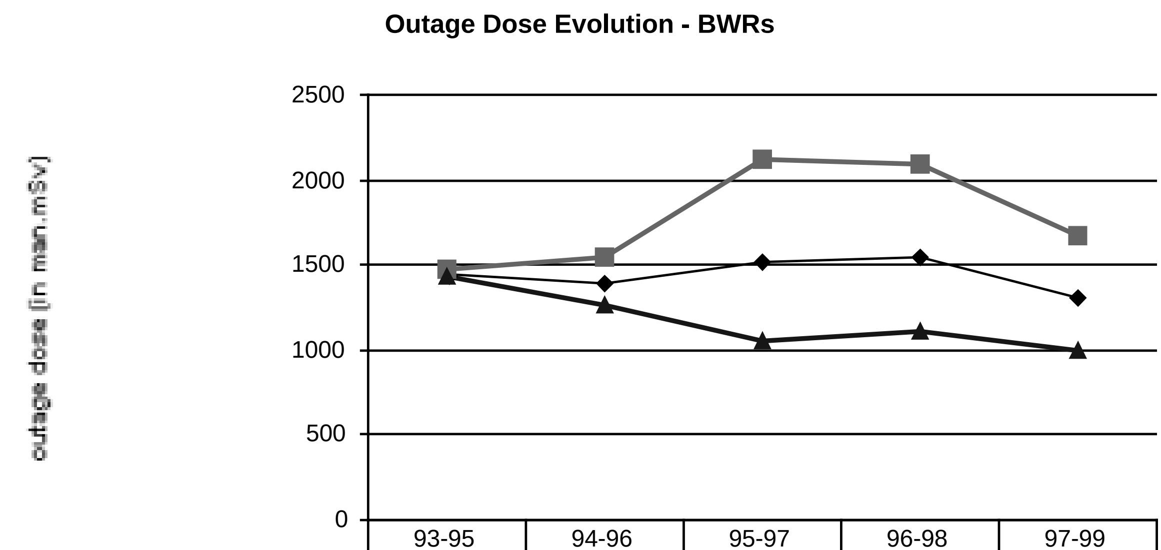
* Data from the ISOE database are available on a calendar year basis. Therefore, when an outage starts during one calendar year and ends during the next year, doses and duration from the first year have been added to those of the second year.

For VVERs, an increase in average outage dose is seen until 1998, followed by a slight decrease. During the period, the outage dose per day remained quite stable. The correlation coefficient between outage dose and outage duration is 0.97.

More detailed analyses were performed to illustrate BWR trends by countries and PWR trends by sister units groups.

The dose evolution for BWRs appears to be mainly influenced by the extensive maintenance programme (modernisation) performed in Swedish boiling water reactors. The following figure clearly shows an increase in outage dose in Sweden whereas the dose in BWRs of other European countries decreased during the same period. It can also be seen that as the Swedish modernisation programme reaches its end, the dose per outage starts to decrease in the last period. During the whole period, outage duration continuously increased in Sweden. The dose per day fluctuated around 37 man·mSv/day until 1996-98, it then showed a significant decrease, down to 29 man·mSv/day. Therefore, one may expect in the future a positive impact of the modernisation programme on the outage dose. It will be then interesting to estimate the extra dose corresponding to the programme workload and the consecutive savings.

Figure 12

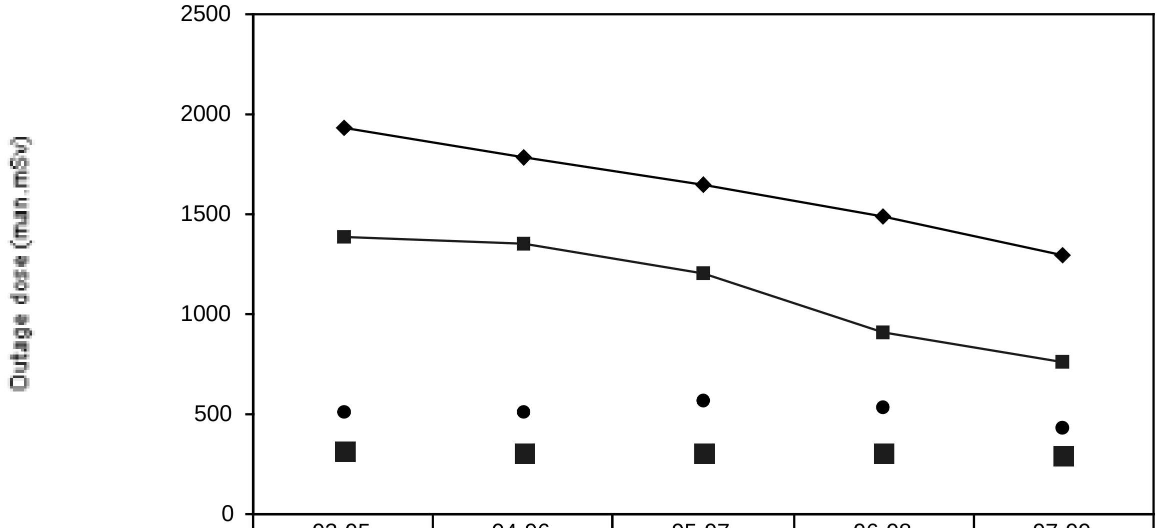


	93-95	94-96	95-97	96-98	97-99
All BWRs	1449.70	1385.40	1515.95	1539.03	1302.89
Sweden	1471.59	1547.36	2117.93	2092.81	1666.03
All BWRs except Sweden	1433.78	1266.32	1059.91	1115.55	998.32

Analysis has also been done for sister units groups, as defined in ISOE to facilitate benchmarking. The following figure shows the evolution of the three year rolling average outage dose for the F32 (Framatome 3 loops 2nd generation) and W32 (Westinghouse 3 loops 2nd generation) sister groups, as well as the evolution of the minimum value recorded. It appears that the three-year rolling average dose decreased for both F32 and W32 groups over the study period. However, W32 results remain lower than those of F32 both in average outage dose and in minimum value of outage dose. The lowest W32 outage dose records being those of Ringhals 4 (Sweden) and Doel 4 (Belgium).

Figure 13

Outage Dose Evolution – PWR Sister Units Groups



	93-95	94-96	95-97	96-98	97-99
Average F32	1931.46	1787.61	1644.11	1487.73	1299.97
Average W32	1381.41	1351.48	1210.12	910.02	766.10
Min F32	507.75	507.75	570.97	534.43	426.66
Min W32	322	309.4	302.04	302.04	298.26

2.4 Deregulation and its implications on radiation protection

One of the major developments in recent years was the decision to deregulate the electricity market, leading to completely new economic conditions for the production and trade of energy. The economic conditions changed in that the electricity spot price decreased while, for example in Nordic countries, production taxes on nuclear power increased. Producers of nuclear energy were in addition faced with gradually increasing safety requirements and the need for modernisation of ageing nuclear power plants.

The deregulation of the electricity market forced the nuclear power plants to improve the work efficiency, to decrease staff and to outsource work activities in order to reduce running costs. In addition, long term investments, research and development activities had to be reduced.

What are the consequences of a deregulated electricity market on radiation protection of workers in the nuclear power plants? Possible consequences of reducing the personnel in the radiation protection division could be decreased redundancy, risk of stress, lack of long-term planning, risk of reduced work quality and a possible increase in human failure. The tendency to outsource activities and tasks bears the risk of receiving reduced work quality due to choosing the best/cheapest offer from the market. In addition, the question of responsibility for the work arises and the collective knowledge and experience in a certain area might get lost for the utility.

In order to reduce running costs, the operator of a nuclear power plant might start questioning radiation protection measures such as decontamination programmes, protective clothing and dosimetry equipment. Expenses for the education of radiation protection staff as well as for regular training of contractors might be reduced leading to a reduced competence and knowledge. Finally, cost optimisation might also lead to the reduction of preventive measures and the tendency to do repair work only if acute. This could result in an increase of worker dose.

In a long-term perspective, cost reduction might have an effect on modernisation projects which then would be delayed, reduced or purely focused on safety issues. The activities and programmes to further reduce dose and dose rates, such as cobalt reduction and ALARA programmes, might be delayed or even cancelled. Research projects such as zinc injection, fuel decontamination and cobalt substitute might also be delayed or cancelled.

At its 10^{th} meeting in November 2000, the ISOE Steering Group held a topical session on "Deregulation of the electricity market and its implications on radiation protection in nuclear installations". The discussion of this topical session is summarised in the following paragraphs.

An open, deregulated electricity market asks for competitive production of electricity from conventional and nuclear energy. The question arises whether the increase in efficiency and reduction in price will be followed by a declining radiological protection performance.

To date, the observation is being made that all radiation protection indicators are still improving and that there is not yet any indication of an effect from deregulation. However, this improvement in radiation protection indicators is due to investments which were introduced 5-10 years ago. Thus, the effect of deregulation on radiation protection might become apparent in a couple of years. It is therefore necessary to look for predictive indicators to be able to better judge future investments.

To date, there is still enough qualified personnel available within radiation protection. However, to gain efficiency in electricity production the staff in the nuclear industry, in general, is reduced and so radiation protection personnel might also be reduced. An interesting indicator to evaluate changes in the management of staff is the ratio of new personnel versus plant experienced personnel. In previous years this ratio has been in the order of 15% whereas, in 2000, numbers up to 60% could be observed.

Some ISOE members reported on the application of the concept of self-protection in radiation protection in nuclear power plants. This leads to the question of taking responsibility – each worker has to be aware of his/her own dose – however the responsibility versus regulation remains with the operator of the nuclear power plant.

The role of the regulator will also be key in the process of deregulation. The main task of the regulator is to ensure a high level of nuclear safety and health safety. This is essential to maintain public confidence in the industry. However, regulators will have to adapt their procedures to account for the increasingly important commercial issues.

For the utilities, health safety and nuclear safety should have no price. In order to evaluate efficiency in radiation protection, new indicators have to be developed.

The ISOE system can support decisions on investments regarding the radiological protection performance by offering a detailed dose data base which can reveal trends at an early stage and can be used to develop the above mentioned new indicators.

The topic will certainly be followed up by further discussion within the ISOE Steering Group as well as in expert groups if appropriate.

2.5 Access and dosimetric follow-up rules in nuclear power plants for foreign workers

Workers in the nuclear field, employed in contractor companies, might spend a considerable part of their professional life in foreign countries. Therefore, it was decided to perform a survey on the rules which apply for foreign workers in nuclear power plants of various countries, before and during their work. The survey covers almost all countries with nuclear power plants in operation. The questionnaire was answered by 44 ISOE contact-persons from nuclear power plants, utilities or national professional organisations in 21 countries.

The professional qualification obtained in the country of origin is not systematically accepted in other countries (20/44 answers). Even if the professional qualification is recognised, additional access tests are mandatory (34/44) and/or a complementary training is provided to the foreign worker (38/44).

All countries ask for a certificate of the employer stating that the doses the worker received in the past are compatible with national and corporate dose limits. A detailed dosimetric history (a "dosimetric passport") of the foreign worker, however, is not everywhere required. It is not necessary, for example, in Belgium, Lithuania, Slovakia and the United States.

The medical examination performed by the country's medical authority is generally accepted in other countries (24/44). For control reasons, the complete medical file of the worker may be requested (13/44). An examination on alcohol and/or drug consumption is widely used (13/44). Less common investigations are the criminal background, as checked in the US, psychological tests, as performed in the Czech Republic and Slovenia or pregnancy tests for female workers, as required in Germany.

The health physics departments of the utilities are, in general, responsible for recording the operational, legal and internal doses of foreign workers. Exceptions are France and Belgium, where the medical department of the utility is in charge of the internal dosimetry and the medical department of the contractor company is in charge of the legal recording of doses.

Official doses from external radiation are in most of the countries recorded with thermoluminescent detectors (TLDs) (25/42) and/or film badges (20/42). Electronic dosimetry has recently become a legal means of dose measurement in the UK, at least for a majority of the nuclear power plants. For operational dosimetry, every country is using electronic dosimeters – with or without alarm.

For the internal dose assessment of foreign workers, one or more of the following methods are used: whole body gamma measurement (36/44); whole body quick counting (32/44); bio-assays in case of incidents (25/44). Large differences can be found in the minimum levels used for records (usually given in % of the Annual Limit of Intake, ALI) and thresholds used to trigger further investigations. The recording and action levels vary from 0.1% of the ALI up to 20% of the ALI. Moreover, most nuclear power plants are not yet using the latest values of dose conversion factors and models recommended by ICRP Publication 60 (1990). The more widespread reference used for the assessment of internal doses is ICRP Publication 30.

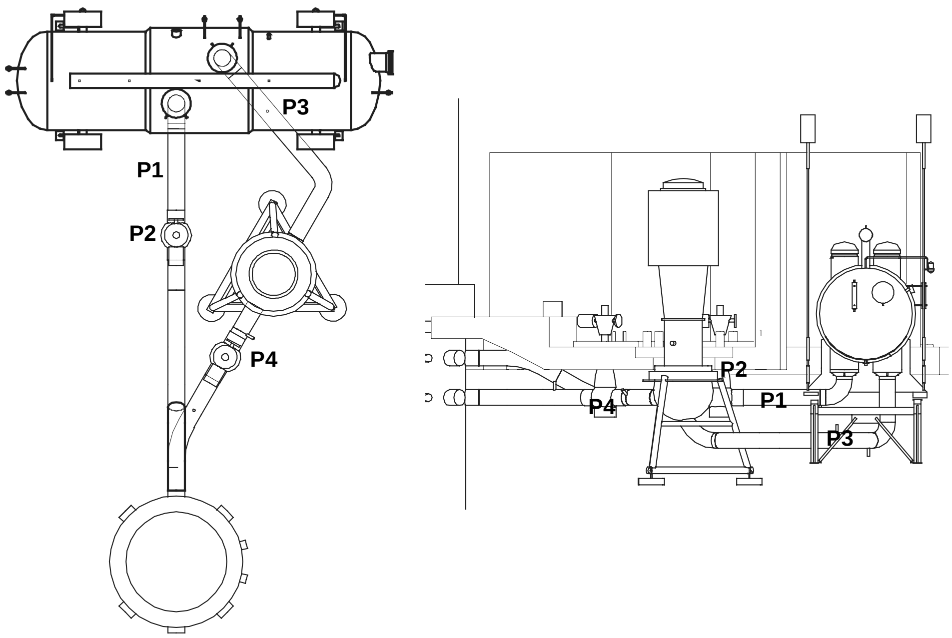
In general, the worker is personally informed about the internal and external doses he has received abroad. In addition, the health physics department of the employer, and/or of the nuclear power plant is informed. In France, only the worker and the medical department of the nuclear power plant receive the internal dose results.

2.6 Standardisation of dose rate measurements in VVER reactors

The Health Physics Groups of VVER and RBMK nuclear power plants launched a standardised dose rate measuring programme in 1998. In the framework of this programme the dose rates are measured according to predefined circumstances during the outage in VVER reactors. The measuring points around the loops are shown in Figure 14.

Figure 14

Dose rate measuring points around the loops



The aim of a standardised dose rate measuring programme is to compare the radiation levels of different VVER reactors and to investigate the factors which can influence the dose rate. Figures 15 and 16 show the average dose rates (six loops average in VVER440 and four loops average in VVER1000) for the years 1999 and 2000. The analyses of the factors which may have had significant impact on dose rate (primary water chemistry, materials etc.) have been initiated. The dose rate measurements and the information exchange will be continuing in 2001.

Figure 15

Measured dose rate in 1999

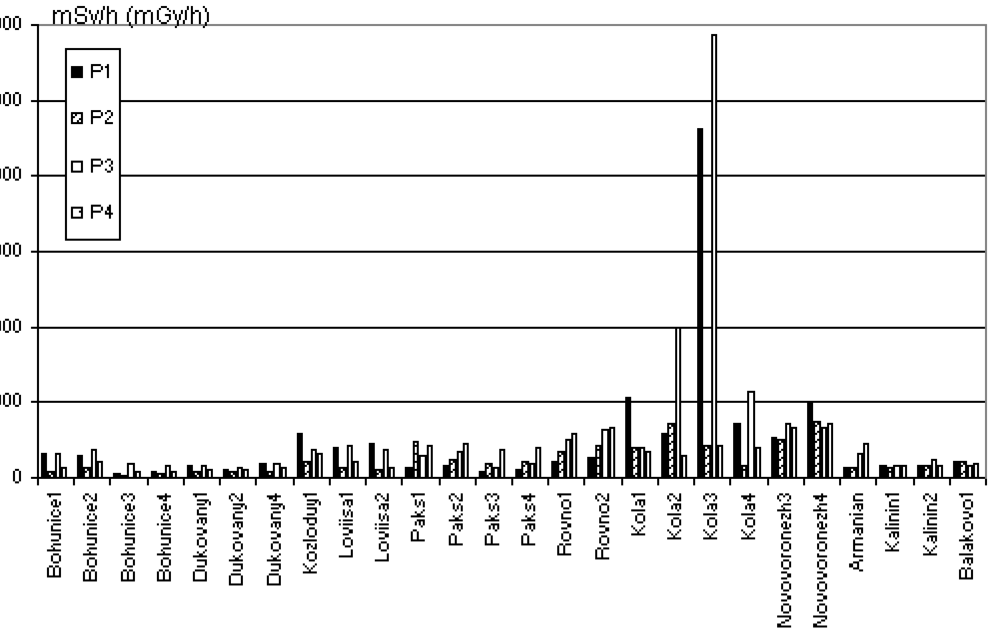
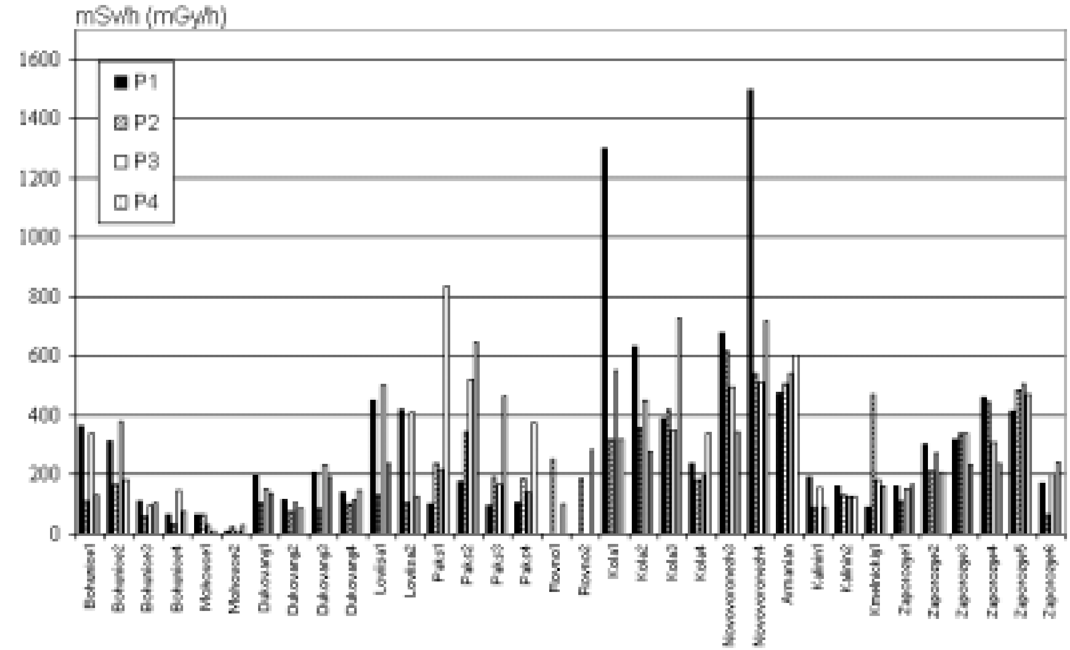


Figure 16

Measured dose rate in 2000



2.7 Summary of the 2001 ALARA Symposium in Anaheim, California, USA

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

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

The plenary session was opened by Borut Breznik, Chairman of the ISOE Steering Group, and Paul Rohwer, President Health Physics Society. The invited plenary presentations included the following topics and speakers:

- Operating Nuclear Power Plants in a Deregulated Electric Market in California. (by Joseph Wambold, Vice President, San Onofre Nuclear Generating Station)
- The Issue of Iodine Distribution in the Vicinity Of French Nuclear Power Plants and Associated Experience Feedback. (by Bernard Le Guen, MD, Laboratory Deputy Director, EDF, Paris France)
- Radiological Protection Challenges in Nuclear Power Plant Management on the Verge of 21st Century. (by Dr. Anibal Martin, Vice-President of CSN, Madrid, SPAIN, Morgan Memorial Lecturer)
- Cassini Mission to Saturn, (by Robert Mitchell, Project Manager, Jet Propulsion Laboratory, Pasadena, California, USA)
- Radiation Litigation: Where we have been. Where we are going? (by David Wiedis, ESQ, Jose & Wiedis, Pennsylvania, USA)

Benchmarking world-class performance in ALARA with special emphasis on radiological operations and dose management was the key topic for the 2001 international symposium. Innovative applications of electronic dosimetry, bioassay and use of containment devices have been featured at the symposium. Finally, global ALARA technical papers were presented for major nuclear power plant initiatives including source term reduction, the use of chemistry treatment programs, decommissioning and refuelling outage length reduction. European judges awarded Best Paper Awards to Scott Schofield: Health Physics Self-Assessment & the New Regulatory Process at a US Nuclear Power Plant and Ellen Anderson: Quad Cities Experience with Noble Metal Injections.

2.8 Principal events of 2000 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 2000. 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 2000 and which may have influenced the occupational exposure trends. These are presented by country.

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ARMENIA

Summary of national dosimetric trends

In spite of a big outage, the dosimetric trends at the Armenian NPP show reduced collective dose for the year 2000.

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

Years	1995	1996	1997	1998	1999	2000
Collective dose	4.18	3.46	3.41	1.51	1.57	0.96

Events influencing dosimetric trends

Modifications on safety systems (SG, MCP, est.), in-service inspections and spent fuel transfer to the dry storage.

Number and duration of Outages

One big outage (114 days) with refuelling and maintenance works in safety systems (also some modifications on safety systems, in-service inspections and so on) was performed. There was special influence on dosimetric trends of transferring spent fuel from the NPP's water pools to dry storage.

The planned exposure doses were agreed with the regulatory body. The exposure doses were planned in advance for the works, demonstrated in the following table:

Planned collective doses for each type of works (man·Sv)

Type of work	Planned dose	In fact dose
Reactor vessel	0.40	0.28
Pressurizer	0.03	0.01
Main gate valve	0.18	0.02
Water purification system	0.12	0.01
Main circulation pump	0.24	0.10
Concrete base	0.12	0.01
Steam Generator	0.36	0.04
In-service inspection	0.14	0.08
Decontamination works	0.18	0.14
Insulation work	0.13	0.05

Type of work	Planned dose	In fact dose
Dosimetric control	0.06	0.01
Feed water deairator	0.05	0.01
Miscellaneous	0.15	0.01
Work on thermal automatic equipment	0.04	0.01
Spent fuel transfer from water pool to the dry storage	0.24	0.04
Total	2.44	0.794

For this stages the maximum individual dose equivalent was 28 mSv.

Major Evolution

The collective dose for the year 2000 at the Armenian (Medzamor) NPP was 0.96 man·Sv, which is the result of strict application of an ALARA programme. This programme includes both organisational and technical issues.

Component or System Replacement

During the big and long term outage, as a modification, the main Steam Isolation Valves, Pressuriser Safety Valves and SG Safety Valves were replaced.

Unexpected Events: for the year 2000 unexpected events were not registered.

2001 Issues of Concern

There are foreseen medium activity radioactive waste including drums replacement, which can have an impact on dosimetric trends.

BELGIUM

Summary of national dosimetric trends

Collective doses for the year 2000 (in man·mSv)

In Tihange	Tihange 1	Tihange 2	Tihange 3	Total	
Plant Personnel	23.5	103.4	84.4	**211.3**	
Contractor's Personnel	17.7	438.3	392.5	**848.5**	
Total	**41.2**	**541.7**	**476.9**	**1059.8**	
In Doel	Doel 1	Doel 2	Doel 3	Doel 4	**Total**
Plant Personnel	44.7	61,0	103.9	43.5	**253.1**
Contractor's Personnel	139,7	283.5	522.1	161.1	**1106.4**
Total	**184,4**	**344.5**	**626.0**	**204.6**	**1359.5**

Collective doses are decreasing. This is due to a continuous application of the ALARA principles and to the reduction of outage duration.

However, very precise trends from one year to another are difficult to draw, because of the different cycle lengths of the units. The units in Doel have yearly cycles, but the units in Tihange have 18 month cycles.

Events influencing dosimetric trends

The outages (In 2000: Doel 1,2,3,4, Tihange 2 and 3) are responsible for the major part of the collective doses.

Number and duration of outages

Unit	Outage information	Number of workers	Collective dose (in man·mSv)
Tihange 1	none		
Tihange 2	Outage duration 28 days, No exceptional work.	979	493
Tihange 3	Outage duration 25 days, No exceptional work	881	410
Doel 1	Outage duration 15 days, No exceptional work	773	158.90
Doel 2	Outage duration : 27 days No exceptional work	1024	307.69
Doel 3	Outage duration : 24 days No exceptional work	666	490.46
Doel 4	Outage duration : 18 days No exceptional work	666	173.73

Component or system replacements

Tihange 3: Replacement of Boraflex.

- The spent fuel pool storage facility of Tihange 3 contains 18 racks, each one is able to receive either 6x7 or 7x7 fuel elements. Between the fuel cells, blocks of neutron absorber have been placed. This neutron absorber is called Boraflex. It is made of B4C scattered in an elastomere matrix (silicon). Due to the ageing, this Boraflex has to be replaced.

- During August 2000, a first rack has been removed, after US decontamination, to determine the state of the material (fragile or ductile).
- The collective doses forecasts for this operation were 5.2 man·mSv. The final result was a collective dose of 1.4 man·mSv.
- The first results being positive, the replacement of Boraflex has begun and will continue till mid-2001.

Organisation evolutions

In October 2000, a complete modification of the organisational structures existing on both nuclear sites (Tihange and Doel) occurred. The previous structure was "plant oriented", which means one hierarchical structure existed for each plant. The new structure is based on a different approach. It is more "job-oriented": On each site, there is one hierarchical structure for each type of job (operations, maintenance, safety supervision, …). This new structure improves the exchange of knowledge among workers performing the same job, which gives an important added value regarding nuclear safety.

Plans for major work in the coming year

Tihange 2: steam generator replacement; all other plants will go through a normal outage.

BRAZIL

Summary of national dosimetric trends

Angra 1 NPP was in normal operation and had one scheduled refuelling outage resulting in 1.348 man·Sv for total collective radiation dose, including 0.138 man·Sv for operation and 1.21 man·Sv for outage. Angra 2 NPP had its first criticality in July 2000, and, at end of the year was executing the 100% integrated full power tests, with no significant collective radiation dose (0.016 man Sv); therefore, this is not included in the total.

Events influencing dosimetric trends

Angra 1 NPP had its 9th 0utage from 1 May to 11 July 2000 involving 1149 workers in the controlled area. 94.8% of the workers dose were lower than 5 mSv. No worker received a radiation dose above 10 mSv or a radioactive intake above 370 Bq.

Radiological important tasks:

- Full scope Eddy Current Test of Steam Generators.
- Change the SG Thermal Insulation.
- One third of the 121 Fuel Elements were changed.

New Plant on line

Angra 2 NPP (1309 MWe projected nominal power, KWU/Siemens project, PWR four loops) achieved its first criticality in July 2000 and, at the end of the year, was generating 1350 MWe during full power test.

New/experimental dose-reduction programme

Eletronuclear established with Siemens/TUV (Germany) a project to apply depleted zinc injection on the primary circuit of Angra 2 NPP, starting during the reactor criticality, in order to maximise the dose reduction on the plant operational phase.

CANADA

Ontario Power Generation

On July 11, 2000, OPG and British Energy announced an agreement to lease the two OPG nuclear generating stations on the Bruce site to a new company called Bruce Power, which will be majority owned by British Energy. The lease runs until 2018, with a provision to extend for a further 25 years. The transition is planned to take place in June, 2001, provided that the necessary operating license approvals are received by then. Bruce Power will operate the stations independently of OPG, but OPG will retain responsibility for nuclear waste and eventual decommissioning. The agreement was a first step towards satisfying a requirement imposed on OPG by the Ontario Government to reduce its share of the electricity market in the province.

Work is continuing on the return to service of the four laid-up Pickering units. Canadian Nuclear Safety Commission hearings on environmental assessment are being held as part of the relicensing process, with public input. The plan is for the first of the units to come on line in late 2001.

Improvements to the Radiation Information System are in progress, with a plan to implement two new releases in 2001. These releases will incorporate numerous user-requested improvements, and they will improve our ability to track dose by task for the ALARA programme.

Teledosimetry is in limited use at all three stations. Its use has been very helpful to the ALARA programme, but it has not expanded as rapidly as hoped due to problems with transmission and interference. Alternative electronic dosimeters are being evaluated.

The new, expanded and centralised radiation protection organisation that was created in 1999 is fully staffed. It now has a much greater field presence, with RP staff doing routine surveys, inspecting rubber areas, observing and coaching other employees to improve radiological work practices, and performing regular ALARA reviews of work plans. A new Director took control in April; he reports to the Senior Vice President of Technical Services.

At the beginning of 2000, four new RP performance indicators were introduced. They are:

- number of personal contamination events;
- number of RP events reportable to the regulatory authority;
- floor area under contamination control;
- rubber areas passing assessment.

Another performance indicator for the ALARA programme will be introduced as soon as the improved information system is in place to record the data.

An initiative was started in mid-2000 to upgrade the Radiation Protection Procedures. The objective is to shorten and simplify the Procedures, removing any non-procedural information from them and putting it into other documents. The process of upgrading all 17 procedures is expected to take about a year.

There are several ALARA programme improvements under way. These include source term reduction, hot spot removal, and improvements in the temporary shielding programme.

A summary of the collective dose by station for first three quarters of 2000 is shown in the table below. There were two notable deviations from planned dose targets:

- The Unit 6 outage at the Bruce site took longer and encountered higher tritium levels than expected, resulting in an increase in internal and total dose.
- The vacuum building outage at Pickering was completed with a dose of about 0.45 man·Sv, well under the target of 0.75 man·Sv. (This is a once-a-decade outage that requires all eight units to be shut down at the same time, to perform inspections and preventative maintenance on the vacuum building that is common to all units.)

The table also shows performance against the annual benchmark, which is based on top quartile performance for water-cooled reactors of similar size and age. If dose were accumulated linearly over time, the percentage of benchmark should be less than 75%.

Ontario Power Generation					
Collective Dose per Unit, Year-To-Date as of 2000-09-30 (in man·Sv)					
	YTD Actual	**YTD Target**	**% YTD Target**	**YE Benchmark**	**% YE Benchmark**
Bruce 1-4	0.013	0.038	34	n/a	n/a
Bruce 5-8	0.767	0.707	108	0.89	86
Darlington	0.315	0.350	90	0.39	81
Pickering	0.401	0.452	89	0.61	66

Gentilly-2 (Hydro-Québec)

Gentilly-2 power station continued to improve its performance in 2000. The 2000 annual outage ran from 4 April to 8 May. The most important activities that were scheduled for the shutdown were related to fuel channel feeder inspection, steam generator primary side eddy current inspection, and secondary side tube sheet cleaning using the water lancing process. We have also changed all Co-60 adjuster rods.

The collective dose to workers for the 2000 outage was 0.845 man·Sv, which represents 77% of the outage collective dose target of 1.100 man·Sv. The collective dose at power is actually exceeding our target by 32%, 0.290 man·Sv received instead of the 0.220 man·Sv target. But we are still confident that we will be able to meet our annual dose target of 1.320 man·Sv.

Regarding the Human Performance Programme implementation, we benchmarked our Programme with two US nuclear stations, Seabrook in Connecticut and Millstone in New Hampshire, and came out with recommendations to improve our Programme. We are also reviewing all 1997 to 2000 radiation protection related events for trending regarding human performance. Finally, a one-day human performance training course will be given to all station personnel.

Our dose reduction programme will focus on the antimony source term, which represents our main contributor for gamma radiation fields during shutdown activities. We have also put in place an electronic dosimeter data acquisition system, which sends all electronic dosimeter dose values directly into our official occupational dose database.

A teledosimetry system will be tested during the next shutdown in 2001. We are looking to use this system for: continuous monitoring of worker's doses; dose rate mapping of the main reactor vault faces before giving access to workers; and monitoring the antimony removal process.

Point Lepreau (New Brunswick Power)

General Station Issues

Considerable effort has been expended over the past year to improve personnel relations and safety culture at Point Lepreau GS. The future of the station is on the line, and this has been communicated clearly to all personnel. Early in 2002, a decision will be made on whether to replace the reactor tubes in 2006 and continue to operate for another 20-30 years, or to begin decommissioning around 2008. Several factors will influence that decision, most of which boil down to operating the station safely to the planned capacity factor and within budget. Since the station accounts for thirty percent of the province's energy needs, its stability is paramount to the fiscal health of New Brunswick.

To align personnel to meet our goal of a positive refurbishment decision, everyone attended a three-day teambuilding session (in groups of approximately 30 over seven months) on Vision and Interpersonal Skills (VIPS). Additional sessions were presented to work groups on the history of WANO and the importance of adapting our station objectives to those of WANO.

Other station programmes or initiatives that have been implemented in the past year include:

- An Outage Planning group was formed much sooner than for previous outages. Work plans were finalised several months prior to the beginning of the outage. Consequently, the 2000 maintenance outage was completed on time, within budget, and within the dose target.
- An Operating Experience group was formed to monitor, organise and communicate internal and external experience. This group provided valuable information for pre-job briefings during the outage.
- A process for the identification of problems and tracking of subsequent actions was implemented. Central to this process is the Problem Identification and Corrective Action (PICA) database.
- Changes were made to the work permit system to facilitate the authorisation of low risk repairs to equipment. Also, a process is being developed to separate general maintenance from the production group.
- Much greater emphasis has been placed on the development and use of a business plan that is aligned to station objectives.
- The first stage of an improved inactive waste management plan was implemented, with waste being sent to a public landfill. The next stage, which may include reclaiming waste from on-site storage for reassessment of activity, will be implemented within the next year.

Radiation Protection Issues

New radiation protection regulations were enacted in Canada on 31 May. Many of the major changes were already in practice at Point Lepreau. Revision to the programme is in progress.

The permanent installation of alarming area tritium monitors continues, but networking the system to the Control Room might not occur.

A formal ALARA programme document was issued, with implementation of the programme expected over the next year.

To alleviate the demand for Protection Assistants during the outage, approximately 30 contractors completed a five-day advanced radiation protection training programme that would allow them to work unsupervised in radiation areas. The candidates were approved by Health Physics based on their experience with radiation work at the station. Limitations were placed on the types of work they could perform, and frequent checks of progress were required of the supervisors. This programme received positive feedback during the outage.

The station has been preparing for a major Emergency Planning exercise that will occur 22 November, 2000.

CHINA

Summary of national dosimetric trends

The average collective dose per unit for the year 2000 was 0.586 man·Sv.

	Planned outage	Forced outage	Refuelling outage	Average collective dose, man·Sv
Daya Bay U106			42 days	0.565
Daya Bay U207			36.5 days	0.565
Qinshan	14 days	14 days	42 days	0.627

Events influencing dosimetric trends:

Component or system replacements in the Qinshan NPP

The reactor cables were replaced. The Inadequate Core Cooling Monitoring System (ICCMS) was installed. The refuelling machine was modified.

New/experimental dose-reduction programmes

Qinshan NPP: oxidisation operation, "Hot point" controlling and management, temporary shielding, lower dose-rate area setting up. Daya Bay NPP: enhanced pH of primary coolant from 6.9 to 7.2.

Issues of concern for the year following the report in the Qinshan NPP:

Technical Dose Reduction of SG primary side works, Dose Reduction of contractors

- ALARA Data Bank setting up
- Dose reduction of RPV closure head inspection
- Dose reduction of Scaffolding /insulation

Plans of major work in the coming year

There is no outage in the coming year. Radiation protection personnel mainly focus on the on-power entry in the containment building and the modification of fuel element storage pool and transporting channel.

CZECH REPUBLIC

Harmonisation of the Czech legislation with EU Council Directives

Implementation plan for the Council Directive 90/641/Euratom on the operational protection of outside workers exposed to the risk of ionising radiation during their activities in controlled areas.

Actual legislation ensures the protection of the workers handling IRS on a high level and is in principal in compliance with the Council Directive 96/29/Euratom. The term outside worker is not introduced in the Czech legislation and therefore no particular requirements for their radiation protection are laid down. To fulfil this requirement, it is necessary to amend the existing law.

The State Office for Nuclear Safety (SUJB) operates a Central Register of Professional Exposures within the Czech Republic. In the draft amendment to the Atomic Act, it is proposed to authorise SUJB to issue and register radiation passports.

Forms of these passports, ways of completing the forms and verification of data registered in them will be laid down in special Decree of SUJB. Obligations relating to outside workers and operators of the controlled areas will be laid down in the amendment to the Atomic Act.

Licensing of nuclear power plant Temelín – personal monitoring

October 2000 – issued an approval of personal dosimetric service covering all parts of personal monitoring

- external legal dosimetry – film;
- internal dosimetry – whole-body counter, measurement of excreta;
- operational dosimetry – TLD, electronic (Siemens);
- neutron dosimetry – TLD;
- extremities dosimetry – TLD.

Fuel to the first reactor was loaded 5 July 2000.

First criticality of NPP Temelín, Unit 1, was reached 11 October 2000, first connection to the grid was made 21 December 2000.

The total collective effective dose for 2000 was 0.172 man·Sv, for utility employees was 0.160 man·Sv, respectively for contractors was 0.012 man·Sv.

Dukovany NPP

The total collective effective dose for 2000 was 0.987 man·Sv, for utility employees was 0.104 man·Sv, respectively for contractors was 0.883 man·Sv. The average collective effective dose per unit was 0.247 man·Sv (Dukovany NPP has installed four units of VVER-440, Model 213).

The total value of collective effective dose (0.987 man·Sv) for 2000 is repeatedly lower in comparison with previous years (collective effective dose for 1999 was 1.126 man·Sv). The maximal individual effective dose was 17.95 mSv registered for one contractor worker. He had performed the replacement of the SG upper feedwater distribution system at third unit and further also he had performed the SG internal equipment inspections at all outages.

The reason for this very good results can be seen in the following positive factors:

- full application of electronic dosimetry system;
- improving radiation protection for all works with high radiation risk (so called "Programme of insurance radiation protection");
- lower total number of workers in controlled area (867 utility employees and 1294 contractors).

The planned outages at Dukovany NPP in 2000:

Unit 1	32 days standard maintenance outage with refuelling; total collective effective dose during outage was 0.206 man·Sv
Unit 2	62 days major (long) maintenance outage with refuelling; total collective effective dose during outage was 0.332 man·Sv
Unit 3	35 days standard maintenance outage with refuelling; total collective effective dose during outage was 0.313 man·Sv
Unit 4	35 days standard maintenance outage with refuelling; total collective effective dose during outage was 0.106 man·Sv

During 6 months (March to September) of operation, the activity of gaseous effluents, especially noble gases and iodine, was increased. This was caused by small damages of two fuel elements at the fourth unit. After refuelling, the activity of effluents decreased, still resulting in the highest total annual releases of noble gases and iodine during the last five years.

During the outage of unit 3, the upper feedwater distribution system of the last steam generator (of a total of 24) at NPP was replaced.

In 2001 at Dukovany NPP we will start the new system called "ISE" (Information system of power plants), which will also have an influence on the radiation protection operational system. We will also prepare the reconstruction of equipment for monitoring radiation of workers at the exit of the controlled area or reconstruction of "hygienic loop" equipment.

FINLAND

In 2000, the annual maintenance outages at the four Finnish NPPs took altogether 90 days. Approximately **93%** of the annual collective dose was received during these outages.

At **Olkiluoto 1** unit the outage lasted 14 days even though these were two damaged fuel rods in the core. The received collective radiation dose was 0.873 man·Sv. At Olkiluoto 2 unit the outage lasted 13 days. The received collective dose was 0.673 man·Sv.

The high steam moisture (0.30 to 0.35%) at both units led to increased dose rates in the main steam lines by a factor of 2 to 10. In the turbine building the increased steam moisture caused a minor increase on individual doses.

Exchange of part of the reactor vessel head spray system was one of the most extensive jobs at Olkiluoto 1.

Other main works in which radiation protection paid special attention were:

- ASME inspections;
- repair of steam separator core flooder pipes;
- exchange of two low pressure bled steam lines;
- exchange of two valves in the shutdown cooling system.

At **Loviisa 1** unit the outage lasted 44 days and the collective dose was 1.675 man·Sv.

The improvement relating to the management of serious accidents (SAM) made at unit one were, from the viewpoint of radiation protection, the most significant work of this long outage. A total of 103 persons participated in this work and the collective radiation dose of these persons was about 0.107 man·Sv.

The replacement of a feed water distribution pipes in two of the steam generators was also a quite demanding work. However, the experience from earlier outages could be successfully utilised. Other significant works from the point of radiation protection were:

- replacement of actuator cables (continuation to the work done in 1999);
- removal of the water seal pipes;
- extensive ASME inspections were carried out during the long outage.

At **Loviisa 2** unit the maintenance outage lasted 19 days and the collective dose was 0.471 man·Sv.

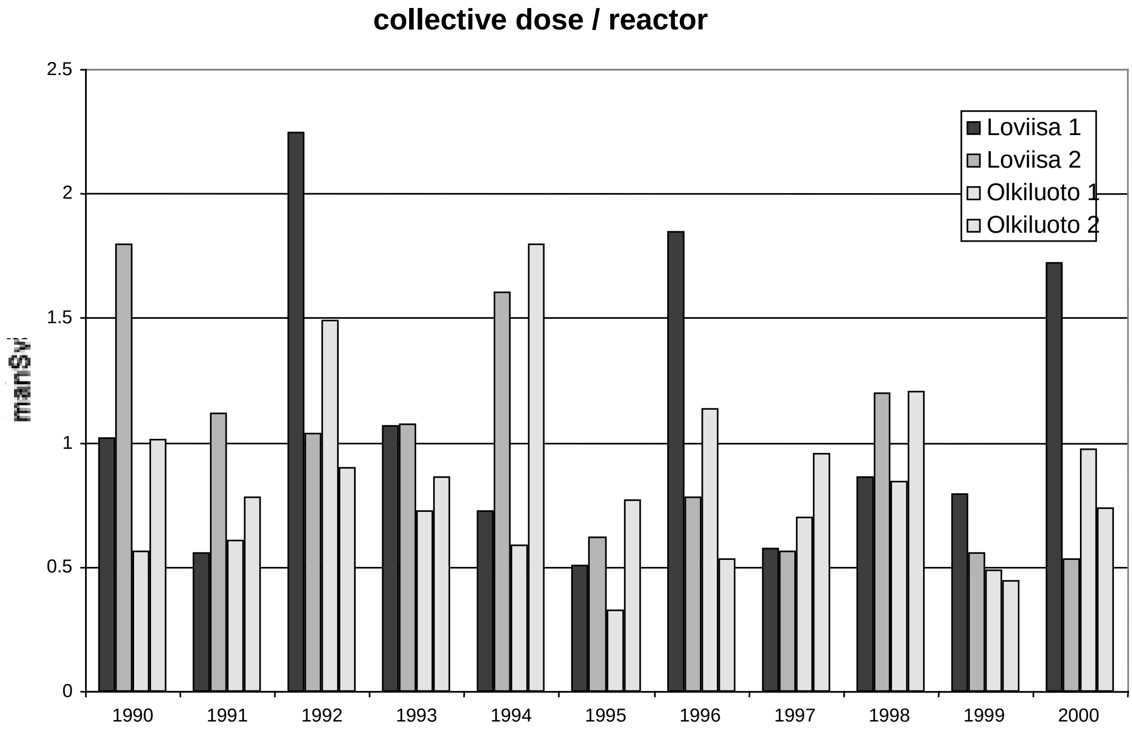
The highest occupational dose was received related to mechanical maintenance, specially to the improvements relating to the management of serious accidents (SAM).

A new unexpected work was the renewal of surface painting in parts of steam generator room. This work was partly made in areas where high dose rates occurred causing high individual doses. Highest of them was 7.29 mSv.

The highest individual dose, 18.44 mSv, was received during insulation and metal cladding work.

In the beginning of 1999 the Radiation Act and Decree were revised in Finland due to the adoption of the European Union BSS directive. Radiation workers have to be categorised into two groups, A and B. The medical check of workers belonging to the A category is to be held annually when it was done earlier every three years.

The most challenging future tasks concern the upgrading of installed radiation monitor systems. This project has already started at Loviisa units.



FRANCE

Summary of national dosimetric trends

Collective doses

The average collective dose fell from 1.17 man·Sv in 1999 to 1.08 man·Sv in 2000 (the first objective for 2000 set up in 1999 was 1.12 man·Sv per reactor). The number of short outages increased from 20 in 1999 to 23 in 2000. The number of 10-yearly outages stayed at 6 (5 in 1999). The number of standard outages decreased from 24 in 1999 to 15 in 2000. The averages for the 900 (34 reactors) and 1300 MWe units (20 reactors) were 1.34 man·Sv (1.42 in 1999) and 0.66 man·Sv (0.73 in 1999) respectively.

Individual doses

The number of workers who received annual doses exceeding 20 mSv, which was still 8 in 1999, fell to 2 in 2000. At the beginning of 2001, the national alarm level for individual dose over 12 months is reduced from 20 to 18 mSv. This level requires an investigation of each individual dose situation.

Events influencing dosimetric trends, number of outages

EDF 4 loop reactors

In 2000, the main contributors were 7 standard outage, 5 short outages and 1 10-yearly outages. The lowest collective dose for a short outage was in NOGENT 2 with 0.43 man·Sv. The lowest dose for a standard outage was in PENLY 1 with 0.50 man·Sv. The highest dose for an outage was in BELLEVILLE 1 with 1.69 man·Sv for a 10-yearly outage.

EDF 3 loop reactors

In 2000, the main dose contributors were 15 standard outages, 18 short outages, 5 10-yearly outage, a SG Replacement in GRAVELINES 4 and a vessel head replacement in GRAVELINES 2. The lowest collective dose for a short outage was 0.48 man·Sv in TRICASTIN 1. The lowest dose for a standard outage was 0.64 man·Sv in BLAYAIS 1. The highest outage dose was in BUGEY 2 with 3.59 man·Sv (hot spots) for a 10-yearly outage.

Organisational evolutions

The reinforcement of the Radiation Protection organisation at EDF should continue in 2001. 400 persons (technicians, high level technicians and experts) should be recruited in the radiation protection field over 5 years.

Futures activities(Outages and dosimetry)

In 2001, EDF NPP Operation Division is planning 12 short outages, 24 standard outages and 6 10-yearly outages.

GERMANY

Utility Report

During 2000 most of German NPPs were in normal operation with short outages in a range of two to three weeks. The influence of the short outages can be clearly seen in low collective doses. The average dose per reactor was strongly influenced by the high dose of a few plants which had to perform additional inspections as required by the authorities.

The German government's intention to phase out nuclear power clearly demonstrates the political situation in Germany towards nuclear energy. Part of this policy is a political "Consensus" between the Federal Government and the four leading utilities to phase out nuclear power in Germany by 2020. The agreement is based on an average operating time per NPP of 32 years. Most of the units will end operations before 2020.

A transport ban on the shipment of spent fuel has been in force since 1998 as a result of detected surface contamination on transport containers. As a countermeasure, a protective shirt was added to cover the whole surface of the container during loading. This concept was accepted by the independent expert group and the effectiveness of the measure was proven by tests in three NPPs.

In 1999 and in 2000 some cases of minor contamination on the personal clothing of contractor personnel were detected by entrance monitoring systems, consisting of surface contamination and hot-spot particles of different radionuclides. In order to clarify sources and scenarios for the different possible contamination pathways, some German NPPs performed internal peer reviews. As a result, the VGB working group "Practical Radiation Protection" elaborated a list of administrative and technical proposals which shall serve radiation protection officers in the plants to improve procedures for better control or avoidance of contamination risks. In addition to the internal reviews, VGB ordered a study which was performed by an independent expert. The objective of this study was to evaluate the dose impact of such contamination under deterministic and probabilistic aspects, in view of the new and more restrictive limit values given by the EU-directive. Taking into account highly conservative scenario assumptions, the results of the deterministic consideration show that contamination with hot-spot particles may lead to exposures for individuals in the public slightly exceeding the limit value of 1 mSv/a. By considering these cases under probabilistic aspects one can be sure that these exposures will be significantly below 1 mSv/a in reality. Discussions with the authorities have not yet been finalised. Based on the VGB list of proposals for the reduction of contamination risks and on the results of the independent expert study, the German NPPs can demonstrate that the risk of contamination of personal clothing can be kept in a range below that which would constitute a health-risk for workers in NPPs and for the public.

Authority Report

The objective of the Federal Government of Germany to terminate the use of nuclear energy has been negotiated with the major energy producing companies. An agreement was signed in June 2000 covering essentially:

- termination of operation of nuclear power plants on a base of prescribed amounts of energy produced by each plant (leads to an end of operation in about 2020 for the last plant);

- termination of reprocessing in 2005;
- erection of storage facilities for casks with spent fuel elements at or close to each site of a NPP to minimise current transports.

Main features of the agreement will be incorporated into the national Atomic Act. An amendment has been drafted and will be discussed with industry and interested public in 2001. Implementation of Euratom Basic Radiation Protection Standards into national radiation protection regulations has been drafted and discussed with all institutions affected. It is planned to bring into force the new regulations up to mid of 2001. New essential features are:

- lower dose limits (e. g. 20 mSv effective dose per year for workers, 1 mSv for public);
- detailed requirements for clearance including extended list of radionuclide specific activity values for unconditional clearance based on “10 microSv concept”.

HUNGARY

Upon the result of operational dosimetry the collective radiation exposure was 3048 man·mSv for 2000 at Paks NPP. The highest individual radiation exposure was 20.6 mSv, which was well below the dose limit of 50 mSv/year, but higher by 0.6 mSv than the target value of the power plant specified for the individual dose (<20 mSv/year).

During the year 2000 several works, involving significant radiation exposure, was to be performed, which were beyond the normal scope of operational or outage activities. The duration of outages were 52 days on Unit 1, 69 days on Unit 2, 24 days on Unit 3 and 27 days on Unit 4.

The activities associated with the chemical cleaning of 163 fuel assemblies and the transport of 500 spent fuel assemblies into the interim spent fuel store (ISFS) can be highlighted from radiation protection point of view, among those performed apart from the outages but not in direct relation to the operation of the Units.

The implementation of the so–called safety enhancement modifications, initiated to improve the safety of the nuclear power plant, went on during the outage periods. The reconstruction of the Reactor Protection System of Unit 2 and preparation for the same reconstruction of Unit 3 and 4 were completed. The earthquake protection improvement related reconstruction of the primary water purification system was performed for all four Units. The modification to manage PRISE, and the reconstruction of cold overpressure protection system have been carried out for Unit 1 and 2.

Unscheduled works involving significant radiation exposure had also to be performed during the outages. The feedwater collectors of three steam generators were replaced out of schedule at Unit 1. The removal of the magnetite deposit revealed on the secondary side of the steam generators of the Units was also an unscheduled item of work to be performed.

The implementation of the safety enhancement measures involved a collective dose of 461 man·mSv, while 101 man·mSv collective dose was received during the replacement of the feedwater distribution collectors of three steam generators of Unit 1. The chemical cleaning of the fuel assemblies discharged from Unit 2 also caused a considerable amount of collective dose of 114 man·mSv. The removal of the sediments deposited in the secondary side of the steam generators resulted in 197 man·mSv.

JAPAN

Fiscal Year 2000

Summary of National Dosimetric Trends

Collective doses

The fiscal year 2000 has resulted in almost the same level in dosimetry as the previous year for both BWRs and PWRs. The average annual collective dose per unit is 1.54 man·Sv, 1.96 man·Sv, and 1.03 man·Sv for all operating units, BWRs and PWRs, respectively.

In FY 2000, the major improvement works having significant collective dose during the planned outage were as follows:

BWRs:

- replacement of a shroud and other reactor internals (14.2 man·Sv for 4 units);
- replacement of PLR pipe lines (4.2 man·Sv for 2 units).

Individual doses

The annual average exposure of radiation workers was 1.2 mSv which was the same level as previous year and the highest annual individual exposure was 20.0 mSv, which was well below the dose limit of 50 mSv/y.

Periodical inspections were completed at 23 BWR units and 20 PWR units. The average duration for periodical inspection was 93 days for BWRs and 63 days for PWRs. The shortest outage lasted 39 days.

For the Following Years

Japan adopted the ICRP publication 60 in the regulatory framework, from the beginning of FY 2001.

Plans for Major Work in the Coming Year

Steam generator replacement and vessel head replacement are scheduled at one PWR in FY 2001.

LITHUANIA

Summary of national dosimetric trends

The average annual collective dose per unit for the year 2000 for the Ignalina nuclear power plant (INPP) (2 units with LWGR (RBMK) reactors) was: INPP personnel – 4.259 man·Sv, outside workers – 1.097 man·Sv. Total collective dose per unit was 5.35 man·Sv.

Principal events of 2000

The national trends of occupational exposure are declining. Since the year 1997, occupational exposure is decreasing significantly. In 2000, the average annual collective dose per unit was 16.4% lower than the value of 6.4 man·Sv per unit in 1999. This is due to continuous application of the ALARA principle, for example, through the adaptation of effective work management programmes and modernisation of equipment at the INPP. The comparison of planned and actual doses has been used as an indicator to evaluate the effectiveness of measures taken to reduce occupational exposure. The planned annual collective dose for INPP personnel was 10.3 man·Sv, and for outside workers – 3.60 man·Sv, or a total of 6.95 man·Sv per Unit. Thus the actual dose was 23% below the planned value.

In 2000, two outages were performed at the INPP, the outage of Unit 1 took 143 days, and the outage of Unit 2 was 66 days. The collective dose was distributed as follows: normal operation – 12%, outage of Unit 1 – 70.2%, outage of Unit 2 – 17.8%. The collective doses for the outages were 6.482 man·Sv for Unit 1 and 1.382 man·Sv for Unit 2.

Total number of workers wearing individual dosimeters was 3844 (3269 INPP personnel, 575 outside workers). The average effective individual dose was 2.786 mSv, with a maximum dose of 24.02 mSv. 48 INPP workers exceeded the 20 mSv dose limit.

In 2000 the assessment of internal exposure for 465 workers was carried out. There was no internal overexposure detected.

Issues of concern for 2001

Goals for the Ignalina Nuclear Power Plant for the year 2001:

- maximum individual dose shall be below 20 mSv;

- collective dose of the plant personnel shall not exceed 11.29 man·Sv. This limit is determined in the dose budget for the year 2001 and approved by the Radiation Protection Centre;
- further implementation of the ALARA principle will be continued by conducting appropriate activities, such as: management of jobs, training of personnel, improving working conditions, technological processes, strengthening of quality assurance, safety culture and avoiding human errors.

Regarding occupational exposure, the Radiation Protection Centre intends for the year 2001:

- to approve the dose budget for the coming year, including outage periods;
- to control how the requirements of legal acts are implemented at the INPP;
- to improve constantly the form and contents of performed inspection activities at the plant;
- to evaluate trends of the occupational exposure of INPP personnel and outside workers;
- to perform an evaluation of the implementation of the optimisation principle at the plant.

MEXICO

2000 Collective Dose for Laguna Verde Nuclear power plant (LVNPP), a two unit BWR with 684 MWe each.

	Dose (man·Sv)
Unit 1 total	1.34
Normal operation	0.75
Non-refuelling outage	0.59
Unit 2 total	4.32
Normal operation	0.88
Unit 2 4th refuelling outage	3.44
Average per unit	**2.83**

Main events influencing dosimetric trends /results

Unit 2 4th refuelling outage

Task	Dose (man·Sv)
Control rod drives change/maintenance	0.29
Chemical decontamination	0.28
Radiological inspections/coverage in the Drywell	0.17
Safety relief valves maintenance	0.10

The fact that the dose investment in actions intended to reduce dose (i.e. RP coverage and chemical decontamination) was high, was due to the radiological agressivety of the radiation fields in the drywell due in turn to high levels of crud inside the reactor vessel, the recirculation loops and other components related to the primary coolant system. At the end, the crud was successfully reduced by a combination of chemical decontamination of the recirculation loops and physical removal from the reactor vessel.

Unit 1 non-refuelling outage

Unit 1 had to make a 47 days outage in order to replace turbine blades as indicators suggested to make such replacement (after the reactor shutdown the inspection confirmed damaged blades). To take advantage of this outage, besides the turbine activities other jobs were made (i.e. fuel sipping to locate suspected damaged fuel elements, drywell insulation adjustments and regulatory surveillance). The collective dose for this outage was 0.59 man·Sv.

Major evolutions

By mid October 2000, an independent inspection to the LVNPP was started. Such inspection was achieved by the German company TUV, as a commitment of the Mexican government with antinuclear national and international organisations, some of them highly politicised. According to that commitment, the plant would be closed if the results of the inspection would imply that the plant is unsafe. The inspection, achieved by a team of ten experts ended by the end of January 2001. The results of this thorough, long inspection were favourable and guarantee the plant would continue in line.

LVNPP collective dose decreasing trend has been evident since 1996, and in 2000 has shown a reduction for a third consecutive year.

Component or systems replacement

As stated before, a 47 days outage that started 11 August, 2000 was devoted mainly to replace cracked blades of the high pressure turbine in Unit 1.

Dose reduction programme evolution

Zinc injection for both Units started in 1998. While Unit 1 showed good exposure reduction trends since the beginning, Unit 2 hadn't shown any improvement by the end of 1999. The reason of this was determined to be a sustained Fe concentration in the reactor feedwater of about 3 to 4 ppb plus a even higher Fe input history. So it was decided that, during that Unit 4 refuelling outage (starting 18 March, 2000), the problem of excess Iron should be remedied in order to be able to restart Zn injection under a feedwater Fe concentration of less than 2 ppb. The concrete actions were as follows:

- To find the main source or sources of Iron and make the necessary actions to eliminate or reduce it: the main source resulted to be, in agreement with LV Engineering group suggestion, the internals of the main steam reheaters (MSRs). So, a stainless steel liner was installed on selected internals of these components.

- To make a chemical decontamination of the recirculation loops, and portions of the RHR and RWCU systems.
- To remove, trough vacuum machines with submerged filters, most of the crud accumulated in the reactor vessel and the control rod drives (CRDs) housings: Twenty six spent filters were generated with a maximum and an average dose rate of 13 and 4.3 Gy/hr and a total weight of about 600 Kg. This was a 400 man-hours activity in ten days and consumed a collective dose of 0.054 man·Sv.
- During the following operating cycle, Zn injection was restarted, this time successfully, and the Fe concentration in the reactor feedwater has been quite acceptable, around 1.2 ppb.

Technical aspects for the year 2001

For year 2001 the collective dose of LVNPP is expected to increase since it will be a two refuelling outage year. An average collective dose of around 3.1 man·Sv/year Unit is expected. However the dose reduction trend is expected to be continued from year 2002 on.

NETHERLANDS

General

The Dutch electricity production market is being liberalised. Trading in electrical power has resulted in a significant increase of import contracts. Presently, an average 20% of the Dutch electricity consumption is being imported.

The Dutch policy so far was, to privatise the electricity distribution companies as well as the electricity producing companies. However, his privatisation of the distribution networks has not yet been decided upon, and the policy is being reviewed.

Nuclear Power Plant operation

The Netherlands has only two nuclear power plants: Dodewaard and Borssele.

The **Dodewaard BWR** (57 MWe), operated by GKN, was shut down in March 1997 for political and economical reasons. Political and legal difficulties have delayed removal of its fuel for reprocessing between 1997 and December 2000. The “Post Operation activities” and the project to realise a “safe enclosure” are progressing according to plan.

The transportation of used-fuel elements back to Sellafield has been resumed.

At the moment, it is expected that defuelling will be completed by the end of 2002. Afterwards, the unit will be converted in a “safe enclosure” facility, prior to final dismantling after a 40 year period.

The collective dose for the Dodewaard plant in 2000 was 318 man·mSv.

The **Borssele PWR** (449 MWe), operated by the company NV EPZ, is a baseload unit. It has enjoyed uninterrupted commercial operation after completion of a major backfitting programme in 1997.

The collective dose for the Borssele NPP in the year 2000 was 553 man·mSv.

The outage in 2000 lasted 17 days. The outage dose was 428 man·mSv, which was 9% lower than planned in advance. Eddy current inspection of both steam generators was carried out, 1 pipe was plugged. One fuel element had a leakage and was repaired during the outage. Contamination problems were experienced during the outage, mainly due to a shortage of protecting clothing, masks and shoes and due to failures made by inexperienced personnel in the nuclear laundry. Lessons learned are that shorter outages put quite some pressure on the logistics, bigger stocks are required. The plant has initiated an further investigation in order to prevent these problems in the future.

Transports of used fuel to Cogema have been resumed this year.

Presently, the company NV EPZ is shedding most of its fossil-fired generating capacity and is in the process of being shrunk to the Borssele production site only (one nuclear power unit of 449 MWe, one coal-fired unit of 405 MWe and one 20-MWe gas turbine). The new company EPZ will produce 6% of the Dutch national electricity consumption.

In December 2000, the Borssele NPP hosted a WANO Follow-up Peer Review. The WANO team noted significant progress on the recommendations made during the previous Peer Review in 1999. For ten out of the thirteen issues the team agreed that they were fully satisfied with the completion. For the other items the actions taken will be completed in the year 2001.

Next year the second 10-yearly safety review project will start in Borssele NPP.

The radiation protection standards based on the Euratom Guidelines (96/29 and 97/43) will be implemented in the Netherlands in 2001.

ROMANIA

Summary of National Dosimetric Trends

SNN-CNE PROD CERNAVODA operates a single Nuclear Power Plant of CANDU-600 type. The year of 2000 is the fourth full year of commercial operation.

For this year, the station collective dose was 466 man·mSv (including both external & internal doses), distributed over 370 exposed individuals i.e. those receiving reportable doses.

The highest individual dose was 6.85 mSv and the average dose for exposed workers was 1.25 mSv. Approximately 50 percent of exposed individuals received doses less than 1 mSv and further on less than 2 percent received doses above 5 mSv. No individual received doses above 10 mSv.

In comparison to previous years, the highest individual dose for year 2000 was lower than the highest individual doses for previous years. With respect to number of exposed workers and number of individuals receiving doses above 5 mSv, the figures are similar to previous years.

Station collective dose was comparable to the previous year. The main contribution was from annual planned outage and its extension which count for about 80% of the total collective dose of the year.

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

- steam generator inspection;
- work in feeder cabinets (swagelock replacement, tubing inspection) during the planned outage;
- feeder inspection, during the extension of planned outage.

For the following year the main projects refer to:

- improvement of contamination control at main airlock with full body monitors;
- acquire portal and vehicle monitors for security gates;
- acquire additional TLD dosimeter reader and dosimeters.

Further Information

Annual collective doses

- total effective dose: 466.2 man·mSv;
- external effective dose: 110.8 man·mSv;
- internal effective dose (due to tritium): 110.8 man·mSv;
- internal effective dose (due to other radionuclides, excluding tritium): 0.4 man·mSv.

Summary of annual dosimetric trends

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

All individual doses were below 10 mSv.

Events influencing dosimetric trends

Two planned outages (22 days, respectively 4 days) and 4 unplanned outages (2 days, 2 days, 2 days, 7 days, respectively).

Major evolutions

- The main contribution to collective dose is due to annual outage and its extension (the 2 planned outages have contributed with approximately 80% to the collective dose of year 2000).
- The annual outage included a boiler inspection.
- The new Romanian Fundamental Radiation Safety Regulation was issued in August 2000.
- The continuous increase of internal dose is due to tritium build-up in CANDU primary heat transport system and moderator system.

Issues of concern for 2001

Technical

It is necessary for the utility to prepare and submit the documentation for siting of the spent fuel dry interim storage.

Regulatory

The implementation of the new Romanian Fundamental Radiation Safety Regulation requires some modifications in the NPP reference documents regarding the training and qualification in radiation protection, including the qualification of qualified experts.

During the year 2001, a new regulation regarding radiation protection and medical surveillance of outside workers will be issued, but the impact of this regulation on the plant activity is not major, because most of the future requirements are already fulfilled by internal rules of NPP.

SLOVAK REPUBLIC

The average annual collective dose per unit and reactor type for 2000 was 831.80 man·mSv.

Bohunice Nuclear Power Plant (4 Units)

The total effective dose in Bohunice NPP in 2000 was 3238.54 man·mSv (employees 1207.49 man·mSv, outside workers 2031.05 man·mSv). The maximum individual dose was 32.11 mSv (contractor).

The reconstruction works at Unit 1 were the main contributor to the total collective dose.

Number and duration of outages

Unit 1 – 140 days standard maintenance outage with refuelling combined with reconstruction works. Total collective dose was 2475.28 man·mSv; the dose from reconstruction works created approx. 50% of the total.
Unit 2 – 39 days standard maintenance outage. Total collective dose was 277.79 man·mSv.
Unit 3 – 40 days standard maintenance outage. Total collective dose was 184.25 man·mSv.
Unit 4 – 77 days major maintenance outage. Total collective dose was 238.96 man·mSv.

Major Evolutions

The beginning of the modernisation of Units 3 and 4 (so called V2 NPP) in the field of preparation of the safety concept. The modernisation concept will also contain a certain part of RP instrumentation and will be finished approx. by 2008.

The reconstruction of Unit 1 and Unit 2 (so called V1 NPP) had been finished in 2000 with the outage at Unit 1. Main radiation risk works were performed on the same systems and parts as at the Unit 2 in the year 1999, i.e. ECCS&spray system, reactor protection system, hermetical zone, ventilation systems, antiseismic measures.

Component and system replacement

Radiation instrumentation – new fast monitor for internal contamination, upgraded whole body counter and new operational electronic personal dosimetry system was put in operation. The completion of exchanging of portal monitors at the exits from radiation controlled areas was postponed into the year 2001 due to technical problems.

Unexpected events

Exceeding of internal individual dose limit at Unit 4. The event happened during the outage at the Unit 4 when the supply firm performed the internal inspection of the reactor pressure vessel. Three persons of that firm seriously violated the NPP rules by a) putting off the assigned operational personal electronic dosimeters, b) entering the rooms without previous approval, c) performing the unauthorised works. One person of them got a monthly dose 29.48 mSv measured by legal film dosimeter. His total year's dose (obtained in different installations) was 32.66 mSv.

Expected Principal Events for the Year 2001

Plans for major works in the coming year:

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

Technical issues of concern from radiation protection point of view:

Following events in the field of modernisation of radiation instrumentation are expected: beginning of the installation of N-16 monitors for Unit 3 and 4, beginning of the installation of spectrometry system for monitoring gas releases in ventilation stacks.

Mochovce Nuclear Power Plant (2 Units)

Total collective dose for the two units was 88.65 man·mSv, maximal individual dose was 1.53 mSv.

Events Influencing Dosimetric Trends in 2000

The main contributors to the total collective dose at Mochovce NPP were planned outages and safety improvement project at Units 1 and 2.

Mochovce NPP, Unit 2 was put in commercial operation.

Number and duration of outages

Unit 1 – 15 days long planned short maintenance outage.
Unit 2 – 15 days long planned short maintenance outage

Expected Principal Events for the Year 2001

Plans for major works in the coming year

Unit 1 – 85 days major maintenance outage combined with safety measures implementation
Unit 2 – 60 days standard maintenance outage combined with safety measures implementation

Technical issues of concern from radiation protection point of view

Following events are expected in 2001 – finalising of installation of new radiation measurements – primary coolant spectrometry, N-16 monitoring, stack instrumentation, radiation accident monitoring, central radiation monitoring computer system.

SLOVENIA

Summary of National Dosimetric Trends

Radiological performance indicators of Krsko nuclear power plant for the year 2000 were: Collective radiation exposure was 2.60 man·Sv (0.546 man·mSv/GWh, per electrical output). Maximum individual dose was 20.99 mSv and average individual dose 2.30 mSv.

Events influencing dosimetric trends

Planned outage and steam generators replacement (SGR) (15.4.00-15.6.00), 62 days:

Outage collective dose was 0.71 man·Sv, steam generators replacement dose was 1.48 man·Sv, measured by electronic dosimeters. For the replacement itself the final dose was about 4% over the planned value.

One boundary condition for SGR was primary circuit dose rate, which was in the unshielded state 3 to 4 mGy/h and about 8 mGy/h when drained. Replacement time was 27.5 days.

Major evolution at Krško NPP

With steam generator replacement the power up-rate has been achieved to 707 MWe of gross power.

New training building with plant simulator was also completed in this year.

Considering radiological protection facilities the new automatic electronic dosimetry system was introduced before outage and connected to plant data base, exit from the controlled area was modernised with four portal monitors, laundry was equipped with three new washing machines and three dryers, and also new decontamination building was put into operation.

Authority considerations

The most of annual collective dose and individual effective dose at the NPP resulted from the exposure received during the annual outage.

The increase of average individual dose and collective dose was caused by on the works for plant modification and upgrade.

The IAEA peer review team has been invited to evaluate the activities performed by national dosimetric system. During this period the occupational exposure of the workforce will be reviewed in the year 2001.

SOUTH AFRICA

Summary of national dosimetric trends

During the year 2000, one thousand and eight hundred four people were occupationally exposed at Koeberg Nuclear Power Station. The total collective dose for the workforce was 0.848 man·Sv versus a target of 1 man·Sv. The average annual dose per reactor was 0.424 man·Sv. The average annual dose for the occupationally exposed workforce was 0.45 mSv. The highest individual dose was 9.44 mSv.

Events influencing dosimetric trends

Koeberg Nuclear Power Station successfully completed a refuelling outage of Unit 1 within 45 days. The refuelling outage contributed with 0.622 man·Sv, 73% of the collective dose for 2000.

Koeberg Nuclear Power Station replaced the large heat exchangers used to remove the residual heat from the primary system during the Unit 1 refuelling outage.

New/experimental dose-reduction programmes

Koeberg Nuclear Power Station has successfully implemented various dose reduction programmes. The 2000 three year average collective dose per unit for Koeberg Nuclear Power Station was 0.649 man·Sv. This was accomplished via the following dose reduction initiatives:

- strict dose management by the Koeberg ALARA team;
- introduction of formal ALARA pre-job briefings for most work which poses a radiological risk;
- lower doses during the refuelling outage than anticipated, especially with Steam Generator inspection and maintenance work;
- Improvements to radiation workers training courses and evaluation methodologies;
- introduction of a “Hot Spot” management and reduction programme.

Organisational evolution

A Corporate Radiation Protection Custodian has been appointed to help the radiation protection line functions at Koeberg with refinement of processes, strategic direction, rules and regulatory interface.

The Koeberg Radiation Protection Group has introduced dose targets for each group on the station. Managers are being held accountable for managing these dose targets in order to maintain all radiation exposures as low as reasonably achievable.

Issues of concern for 2001

Technical

The Spent Fuel Pool storage facilities will be modified during 2001 to accommodate more fuel. This task may result in an estimated collective dose of 0.04 man·Sv per unit. Two refuelling outages are planned for 2001.

Regulatory

The National Nuclear Regulator is planning to revise the format of nuclear licences issued to licensees in South Africa. The Generation Safety and Assurance Division is representing Eskom and Koeberg Nuclear Power Station during licensing discussions with the National Nuclear Regulator.

Plans for major work in the coming year

Dose assessments have been conducted for all major tasks. The dose target for 2001 at Koeberg Nuclear Power Station is set at 1.9 man·Sv.

SPAIN

In the year 2000 the **average dose per outage** has been 0.571 man·Sv for PWR (6 units) and 2.146 man·Sv for BWR (1 unit). Per plant, these collective doses are shown in the following table.

NPP	Type	Duration (days)	Coll. Doses (man·Sv)	Comments
J. Cabrera	PWR	36	0.637	
Almaraz I	PWR	25	0.787	Residual antimonium contam in primary coolant. Replacement of impeller main coolant pump.
Almaraz II	PWR	25	0.365	
Ascó I	PWR	26	0.568	
Ascó II	PWR	–	0.017	No outage.
Vandellos II	PWR	33	0.816	
Trillo	PWR	22	0.255	One main coolant pump inspection (0.061 man·Sv).
S.M Garoña	BWR	–	0.311	No outage.
Cofrentes	BWR	40	2.146	Replacement all condenser tubes. Dose rate increased in dry well.

Relating the total **annual collective dose**, the PWR average for this year is 0.59 man·Sv and the 3 year rolling average is 0.62 man·Sv.

For BWR the total collective dose average for this year is 1.47 man·Sv and the three-year rolling average is 1.48 man·Sv.

	PWR			BWR		
Year	Outages	Collective doses (man·Sv)	3 year rolling average	Outages	Collective doses (man·Sv)	3 year rolling average
1996	4	1.47		2	3.36	
1997	5	1.35		1	2.39	
1998	4	0.55	1.12	0	0.53	2.09
1999	5	0.71	0.87	2	2.45	1.79
2000	6	0.59	0.62	1	1.47	1.48

As it can be seen, in PWR the downward trend in the three year rolling average that started last year (after steam generator replacement) continues, with values in line with those of the previous years. For the yearly values the increase in 1999 was caused by the increase of the collective dose in Almaraz 1 due to the contamination of antimonium, which provoked higher radiation levels than usual. For the year 2000 the levels are similar to those of 1998, taking into account that there have been 6 outages this year instead of 4 in 1998. For BWR, there is also a downward trend in the three year rolling average, and the yearly value is lower since there has been only one unit with refuelling outage.

During this year, the outages have been normal with no special works that meant very high doses. The most important ones have been the replacement of a main coolant pump impeller in Almaraz, the inspection of a main coolant pump in Trillo (responsible for 25% of the doses) and the replacement of all the condenser tubes in Cofrentes, with a collective dose around 20 man·mSv. The increase of the dose rates measured in the drywell has produced an increase in collective doses in works such as ISI. In all the PWR plants the collective dose objective have been under 1 man·Sv. In Garoña it is interesting to point out that after the decontamination of recirculation loops in 1999, the decontamination factor has been around 10% in one year.

During the outage, Almaraz Unit II has proceeded to take out the neutron secondary source to avoid the problem they had with the antimonium released last year in Unit I, which produced much higher doses than usually.

In Trillo NPP, as the storage fuel pool is becoming filled up, a specific design of spent fuel dried storage cask, placed in a special storage building on site, is planned to be used in 2002. The cask design, for use in spent fuel storage and transport, was approved by the CSN in June 1997. Manufacturing and fabrication tests are still in process.

Decommissioning labours in Vandellos I NPP are in progress. In the year 2000 the following main activities were carried out: The 100% of the inner surface of the spent fuel pools and the water systems were removed. Works in the Conditioned Graphite Silos Sleeves building started. Scarifying of walls, ceilings and floors in the locals and zones, previously dismantled, started and radioactive wastes were sent to the repository El Cabril (operated by ENRESA) facility. The total collective dose for the whole year 2000 was around 86.9 man·mSv. No action will be taken with respect to the vessel, in which the reactor structures will remain confined without nuclear fuel and with its internals intact until completion of the dormancy period previous to the Decommissioning Level 3.

The draft of our new regulations (based on the European Directive 96/29/Euratom) is under the final administrative revision prior submittal to the Council of Ministers for its approval by the mid-year of 2001. After a period of 6 months established to adapt the practical implementations of these new requirements, they will come into force the first of January 2002. A working group with representatives of the regulatory body and the utilities has been created with the objective of developing a “Generic Radiation Protection Plan” in order to harmonise the practical criteria to be implemented and the strategies for this implementation.

In May 2000 a reorganisation of the Spanish Regulatory Body (CSN) took place splitting the former Technical Direction into a Safety and a Radiation Protection Technical Directions. This new structure aims to adapt the existing resources to the new functions (mainly in environmental radiation protection and emergencies) and to face the implications of the deregulation in electricity market.

SWEDEN

Summary of National Dosimetric Trend

The dosimetric trend is also this year kept at a reasonably low level. As result from Swedish nuclear energy production of 56.5 TWh the annual collective dose was 8.2 man·Sv. This corresponds to 8.1 man·Sv from the eleven operational nuclear reactors and 0.1 man·Sv from one permanently shutdown reactor.

Average collective dose per reactor type BWR was 0.86 man·Sv and 0.43 man·Sv for the PWR.

Average individual exposure 2.0 mSv and the highest 20.7 mSv.

All NPPs personnel dosimetry laboratories have been tested, validated and approved according to the EUR directives as outcome of the EURADOS project.

Twelve regulations issued from the Swedish authority (SSI) mainly due to implementation of EUR directives.

Events Influencing Dosimetric Trend

The total nuclear energy production for year 1999 was 72.2 TWh. The same figure for year 2000 has decreased to 56.5 TWh and that's close to 28 percent less produced energy this year. Comparing the figures for collective dose per produced energy, which for 1999 was 0.147 man·Sv/TWh and for year 2000 was 0.145 man·Sv/TWh, indicates that the source term includes one operational reactor less, the Barsebäck 1 permanently shutdown in late November 1999.

Other factors that helped keeping the collective dose on unchanged level are mentioned in descending influence order and ease to measure:

- Effects on the economical situation caused by the deregulation of the electrical market leading to decreasing monetary investments. Therefore less modifications and a more selective maintenance programme.
- Job's in high doserate areas rescheduled to be included in future modernisation projects where decontamination is planned.
- Remaining positive effects from previously decontaminations performed under the extensive modernisation projects.
- Several reactor units had prolonged outages with little or none workload in dose demanding areas.
- Reduced dose rates in the Swedish PWRs due to developed primary chemistry at start up and shutdown. Including prolonged primary water cleanup before opening the primary system enabled by early shutdown due to low power demand covering the last couple of year.
- Dose rate reduction resulting from DZO injection (only Barsebäck 2).

- Stronger efforts put into the dose reduction programmes developed by the operational and maintenance departments, supervised by the health physics board.
- Continuing developing guidance through the general HP criteria of the maintenance ALARA organisations.

New Plants on Line/plants shutdown

Barsebäck unit 1 is permanently shutdown and the organisation reconstructed to take care of the plant decommissioning.

There is a political decision to close Barsebäck unit 2 before year 2003.

Unexpected Events

Indications on material fatigue discovered in the reactor vessel nozzle on the PWRs.

Plans for Major Work in Coming Year

- Continuing modernisation programme of the elderly reactor units.
- Research programme started addressing decontamination of BWR fuel.
- Studies on the effect of low power demands on DZO injection showing temperature and crud increase on residual and heat removal system.

SWITZERLAND

Dosimetric trends (1999 data are shown in brackets)

In 2000, the 3203 (3840) occupationally exposed persons concerned in four sites with five nuclear power reactors accumulated 3.05 (4.48) man·Sv effective dose. The maximum registered individual effective dose amounted to 15.9 mSv. No individual effective dose above 20 mSv has been registered since 1994. The mean individual doses varied between 0.6 and 1.5 mSv being generally somewhat higher for plant personnel compared to contract personnel.

Events influencing dosimetric trends

Aspects that helped to reduce the dose load at the plants:

- low work load during outages in all Swiss plants in 2000;
- efforts to shorten outage lengths in all Swiss plants;
- generally good fuel behaviour in all Swiss plants in 2000.

Number and duration of outages

All plants except KKB 1 (Beznau) and KKB 2 had normal refuelling/inspection outages of roughly three weeks duration. KKB 1 had an outage of roughly 1.5 months duration due to an upgrade of the reactor safety system and KKB 2 had a two week refuelling outage.

New plants on line/plants shut down

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

Major evolutions

KKL (Leibstadt) realised in 2000 12% of the permitted 14.7% power increase with the expected, slightly over proportional influence of the power increase on plant dose rates mainly due to N-16. No negative influence on outage doses could be observed.

Components or system replacements, safety related issues, unexpected events

KKM (Muehleberg) started noble metal coating and after the regular outage hydrogen injection. Increased plant dose rates up to 60% of permitted limits have been observed.

New/experimental dose reduction programmes

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

Issues for 2001

Issues of concern

The economical liberalisation of the electric power market is partially reflected in personnel reduction programmes increasing the individual work load. Furthermore, outages are concentrated during July and August, possibly leading to shortages of qualified manpower. These developments have to be closely monitored by the authority.

Technical issues

As a lead site, KKB 1999 went back from 18 month cycles to a so called hybrid cycle (one full inspection/refuelling outage followed by a refuelling outage only). KKM (Muehleberg) and KKL (Leibstadt) will follow with similar schemes.

Regulatory issues

Reorganisation of the Swiss authority in order to achieve a process oriented work scheme with quality management tools that will be certified at the end of the year 2001.

Plans for major work in 2001

In KKB 2, an upgrade of the reactor safety system is planned. No other work with a significant additional dose load are planned at the Swiss plants in 2001.

UKRAINE

Summary of national dosimetric trends

For the year 2000, the total collective dose and the average annual individual dose are shown in the following table, compared to the previous year.

NPP Name (number of reactors)	Annual collective dose (man·mSv/year)		Average annual individual dose (mSv/year)		Individual dose relative to 1999 %
	1999	2000	1999	2000	
Zaporozhe (6)	3 784.7	4 365.8	0.81	0.91	112
Rovno (3)	4 240.7	4 776.3	1.33	1.13	85
South-Ukraine (3)	8 613.1	8 308.8	3.23	3.09	96
Khmelnitsky (1)	1 634.3	2 455.0	0.8	1.19	146
Chernobyl (1)	37 028.2	21 355.0	5.4	2.98	55

The overall collective dose for the year 2000 has decreased by 25% in comparison with the previous years; however, for the WWER reactors (Khmelnitsky , Rovno, South-Ukraine, Zaporozhe), there is an increase by 8.9%.

The average annual collective dose for WWER reactors is given in the following table:

Reactor Type	Number of Reactors	Total Collective Dose (man·Sv)	Collective dose per Reactor (man·Sv)
WWER	13	19.90	1.53

Events influencing dosimetric trends

Chernobyl – NPP was closing, absence of long term outages has reduced a collective dose and individual dose accordingly.

Khmelnitsky NPP – series of exposure related and maintenance operations during outage resulted in increase of collective and individual doses.

Zaporozhe NPP – major repairs at Unit 1 and planned repairs at all six units (only 5 units were operating in 1999) resulted in a dose increase.

Rovno NPP – longer duration of repairs at Unit 3, additional works at Steam Generators at Unit 2 has led to an increase of collective and individual doses.

New plants on line/plants shut down

On 15 December 2000, the last unit in operation at Chernobyl NPP was shut down. The plant will be decommissioned. Rovno 4 and Khmelnitsky 2 are to be completed.

Safety-related issues

NRBU–97/D2000 (a supplement to NRBU-97) was entered in force in the middle of 2000. This standard introduces a concept of potential exposure and regulates probabilities of critical events connected to exposure. It also defines three basic principles of radiation protection with reference to potential exposure:

- Principle of correctness – practical activities that may lead to exposure should not be realised if it does not bring more advantages to persons exposed and the public than the harm it causes now and in future in connection with a possible critical event.
- Principle of no excess – practical activities (under sanitary regulation) of all kinds should not result in exceeding of dose values and potential exposure probabilities, which are regulated by NRBU-97
- Principle of optimisation (ALARA) – critical event probabilities and doses of potential exposure (and number of persons involved) should be as low as reasonably achievable for economic and social factors.

Those principles are to be used in practical activities planning.

3. ISOE PROGRAMME OF WORK

3.1 Achievements of the ISOE Programme in 2000

Renewal of Participation in ISOE

In the beginning of 2000, all members of the ISOE programme renewed their participation in ISOE for another period of four years. With the renewal of participation in ISOE, the revised ISOE Terms and Conditions will be valid for this period of four years, ending 31 December 2003.

Renewal of the ISOE Working Groups

At its last meeting, the ISOE Steering Group approved the Terms of Reference for the ISOE Working Group on Data Analysis as well as for the ISOE Working Group on Software Development to be valid for another period of two years. ISOE participants reviewed their representation in these working groups and nominated new members or approved the existing membership (see Annex 3).

Status of participation

As of December 2000, the ISOEDAT database includes occupational exposure data from a total of 452 reactors (398 operating and 54 in cold-shutdown or some stage of decommissioning) from 28 countries representing 72 utilities. In addition, regulatory authorities from 25 countries participate in the ISOE Programme. The participation of 398 operating commercial nuclear reactors in the ISOE programme represents some 92% of the World's operating commercial nuclear reactors (total of 433).

All European operating reactors are participating in the ISOE System. As of September 2000 participation in the ISOE through the IAEA includes twelve utilities (representing 45 operating reactors) in Armenia, Brazil, China, Lithuania, Romania, Russian Federation, Slovakia, Slovenia, South Africa and Ukraine and nine regulatory authorities in Armenia, Bulgaria, China, Lithuania, Pakistan, Romania, Slovakia, Slovenia and South Africa.

During 2000, Russia joined the ISOE Programme with 14 operating reactors (13 VVER and one fast breeder reactor) and 4 reactors in cold-shutdown or some stage of decommissioning. In addition, the Slovakian nuclear power plant Mochovce joined the ISOE programme with 2 units. The regulatory authorities from Lithuania and South Africa now also participate in ISOE.

Data collection and management

Collection of ISOE 1 data using the new ISOE data input module.

For the first time, ISOE participants used the new ISOE Input module ISOEDAT under ACCESS for 1999 data collection. This new software was sent to the participants after approval by the Working Group on Software Development only in May 2000. The delay was caused by the extended quality assurance procedure.

Data release

All the ISOE 3 Questionnaires under ASPIC were sent to the participants in May 2000.

At the beginning of August 2000, the ISOEDAT database with data from 1969 to 1999 was sent together with the Version 3.2 of MADRAS Interface programme to the European participants and to the other Regional Technical Centres for distribution. A second release including the Asian data was sent in October 2000 (Version 3.3).

Database and interface programme were provided on CD-ROM in ACCESS 97, ACCESS 2000 and in a run-time version of ACCESS 97.

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

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

Collection of ISOE 3 data, once the input module has been developed.

The planning and structuring of the input module to collect ISOE 3 data has been started.

Documents and Reports

ISOE Annual Report 1999 – The report has been published and distributed in October 2000.

Information Sheets issued in 2000, as planned during the ISOE Steering Group meeting in October 1999:

Yearly analyses		**Sheet**	**Issued**
1	Japanese dosimetric results: FY 1999 data and trends	ATC No. 13	September 2000
2	Preliminary European dosimetric results for 1999	ETC No. 23	June 2000
3	Preliminary dosimetric results for 1999	IAEATC No. 5	September 2000
Special analyses		**Sheet**	**Issued**
1	Japanese occupational exposure during periodical inspection at LWRs ended in FY 1999 Outage Time Reduction, Fuel Cycle length vs. Total	ATC No. 14	September 2000
2	Annual Dose Analysis of the evolution of collective dose related to insulation jobs in some European PWRs	ETC No. 22	May 2000

Additional Studies:

Special analyses		Sheet	Issued
1	Investigation on access and dosimetric follow-up rules in nuclear power plants for foreign workers	ETC No. 21	May 2000
2	List of BWR and CANDU sister unit groups	ETC No. 24	June 2000
3	Conclusions and recommendations from the 2nd EC/ISOE workshop on occupational exposure management at nuclear power plants	ETC No. 25	June 2000

International ISOE Workshop on occupational exposure in nuclear power plants

Organisation of the 2000 International ISOE ALARA Symposium, 4-7 April 2000, Tarragona (Spain)

Organisation of the 2000 North American Regional ALARA Symposium, 23-27 January 2000, Orlando, Florida (USA)

Data analysis

The IAEA financed the review of information in ISOE D and reconsideration of the questionnaire content. This led to the introduction of the new ISOE D questionnaire in the new ISOE data input module.

As the ISOE System reaches its 10th anniversary, the programme collected numerous results, studies, experiences, trends etc. in the arena of occupational exposure. In order to promote further the ISOE system and to demonstrate its value for applied radiation protection in nuclear power plants, the idea was born to summarise the results of and experience with ISOE in a “Report on 10 years of ISOE”. A proposal for this product was given to the ISOE Steering Group at its meeting 8-10 November 2000. The further preparation will be discussed in the Working Group on Data Analysis.

ISOE 3 Questionnaire

The WGDA together with the WGSD reviewed current content and information management of the ISOE 3 database. The development of a new retrieval-structure was proposed.

The ETC has prepared a proposal for the development of the ISOE 3 Questionnaire under ACCESS following the recommendations issued at the Bureau meeting at Tarragona in April 2000. The ETC made a survey among the ISOE participants in order to better know what are the criticisms concerning the current ISOE 3 questionnaire under ASPIC and what are the needs of the participants. A synthesis of this survey was discussed at the WGDA and WGSD meeting in Vienna, 6-7 November 2000. The results are currently being implemented.

Software development

ISOE 1 Questionnaire

The ETC has continued to develop and improve the ISOE 1 Questionnaire input module:

- the questionnaire was translated into German, French and Spanish. The IAEA in collaboration with ETC is working on a Russian translation. Any translation of the questionnaire is easily implemented in the software;
- a new column "Reason for work" has been added to Table E (Dose per Job): for each task, one or several sub-tasks may now be created for a task; a WGSD proposal of a new list of tasks (not sorted by job, for the moment) is displayed in pull-down menu.

Data collection and retrieval software under Japanese environment was modified to accommodate to the change in ISOE 1 database structure.

MADRAS

The MADRAS interface software was improved by the creation of six new push-buttons allowing the participants to perform comparative analysis at the level of the reactor (on annual collective dose, on dose per Job or on dose per occupational category). These push-buttons can be used to generate the statistical contents of the ISOE Plant Dossier.

ISOE 2 Questionnaire

The new ISOE 2 Questionnaire shape has been validated by the ISOE Working Groups. It has then been asked to the national co-ordinators to complete one ISOE 2 Questionnaire for PWR and one for BWR as a trial. The answers received have been used as a test database by the ETC.

The ETC in collaboration with the Working Group on Software Development (WGSD) is currently developing the implementation of the ISOE 2 questionnaire into the ISOE database. The objective is to create a combined ISOE 1 and ISOE 2 database within ISOEDAT. A document describing the specification of database structure of ISOE 2 was discussed at the WGSD meeting in Vienna.

Web pages

ISOE Web information at the NEA's, IAEA's and ISOE Technical Centres' web sites is co-ordinated, continuously maintained and regularly updated by the Joint Secretariat and the Technical Centres.

The accessible web pages are:

ATC	http://www.nupec.or.jp/isoe/
ETC	http://isoe.cepn.asso.fr
IAEATC	http://www.iaea.org.ns/rasanet
NATC	http://hps.ne.uiuc.edu
NEA	http://www.nea.fr/html/jointproj/isoe.html

3.2 Proposed programme of work for 2001

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

Status of participation

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

Data collection and management

- Promotion of the preparation of ISOE 3 reports;
  - Implementation of the agreed structure and content of the ISOE 3 reports in the ISOEDAT database under Microsoft ACCESS;
  - Improvement of collaboration and synergy with WANO;
  - Commitment of National co-ordinators to organise the preparation and inclusion of at least a few ISOE 3 reports into the system;
  - The best ISOE 3 reports will be awarded each year at the annual ISOE ALARA Workshop.
- Reorganisation and collection of ISOE 2 data, using the new ISOE data input module;
- Collection of ISOE 1 data for the year 2000;
- Provision, on request, of Excel files with specific data to National co-ordinators in order to help them to prepare the national ISOE nuclear power plant dossier.
- Issuance of two updates of the ISOEDAT database and distribution in June 2001 and September 2001

Documents and Reports

ISOE Annual Report 2000 – Objective to publish the report in September 2001

Information Sheets planned for 2001:

Yearly analyses		Technical Centre
1	Asian dosimetric results: 2000 data and trends	ATC
2	Preliminary European Dosimetric Results for the year 2000 (general distribution)	ETC
3	Preliminary Dosimetric Results for the year 2000	IAEATC

Special analyses		Technical Centre
1	Asian occupational exposure during periodic inspection outages	ATC
2	Analysis on dosimetric control by reactor group in Japan	ATC
3	Analysis of the vessel head replacement – update (general distribution)	ETC
4	Survey on neutron doses (general distribution)	ETC
5	Steam generator analysis – update (general distribution)	ETC
6	Partial replacements of the Residual Heat Removal system piping in France	ETC
7	Dose constraints	NEA
8	Status of decommissioning data in the ISOEDAT database	ETC and NEA
9	Trends in doses per job for different sister unit groups	ETC
10	Standardisation of dose rate measurements in VVER reactors	IAEATC
11	Control rod drive maintenance dose trends at BWR	NATC
12	Dose trends with motor operated valves at CANDU plants	NATC
13	Radiation protection outage staffing	NATC

International ISOE Workshop on occupational exposure in nuclear power plants

The organisation of the third EC/ISOE Workshop in Slovenia will begin in 2001 with the constitution of the Programme Committee, selection of the dates for the Workshop, and organisation of Programme Committee meetings.

Data analysis

Preparation and publication of a report on **"Ten years of ISOE"**. As the ISOE System reaches its 10th anniversary, the programme collected, analysed and discussed numerous results, studies, experiences, trends etc. in the arena of occupational exposure. In order to promote further the ISOE System and to demonstrate its value for applied radiation protection in nuclear power plants, this report should summarise the experience and achievements of ISOE in the last ten years. The outline and content of this report will be drafted by a small drafting group consisting of one or two radiation protection managers, representatives of the Technical Centres and the Joint Secretariat. The preparation of this report will be performed under the auspices of the ISOE Working Group on Data Analysis. Publication is foreseen in the year 2002.

Preparation of a **"Dose index**" application study under the auspices of the ISOE Working Group on Data Analysis.

Software development

Development of the approved ISOE 3 input module under ACCESS and creation of the corresponding ISOE 3 database.

The ISOE 1 input module will be further improved by providing additional translations.

Further improvement of the MADRAS software by implementing new push-buttons.

After the development of the new questionnaires in ISOEDAT and of MADRAS, the ETC is planning to organise training sessions in the different European countries on request in order to meet the user's needs.

Finalisation of the development of the ISOE 2 Questionnaire under ACCESS following the recommendations of the Working Group on Software Development (WGSD).

Further Topics of Interest

Topic	Further action
Official Dosimetry: Electronic vs. TLD. Active vs. Passive	
Optimisation and training in RP	
External companies responsibilities in optimisation	
Deregulation and optimisation	The debate during the ISOE Steering Group meeting in November 2000 will be summarised and distributed to ISOE participants
Application of the new ICRP 60 dose limit	Survey by CEPN and NRPB, which will be published in the European ALARA Newsletter, Spring 2001
Criteria for the calculation of collective dose (reporting level)	

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Annex 1

LIST OF ISOE PUBLICATIONS

Reports

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

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

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

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

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

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

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

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

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

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

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
European Technical Centre	
No. 1, April 1994	Occupational Exposure and Steam Generator Replacement
No. 2, May 1994	The influence of reactor age and installed power on collective dose: 1992 data
No. 3, June 1994	First European Dosimetric Results: 1993 data
No. 4, June 1995	Preliminary European Dosimetric Results for 1994
No. 6, April 1996	Overview of the first three Full System Decontamination
No. 7, June 1996	Preliminary European Dosimetric Results for 1995
No. 9, December 1996	Reactor Vessel Closure Head Replacement
No. 10, June 1997	Preliminary European Dosimetric Results for 1996
No. 11, September 1997	Annual individual doses distributions: data available and statistical biases
No. 12, September 1997	Occupational exposure and reactor vessel annealing
No. 14, July 1998	PWR collective dose per job 1994-1995-1996 data (restricted distribution)
No. 15, September 1998	PWR collective dose per job 1994-1995-1996 data (general distribution)
No. 16, July 1998	Preliminary European Dosimetric Results for 1997 (general distribution)
No. 17, December 1998	Occupational Exposure and Steam Generator Replacements, update (general distribution)
No. 18, September 1998	The Use of the man-Sievert monetary value in 1997 (general distribution)

European Technical Centre	
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
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
North American Technical Centre	
No. 1, July 1996	Swedish Approaches to Radiation Protection at Nuclear Power Plants: NATC site visit report by Peter Knapp

ISOE Topical Session Reports

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

ISOE International Workshop Proceedings

North American Technical Centre	
March 1997, Orlando, Florida, USA	First International ALARA Symposium
January 1999, Orlando, Florida, USA	Second International ALARA Symposium
January 2000, Orlando, Florida, USA	North-American National ALARA Symposium
February 2001, Anaheim, California, USA	Third International ALARA Symposium
European Technical Centre	
September 1998, Malmo, Sweden	First EC/ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants
April 2000, Tarragona, Spain	Second EC/ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants

Annex 2

ISOE PARTICIPATION AS OF DECEMBER 2000

Operating Reactors

Country	Utility	Plant Name
Armenia	Armenian (Medzamor) NPP	Armenia 2
Belgium	Electrabel	Doel 1, 2, 3, 4 Tihange 1, 2, 3
Brazil	Electronuclear A/S	Angra 1
Canada	Ontario Hydro/Ontario Power Generation Hydro Quebec New Brunswick Electric Power Company	Bruce A1, A2, A3, A4, Bruce B5, B6, B7, B8 Pickering A1, A2, A3, A4 Pickering B5, B6, B7, B8 Darlington 1, 2, 3, 4 Gentilly 2 Point Lepreau
China	Guangdong Nuclear Power Joint Venture Co., Ltd Qin Shan Nuclear Power Co	Guangdong 1, 2 Qin Shan 1
Czech Republic	CEZ	Dukovany 1, 2, 3, 4
Finland	Fortum Power and Heat Oy Teollisuuden Voima Oy	Loviisa 1, 2 Olkiluoto 1, 2
France	Électricité de France	Belleville 1, 2 Blayais 1, 2, 3, 4 Bugey 2, 3, 4, 5 Cattenom 1, 2, 3, 4 Chinon B1, B2, B3, B4 Chooz B1, B2 Civaux 1 Cruas 1, 2, 3, 4 Dampierre 1, 2, 3, 4 Fessenheim 1, 2 Flamanville 1, 2 Golfech 1, 2 Gravelines 1, 2, 3, 4, 5, 6 Nogent 1, 2 Paluel 1, 2, 3, 4 Penly 1, 2 Saint-Alban 1, 2 Saint Laurent B1, B2 Tricastin 1, 2, 3, 4

Country	Utility	Plant Name
Germany	Energie-Versorgung BadenWürttemberg (EnBW)	Obrigheim Philippsburg 1, 2
	E.On	Grafenrheinfeld Isar 1 Isar 2 Brokdorf Grohnde Stade Unterweser
	Neckarwerke AG, TWS Stuttgart	Gemeinschafts – Kernkraftwerk Neckar, Neckarwestheim (GKN) 1, 2
	Hamburgische Elektrizitäts-Werke AG (HEW)	Brunsbüttel
	HEW and PE	Krümmel
	RWE Power	Biblis A, B Mülheim-Kärlich Gundremmingen B, C Emsland
Hungary	Magyar Vilamos Muvek Rt	Paks 1, 2, 3, 4
Japan	Hokkaido Electric Power Co.	Tomari 1, 2
	Touhoku Electric Power Co.	Onagawa 1, 2
	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

Country	Utility	Plant Name
Korea	Korean Electric Power Corp.	Wolsong 1, 2, 3, 4 Kori 1, 2, 3, 4 Ulchin 1, 2, 3 Yonggwang 1, 2, 3, 4
Lithuania	Ignalina Nuclear Power Plant	Ignalina 1, 2
Mexico	Comisiòn Federal de Electricidad	Laguna Verde 1, 2
Netherlands	N.V. EPZ	Borssele
Romania	Societatea Nationala Nuclearelectrica	Cernavoda 1
Russian Federation	Rosenergoatom	Balakovo 1, 2, 3, 4 Beloyarsky 3 Kalinin 1, 2 Kola 1, 2, 3, 4 Novovoronezh 3, 4, 5
Slovakia	Jaslovské Bohunice NPP Slovenske Electrarna	Bohunice 1, 2, 3, 4 Mochovce 1, 2
Slovenia	Krsko Nuclear Power Plant	Krsko 1
South Africa	ESKOM	Koeberg 1, 2
Spain	UNESA	Almaraz 1, 2 Asco 1, 2 Cofrentes Santa Maria de Garona Trillo Vandellos 2 Jose Cabrera
Sweden	Barsebäck Kraft AB Forsmarks Kraftgrupp AB OKG AB Vattenfall 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

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

Definitively Shutdown Reactors

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

PARTICIPATING REGULATORY AUTHORITIES

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

ISOE TECHNICAL CENTRES

European Region (ETC)	Centre d'étude sur l'évaluation de la protection dans le domaine nucléaire (CEPN), Fontenay-aux-Roses, France
	http://isoe.cepn.asso.fr
Asian Region (ATC)	Nuclear Power Engineering Corporation (NUPEC), Tokyo, Japan
	http://www.nupec.or.jp/isoe/
IAEA Region (IAEATC)	International Atomic Energy Agency (IAEA), Vienna, Austria Agence Internationale de l'Energie Atomique (AIEA), Vienne, Autriche
	http://www.iaea.org/ns/rasanet/programme/ radiationsafety/ radiationprotection/isoe/ techcentreact.htm
North American Region (NATC)	University of Illinois, Champagne-Urbanna, Illinois, U.S.A.
	http://hps.ne.uiuc.edu

INTERNATIONAL COOPERATION

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

COUNTRY – TECHNICAL CENTRE AFFILIATIONS

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

Annex 3

ISOE BUREAU AND CONTACT INFORMATION

Bureau of the ISOE Steering Group

Mr. Borut Breznik (Chairman) Radiation Protection Department, Krsko NPP Vrbina 12 SI-8270 Krsko Slovenia	Tel: + 608 242 287 Fax: + 608 21 528 E-mail: borut.breznik@nek.si
Mr. Carl Göran Lindvall (Chairman Elect) Barsebäck Kraft AB Box 524 S-246 25 Löddeköpinge Sweden	Tel: + 46 72 40 00 Fax: + 46 72 45 80 E-mail: carl-goran.lindvall@ barsebackkraft.se
Mr. Pio Carmena Servert (Past-Chairman) Subdirección Nuclear ENDESA Generación,S.A. Principe de Vergara 187 28002 Madrid Spain	Tel: +34 91 213 1426 Fax: +34 91 213 1668 E-mail: pcarmena@endesa.es
Ms. Cheryl Trottier (Vice-Chairperson) Branch Chief, Research Division U.S. Nuclear Regulatory Commission Mail Stop T-9-F-31 Washington, D.C. 20555 United States	Tel: +1 (301) 415 62 32 Fax: +1 (301) 415 53 85 E-mail: cat1@nrc.gov

ISOE Joint Secretariat

Dr. Monica Gustafsson International Atomic Energy Agency Division of Radiation and Waste Safety P.O. Box 100 A-1400 Wien Austria	Tel: +43 1 2600 22725 Fax: +43 1 2600 7 E-mail: M.Gustafsson@iaea.org
Dr. Stefan Mundigl OECD Nuclear Energy Agency 12, boulevard des Iles F-92130 Issy-les-Moulineaux France	Tel: +33 1 45 24 10 45 Fax: +33 1 45 24 11 10 E-mail: mundigl@nea.fr

ISOE Technical Centres

Asia

Naoyuki MURATA
Plant Operation Evaluation Div.,
Safety Information Research Center
Fujitakanko-Toranomon Bldg. 8th Fl.,
3-17-1 Toranomon, Minato-ku,
TOKYO 105-0001
Japan

Tel: +81 (3) 3425 3406
Fax: +81 (3) 3435 3410
E-mail: isoe-atc@nupec.or.jp

Europe

Dr. Christian Lefaure
European Technical Centre (ETC)
CEPN
B.P. 48
F-92263 Fontenay-aux-Roses Cedex
France

Tel: +33 1 46 54 79 08
Fax: +33 1 40 84 90 34
E-mail: lefaure@cepn.asso.fr

IAEA Countries

Dr. Seong Ho Na
IAEA Technical Centre (IAEATC)
International Atomic Energy Agency
Division of Radiation and Waste Safety
P.O. Box 100
A-1400 Wien IAEA
Austria

Tel: +43 1 2600 22716
Fax: +43 1 2600 7
E-mail: s.na@iaea.org

North America

Dr. D.W. MILLER
NATC Regional Coordinator
University of Illinois at
Urbana-Champaign
103 S. Goodwin Avenue
Urbana, Ill 61801
United States

Tel: +1 (217) 333 1098
Fax: +1 (217) 333 2906
E-mail: dwmphd@aol.com

ISOE Working Groups

ISOE Working Group on Data Analysis

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

ISOE Working Group Software Development

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

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