Radiation Protection

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Occupational Exposures at Nuclear Power Plants

OECD Nuclear Energy Agency
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ISOE

INFORMATION SYSTEM ON OCCUPATIONAL EXPOSURE

Thirteenth Annual Report of the ISOE Programme, 2003

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NEA No. 5414

NUCLEAR ENERGY AGENCY
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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NUCLEAR ENERGY AGENCY

The OECD Nuclear Energy Agency (NEA) was established on 1st February 1958 under the name of the OEEC European Nuclear Energy Agency. It received its present designation on 20th April 1972, when Japan became its first non-European full member. NEA membership today consists of 28 OECD member countries: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, the Netherlands, Norway, Portugal, Republic of Korea, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The Commission of the European Communities also takes part in the work of the Agency.

The mission of the NEA is:

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

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

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

FOREWORD

Throughout the world, occupational exposures at nuclear power plants have been steadily decreasing for over a decade. Increased focus on plant operational procedures and work-management practices, improved water chemistry, regulatory pressures, particularly after the issuance of ICRP Publication 60 in 1990, and technological advances 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 augmenting scheduling and budgetary pressures on 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) has co-sponsored 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, and cost-benefit and other analyses promoting the application of the ALARA principle.

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EXECUTIVE SUMMARY

This Thirteenth Annual Report of the ISOE Programme, 2003 represents the status of the ISOE Programme at the end of December 2003.

The ISOE database currently includes information on occupational exposure levels and trends at 471 reactor units (399 operating and 72 in cold-shutdown or some stage of decommissioning) operated by 70 utilities in 29 countries. This database thus covers 91% of the total number of power reactors (439) in commercial operation throughout the world. In addition, the regulatory authorities of 26 countries participate actively in ISOE. During 2003, the Pakistan Atomic Energy Commission joined ISOE with two reactors (Chasnupp 1, a 300 MW(e) PWR, and Kanupp, a 125 MW(e) PHWR). In addition, the State Nuclear Regulatory Committee of Ukraine joined the ISOE

For more than ten years, the ISOE Programme facilitates and supports the optimisation of worker doses in nuclear power plants through a communication and experience exchange network for radiation protection managers of nuclear power plants world wide, and through the development and publication of improved work management procedures. In 2003, the average annual dose reached a fairly low level with a slight decreasing trend to 0.87 man·Sv for pressurised water reactors (PWR), 1.77 man·Sv for boiling water reactors (BWR), 1.10 man·Sv for CANDU reactors, and 4.27 man·Sv for LWGRs (RBMK).

In addition to information on operating reactors, the ISOE database contains dose data from 72 reactors which are shutdown or in some stage of decommissioning. As the reactors represented in the database are of different type and size, and are, in general, at different phases of their decommissioning programmes, it is very difficult to identify clear dose trends and to draw definitive conclusions.

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

The 2003 International ALARA Symposium was held from the 12-15 January 2003, in Orlando, Florida (US). The Symposium, with the theme "Radiological Work Management Techniques during Shortened Refuelling Outages", was organised by the North American Technical Centre, and provided a global forum to promote the exchange of ideas and management approaches to maintaining occupational radiation exposures "as low as reasonably achievable (ALARA). The Symposium was sponsored by the North American Technical Centre (NATC), the OECD/NEA and the IAEA. The European Technical Centre held the 4th ISOE European Workshop on Occupational Exposure Management at NPPs from the 24-26 March 2004, in Lyon, France. The international and broad participation in both these workshops shows the interest in optimisation of radiation protection and occupational exposure issues.

Recent developments and principal events in ISOE participating countries are summarised in Section 2.5 of this report. Details of the continued growth of the ISOE Programme, as well as the programme of work for 2004 are provided in Chapter 3.

SYNTHÈSE DU RAPPORT

Le douzième rapport annuel du Programme ISOE a pour objet de faire le point sur l'avancement de ce programme à fin décembre 2003.

À cette date, la base de données ISOE comportait les données concernant les expositions professionnelles de 471 réacteurs nucléaires situés dans 29 pays et appartenant à 70 exploitants. Elle couvre ainsi près de 91 % des réacteurs commerciaux en fonctionnement dans le monde (439 réacteurs). Les autorités de 26 pays participent également au Programme ISOE. En 2003, la Commission de l'énergie atomique du Pakistan a adhéré au Système international sur la radioexposition professionnelle (ISOE) avec deux réacteurs [Chasnupp 1, un REP de 300 MW(e), et Kanupp, un RELP de 125 MW(e)]. Le Comité de la réglementation nucléaire d'État de l'Ukraine a également fait son entrée dans l'ISOE.

Depuis plus de dix ans, le Programme ISOE facilite et améliore l'optimisation de la radioprotection des travailleurs dans les centrales nucléaires grâce à la communication et au réseau d'échanges de retour d'expérience entre les *responsables* de la radioprotection des centrales nucléaires du monde entier, mais également grâce au développement et à la publication de bonnes pratiques en matière d'organisation du travail. En 2003, la dose collective moyenne par tranche présente une légère tendance à la baisse par rapport aux années précédentes, atteignant ainsi un niveau assez bas de 0,87 H.Sv pour les réacteurs à eau pressurisée (REP), 1,77 H.Sv pour les réacteurs à eau bouillante (REB), 1,10 H.Sv pour les réacteurs CANDU et 4,27 H.Sv pour les LWGR (RBMK).

Par ailleurs, la base de données ISOE contient également des données de dose collective de 72 réacteurs en arrêt à froid ou en phase de démantèlement. Étant donné que les réacteurs présents dans la base de données sont de types et de puissances très différents et sont, en général, à des stades différents de leur programme de démantèlement, il est très difficile de mettre en évidence des tendances sur l'évolution des expositions et d'en tirer des conclusions.

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

Le Symposium international ALARA s'est tenu du 12 au 15 janvier 2003 à Orlando, Floride, (États-Unis). Le Symposium, qui avait pour thème les techniques de gestion des travaux sous rayonnement pendant les arrêts de tranches pour simple rechargement, a été organisé par le North American Technical Centre et a fourni une cadre de portée mondiale pour échanger des idées et des méthodes de gestion visant à maintenir les radioexpositions professionnelles au niveau le plus bas que l'on peut raisonnablement atteindre (ALARA). Le Symposium était patronné par le North American Technical Centre (NATC), l'OCDE/AEN et l'AIEA. Le Centre technique européen a organisé le 4ème Atelier européen de l'ISOE sur la gestion de l'exposition professionnelle dans les centrales nucléaires du 24 au 26 mars 2004 à Lyon, France. Le nombre des participants et la diversité des pays représentés à ces deux manifestations attestent l'intérêt que suscitent les questions liées à l'optimisation de la radioprotection et à l'exposition professionnelle.

Les évolutions récentes et les événements saillants intervenus dans les pays qui participent à l'ISOE sont récapitulés dans la section 2.5 du présent rapport. On trouvera dans le chapitre 3 une description détaillée de l'essor continu du Programme de l'ISOE, ainsi que le programme de travail pour 2004.

ZUSAMMENFASSENDE ÜBERSICHT

Der dreizehnte ISOE Jahresbericht 2003 gibt den Stand des ISOE Programmes Ende Dezember 2003 wieder.

Die ISOE Datenbank enthält zur Zeit Daten zur beruflichen Strahlenexposition in insgesamt 471 Kernkraftwerken (399 Anlagen in Betrieb und 72 stillgelegte Anlagen) von 70 Energieversorgungsunternehmen aus 29 Ländern. Diese Datenbank deckt damit 91% der weltweit in Betrieb befindlichen kommerziellen Kernkraftwerke (439) ab. Außerdem nehmen die Genehmigungs- und Aufsichtsbehörden aus 26 Ländern aktiv am ISOE Programm teil. Im Jahr 2003 trat die Atomenergiekommission Pakistans mit einem Druckwasserreaktor (Chasnupp 1, 300 MWe) und einem CANDU Reaktor (Kanupp, 125 MWe) dem ISOE Programm bei.

Seit mehr als zehn Jahren trägt das ISOE Programms dazu bei, die berufliche Strahlenexposition in Kernkraftwerken durch ein Kommunikations- und Erfahrungsaustauschnetzwerk zwischen Strahlenschutzexperten der Kernkraftwerke weltweit, sowie durch die Entwicklung und Veröffentlichung verbesserter Arbeitsmanagementverfahren, zu optimieren. Im Jahr 2003 erreichte die mittlere jährliche Kollektivdosis pro Reaktor, bei leichtem Abwärtstrend, ein vergleichsweise niedriges Niveau von 0,87 man·Sv für Druckwasserreaktoren (DWR), 1,77 man·Sv für Siedewasserreaktoren (SWR), 1,10 man·Sv für CANDU Reaktoren und 4,27 man·Sv für Leichtwassergekühlte Graphitmoderierte Reaktoren (LWGR bzw. RBMK Reaktoren).

Zusätzlich zu den Daten für in Betrieb befindliche Reaktoren enthält die ISOE Datenbank auch Dosiswerte von Arbeiten an 72 stillgelegten Reaktoren. Da sich die in der Datenbank vertretenen Reaktoren sehr stark in Typ und Leistung unterscheiden und sich zudem in unterschiedlichen Phasen ihrer Stilllegungs- oder Rückbauprogramme befinden, ist es zur Zeit noch schwierig Dosistrends zu identifizieren oder definitive Schlussfolgerungen zu ziehen.

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

Vom 12. bis 15. Januar 2003 fand das internationale ALARA Symposium in Orlando, Florida (US) statt. Das Treffen zum Thema „Strahlenschutz – Arbeitstechniken bei verkürzten Revisionszeiten" wurde vom Nordamerikanischen Technischen Zentrum (NATC) organisiert und bildete ein umfassendes Forum zur Förderung des Erfahrungs- und Gedankenaustausches im Sinne eines optimierten Strahlenschutzes „As Low As Resonably Achievable" (ALARA). Das Symposium wurde vom NATC, von der OECD/NEA und der IAEA gesponsert. Das Europäische Technische Zentrum organisierte den 4. Europäischen Workshop zum Beruflichen Strahlenschutzmanagement vom 24. bis

26. März 2003 in Lyon, Frankreich. Der international breit gefächerte Teilnehmerkreis in diesen Veranstaltungen zeigt das große Interesse an der Optimierung des beruflichen Strahlenschutzes.

Aktuelle Entwicklungen und wichtige Ereignisse in ISOE Teilnehmerländern werden in Paragraph 2.5 des Berichtes zusammengefasst. Einzelheiten zu den Fortschritten im laufenden ISOE-Arbeitsprogramm sowie ein Ausblick auf das ISOE – Arbeitsprogramm 2004 werden in Kapitel 3 gegeben.

正文摘要

职业性照射信息系统计划 2003 年第13 期年度报告提供该计划截至 2003 年 12 月底的状况。

职业性照射信息系统数据库目前包括 29 个国家的由 70 家电力公司运营的 471 台反应堆机组（399 台在运行，72 台处于冷停堆或某一退役阶段）职业性照射水平和趋势方面的资料。因而，该数据库涵盖全世界正在商业运行的动力堆总数（439 座）的 91%。此外，26 个国家的监管机构积极参加了职业性照射信息系统的工作。2003 年期间，巴基斯坦原子能委员会以 2 座反应堆（恰希玛 1 号 300 兆瓦（电）压水堆，和卡拉奇 125 兆瓦（电）加压重水堆）加入了职业性照射信息系统。另外，乌克兰国家核监管委员会也加入了职业性照射信息系统。

10 多年来，职业性照射信息系统计划通过世界范围的核电厂辐射防护管理人员通讯和经验交流网络以及通过制订和发布经改进的工作管理程序，促进并支持开展核电厂工作人员剂量优化工作。2003 年，年平均剂量达到了相当低的水平并略有下降趋势，压水堆的年平均剂量达到 0.87 人·希、沸水堆 1.77 人·希、坎杜堆 1.10 人·希和轻水冷却石墨慢化堆（大功率沸腾管式堆）4.27 人·希。

除了有关正在运行的反应堆资料外，职业性照射信息系统数据库也包括 72 座已关闭或处于某一退役阶段的反应堆的剂量数据。由于数据库中描述的这些反应堆的类型不同，规模各异，而且基本上都处在退役计划的不同阶段，因此，很难确定清晰的剂量趋势和得出明确的结论。

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

2003 年 1 月 12 日至 15 日在美国佛罗里达州奥兰多举行了 2003 年“合理可行尽量低原则”国际专题讨论会。主题为“缩短换料停堆期间放射工作管理技术”专题讨论会由北美技术中心组织，为促进思想交流和保持职业性辐射照射“合理可行尽量低”管理方案的交流提供了一个全球论坛。该专题讨论会由北美技术中心、经合组织/核能机构和原子能机构主办。欧洲技术中心于 2004 年 3 月 24 日至 26 日在法国里昂举办了第 4 期“核电厂职业性照射管理的职业性照射信

息系统欧洲讲习班”。国际上对这些讨论会和讲习班的广泛参与表明对辐射防护的优化和职业性照射问题的兴趣。

本报告第二章第 2.5 节概述职业性照射信息系统参加国的近期发展和主要事件。第三章提供职业性照射信息系统计划持续发展的详细情况以及 2004 年的工作计划。

概　　略

この第 13 回目の年次報告書は、2003 年 12 月末における ISOE プログラムの状況を示したものです。

最新の ISOE データーベースには、29 カ国、70 電気事業者における 471 基（399 基は運転中、72 基は停止または廃止措置段階の原子炉）の原子力発電所に関する職業被ばくのデータが含まれています。このデータベースは、全世界の運転中の商用炉（計 439 基）の 91%にあたります。また、26 カ国の規制当局が ISOE 活動に参加しています。2003 年には、パキスタン原子力委員会が ISOE に参加（Chasnupp1（300MW, PWR）、Kanupp（125MW, PHWR）の２基）しました。さらに、ウクライナ原子力規制委員会が ISOE に参加しました。

ISOE プログラムでは、原子力発電所の放射線防護管理者による世界規模でのコミュニケーションと情報交換、作業管理手順書の作成・発行を通じ、原子力発電所における作業線量の最適化を促進・支援しています。2003 年には、PWR で 0.87 人･Sv、BWR で 1.77 人･Sv、CANDU 炉で 1.10 人･Sv、LWGRs(RBMK)炉で 4.27 人･Sv と若干減少傾向にあり、年間平均線量は十分低いレベルに達しました。

また、運転中の原子炉の情報に加え、ISOE データベースには、停止または廃止措置段階にある 72 基のデータも含まれています。データベースに登録されている原子炉は炉型やサイズが異なっており、また、全般的に廃止措置計画の段階にあることから、被ばく傾向を明確に把握し、結論を出すことは困難です。

放射線防護専門家は、現在進展している国際放射線防護委員会（ICRP)の新勧告に最大の関心を寄せています。この検討を支援するため、ISOE は、放射線防護の運用に関するワーキンググループ（WGOR）を通じ、放射線防護の実践的な側面を強調することにより、ICRP との議論に積極的に参加することを決定しています。本報告書において、これらの議論の最新の状況も紹介されています。

2003 年 1 月 12 日～15 日にかけて、米国フロリダのオーランドにおいて、第３回国際 ALARA シンポジウムが開催されました。本シンポジウムは燃料交換に伴う原子炉運転の短期間停止の際の放射線業務管理技術をテーマとし、NATC の主催により行われ、職業被ばくを ALARA レベルに維持するための考え方や管理手法に関する情報交換を促進することを目的としたグローバルフォーラムも催されました。本シンポジウムの開催費は、NATC、OECD/NEA 及び IAEA より支出されました。ETC は、2004 年 3 月 24 日～26 日にかけて、仏国リヨンにおいて、第 4 回 ISOE 欧州ワークショップを開催しました。これらのワークショップでは、放射線防護と職業被ばくの問題に、多くの参加者が関心を示しました。

本報告書の 2.5 章においては、ISOE 参加国における最近の進展と主要な出来事がまとめられています。第 3 章では、ISOE プログラムの進展の詳細について、2004 年度の作業プログラムとともに記されています。

ОСНОВНЫЕ ИТОГИ

Настоящий тринадцатый ежегодный отчет программы ISOE за 2003 год отражает положение дел с осуществлением программы ISOE на конец декабря 2003 года.

База данных ISOE в настоящее время включает данные об уровнях и тенденциях, касающихся профессионального облучения на 471 реакторах, находящихся в ведении 70 эксплуатирующих организаций в 29 странах мира (399 реактора находятся в эксплуатации и 72 - в состоянии холодного останова или на определенной стадии снятия с эксплуатации). Таким образом, база данных ISOE включает в себя 91% от общего числа энергетических реакторов (439), находящихся в промышленной эксплуатации во всем мире. Кроме того, в работе ISOE активно участвуют регулирующие органы 26 стран. В 2003 году к информационной системе ISOE присоединилось Атомная Энергетическая Компания Пакистана, в ведении которой находятся 2 энергетических реактора (Часнупп 1 мощностью 300 МВт (эл.) типа PWR и Канупп мощностью 125 МВт (эл.) типа PHWR). Кроме того, к работе в рамках ISOE подключилась Государственная Регулирующая Компания Украины.

В течение более чем десяти лет программа ISOE оказывает содействие и поддержку в деятельности по оптимизации получаемых персоналом АЭС доз облучения на основе использования сети связи и обмена опытом для руководителей служб радиационной защиты на АЭС всего мира, а также путем разработки и публикации усовершенствованных процедур управления рабочим процессом. В 2003 году наблюдалась небольшая тенденция к понижению годовых коллективных доз облучения. Средняя годовая коллективная доза для реакторов с водой под давлением (PWR) достигла довольно низкого уровня в 0,87 чел.-Зв; для кипящих реакторов (BWR) эта величина составляет 1,77 чел.-Зв; для реакторов CANDU – 1,10 чел.-Зв; для реакторов LWGR (РБМК) – 4,27 чел.-Зв.

В дополнение к информации о реакторах, находящихся в эксплуатации, база данных ISOE содержит также данные о дозах по 72 реакторам, которые находятся в состоянии останова или на определенной стадии снятия с эксплуатации. Поскольку в базе данных представлены реакторы различных типов и мощности, а также, как правило, данные реакторы находятся на различных стадиях снятия с эксплуатации, определение четких тенденций и формулирование окончательных выводов представляется весьма затруднительным.

Специалисты в области радиационной защиты проявляют большой интерес к осуществляемой в настоящее время Международной комиссией по радиологической защите (МКРЗ) разработке новых рекомендаций. Для оказания помощи в этой разработке было принято решение об активном участии в обсуждениях с МКРЗ через свою Рабочую группу по радиологической защите при эксплуатации (WGOR) ISOE, уделяя при этом особое внимание практическим аспектам радиологической защиты. В одном из подразделов настоящего отчета приводится информация о нынешнем статусе этих обсуждений.

С 12 по 15 января 2003 года в Орландо, Флорида, США состоялась Международная Конференция по вопросам ALARA.. Основным вопросом, обсуждаемым на указанной

Конференции, явилось рассмотрение процедур управления радиационными параметрами облучения при проведении работ, направленных на уменьшение длительности ремонтных компаний. Конференция, организованная Северо-Американским Техническим Центром (САТЦ), позволила специалистам в области радиационной защиты обменяться опытом по вопросам практического осуществления принципов ALARA. Спонсорами Конференции являлись САТЦ, Европейское Агентство по Атомной Энергии и МАГАТЭ. С 24 по 26 марта 2004 года в Лионе, Франция состоялась 4 – я Международная Конференция по вопросам управления облучением персонала АЭС. Конференция была организована Европейским Техническим Центром. Широкое участие в работе указанных двух конференций специалистов со всего мира свидетельствует об интересе к вопросам радиационной защиты и профессионального облучения.

Последние и важнейшие события, произошедшие в странах, участвующих в ISOE, кратко излагаются в главе 2.5 настоящего отчета. Отдельные вопросы развития программы ISOE, а также программа работ на 2004 год представлены в главе 3.

RESUMEN EJECUTIVO

El decimotercero Informe Anual del ISOE, correspondiente al año 2003, presenta el estado del ISOE a finales de diciembre de dicho año.

La base de datos del ISOE actualmente incluye información sobre exposiciones ocupacionales y sus tendencias para 471 reactores (399 en operación y 72 en estado de desmantelamiento), operados por 70 instalaciones nucleares en 29 países.

Esta base de datos cubre así el 91% del número total de reactores comerciales en operación (439) en todo el mundo. Además, Organismos Reguladores de 26 países participan activamente en el ISOE. Durante el año 2003, la Comisión de Energía Atómica de Pakistán se unió a ISOE con dos reactores (Chapsnupp 1 de 300MW(e) PWR y Kanupp, de 125 MW(e) PGR). Además, el Comité Regulador de Ucrania ha entrado a formar parte de ISOE.

Durante más de 10 años, el ISOE ha facilitado y fomentado la optimización de las dosis de los trabajadores de instalaciones nucleares a través de la comunicación y de una red de intercambio de experiencias operativas para los jefes de protección radiológica a nivel internacional y además a través del desarrollo y publicación de procedimientos de mejora de gestión de trabajos. En 2003, la media de dosis anual alcanzó un nivel bastante bajo con una ligera tendencia a la baja hasta 0.87 mSv.persona para los reactores PWR, 1.77 mSv.persona para los reactores BWR, 1.10 mSv.persona para los reactores tipo CANDU y finalmente, 4.27 mSv.persona para los reactores LWGRs (RBMK).

Además de la información sobre los reactores en operación, la base de datos del ISOE contiene datos sobre las dosis de 72 reactores parados o en estado de desmantelamiento. Como los reactores presentes en la base de datos son de diferente tipo y tamaño, y están en general en distinta fase de sus programa de desmantelamiento, es muy difícil identificar tendencias de dosis y llegar a conclusiones definitivas.

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

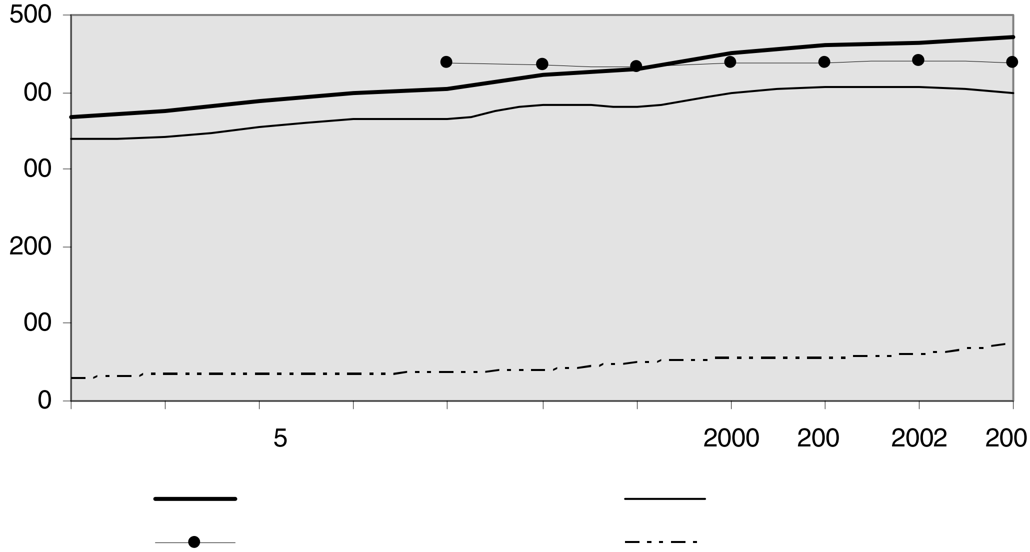
Desde el 12 al 15 de enero de 2003, se celebró el Symposium internacional Alara 2003, en Orlando, Florida. El Symposium, cuyo tema era "Técnicas de gestión de los trabajos con carga radiológica durante paradas cortas de recarga" fue organizado por el Centro Técnico de Norteamérica y supuso un forum global para el intercambio de ideas y políticas de gestión para mantener las dosis ocupacionales "tan bajas como razonablemente sea posible alcanzar" (ALARA). El Symposium estuvo patrocinado por el Centro Técnico de Norteamérica (NATC), la OCDE/NEA y el OIEA. El Centro Técnico Europeo celebró el cuarto Taller Europeo sobre gestión de las dosis ocupacionales en centrales nucleares, desde el 24 al 26 de marzo, en Lyon, Francia. La amplia e internacional participación en ambos de estos forums muestra el interés existente en la optimización de la protección radiológica y en otros aspectos de la exposición ocupacional.

Los progresos más recientes y los sucesos principales acaecidos en los países participantes en el ISOE se resumen en la sección 2.5 de este documento. Detalles del continuo crecimiento del programa ISOE, así como del programa de trabajo para 2004 se detallan en el capítulo 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 (Figure 1). At the same time, the extent 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.

Figure 1. Total number of reactors included in ISOE (1993-2003)



As of December 2003, the ISOEDAT database includes occupational exposure data from a total of 471 reactors (399 operating and 72 in cold-shutdown or some stage of decommissioning) operated by 70 utilities in 29 countries. In addition, regulatory authorities from 26 countries participate actively in the ISOE Programme. The participation of 399 operating commercial nuclear reactors in the ISOE Programme represents some 91% of the World's operating commercial nuclear reactors (total of 439). 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 2003, the Pakistan Atomic Energy Commission joined ISOE with two reactors (Chasnupp 1, a 300 MW(e) PWR, and Kanupp, a 125 MW(e) PHWR). In addition, the State Nuclear Regulatory Committee of Ukraine joined ISOE.

Table 1. Participation summary (as of December 2003)

Operating reactors participating in ISOE							
Country	**PWR**	**BWR**	**PHWR**	**GCR**	**LWGR**	**FBR**	**Total**
Armenia	1	–	–	–	–	–	1
Belgium	7	–	–	–	–	–	7
Brazil	2	–	–	–	–	–	2
Bulgaria	4	–	–	–	–	–	4
Canada[1]	–	–	22	–	–	–	22
China	5	–	–	–	–	–	5
Czech Republic[2]	6	–	–	–	–	–	6
Finland	2	2	–	–	–	–	4
France	58	–	–	–	–	–	58
Germany	13	6	–	–	–	–	19
Hungary	4	–	–	–	–	–	4
Japan	23	29	–	–	–	–	52
Korea	14	–	4	–	–	–	18
Lithuania	–	–	–	–	2	–	2
Mexico	–	2	–	–	–	–	2
Netherlands	1	–	–	–	–	–	1
Pakistan[3]	1	–	1	–	–	–	2
Romania	–	–	1	–	–	–	1
Russian Federation	14	–	–	–	–	1	15
Slovakia	6	–	–	–	–	–	6
Slovenia	1	–	–	–	–	–	1
South Africa	2	–	–	–	–	–	2
Spain	7	2	–	–	–	–	9
Sweden	3	8	–	–	–	–	11
Switzerland	3	2	–	–	–	–	5
Ukraine	13	–	–	–	–	–	13
United Kingdom	1	–	–	–	–	–	1
United States	33	18	–	–	–	–	51
Total	**224**	**69**	**28**	**–**	**2**	**1**	**324**

Operating reactors not participating in ISOE, but included in the ISOE database							
Country	**PWR**	**BWR**	**PHWR**	**GCR**	**LWGR**	**FBR**	**Total**
United Kingdom	–	–	–	22	–	–	22
United States	36	17	–	–	–	–	53
Total	**36**	**17**	–	**22**	**–**	**–**	**75**

Total number of operating reactors included in the ISOE database							
	PWR	**BWR**	**PHWR**	**GCR**	**LWGR**	**FBR**	**Total**
Total	**260**	**86**	**28**	**22**	**2**	**1**	**399**

1. In 2003, 17 CANDU reactors were in operation. The reactors Bruce A1, A2, and Pickering A1, A2, A3 did not operate during 2003.
2. Two of these reactors (Temelin 1 and 2) are still in pre-operational phase.
3. The Pakistan Atomic Energy Commission officially joined ISOE in 2003 with two reactors: Chasnupp 1 (300 MW(e) PWR) and Kanupp (125 MW(e) PWHR).

Definitively shutdown reactors participating in ISOE						
Country	**PWR**	**BWR**	**PHWR**	**GCR**	**LWGR**	**Total**
Bulgaria	2	–	–	–	–	2
Canada	–	–	1	–	–	1
France	1	–	–	6	–	7
Germany	1	1	–	1	–	3
Italy	1	2	–	1	–	4
Japan	–	–	–	1	–	1
Netherlands	–	1	–	–	–	1
Russian Federation	2	–	–	–	2	4
Spain	–	–	–	1	–	1
Sweden	–	1	–	–	–	1
Ukraine	–	–	–	–	3	3
United States	4	3	–	1	–	8
Total	**11**	**8**	**1**	**11**	**5**	**36**

Definitively shutdown reactors not participating in ISOE but included in the ISOE database						
Country	**PWR**	**BWR**	**PHWR**	**GCR**	**LWGR**	**Total**
Canada	–	–	1	–	–	1
Germany	5	3	–	1	–	9
United Kingdom	–	–	–	18	–	18
United States	6	2	–	–	–	8
Total	**11**	**5**	**1**	**19**	–	**36**

Total number of definitively shutdown reactors included in the ISOE database						
	PWR	**BWR**	**PHWR**	**GCR**	**LWGR**	**Total**
Total	**22**	**13**	**2**	**30**	**5**	**72**

Number of **Utilities** Officially Participating:	**70**
Number of **Countries** Officially Participating:	**29**
Number of **Authorities** Officially Participating:	**26**

2. OCCUPATIONAL DOSE STUDIES, TRENDS AND FEEDBACK

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

2.1 Occupational exposure trends in operating reactors

The annual average collective dose per unit has consistently decreased over the time period covered in the ISOE database, reaching a fairly low level in 2003. In spite of some yearly variations, there is a clear downward dose trend.

A summary of the average annual exposure trends for participating countries over the past three years is shown in Table 2. Figures 2 to 5 show the 2003 data in a bar-chart format, ranked from highest to lowest average dose. Figures 6 and 7 show the trends in average collective dose per reactor type for 1993-2003. In 2003, the average annual dose reached a fairly low level with a slight decreasing trend to 0.87 man·Sv for pressurised water reactors (PWR), 1.77 man·Sv for boiling water reactors (BWR), 1.10 man·Sv for CANDU reactors, and 4.27 man·Sv for LWGRs (RBMK).

In Europe, the 2003 average collective dose per reactor for PWRs remained quite stable, compared to 2002, at around 0.7 man·Sv per reactor. Although doses increased in Hungary, this was mainly ascribed to the prevention and recovery work following the incident at Paks Unit 2, and the maintenance work performed at Unit 1. European BWRs have seen an increase of the average collective dose. Finland and Sweden are exceptions to this trend, although collective doses at Swedish BWRs are higher than in 2001

In Japan, the fiscal year (FY) 2003 has resulted in the increase of the total collective dose for both BWRs and PWRs. The increase in BWR collective dose for FY 2003 was mainly due to the long duration of the periodical inspections and repairs of the reactor recirculation pipes and shroud, with several modification jobs taking place under high radiation dose rates. The increase in collective dose of PWRs for FY 2003 was smaller than that in BWRs. The dosimetric trend at Korean PWRs showed continuous reduction, while the collective dose of Korean CANDU reactors increased mainly due to increases at Wolsong 1.

In North America, although the average 2003 PWR dose represents a 5.6% increase from the 2002 value, this is the fifth time since the first commercial reactor commenced operations in 1969 that the average PWR annual dose has been under 1.00 man·Sv/unit. The average collective dose per US BWRs in 2003 represents a 9% decrease from the 2002 value, and is the third lowest recorded average dose per unit since 1969. In Canada, the average 2003 CANDU dose of 1.03 man·Sv/unit represents a 14% increase over 2002.

In countries participating through the IAEA Technical Centre, the PWR average collective dose per reactor continued to decrease. The average collective dose for PHWRs, however, is still higher than for other types of reactors. In China, Slovenia and South Africa the collective doses for PWRs increased by about 0.2 man·Sv, though they are still lower than the average collective dose per reactor in other countries participating through the IAEA Technical Centre.

Due to the complex parameters driving the collective doses and the varieties of the contributing plants, the above discussion and figures do not support any conclusions with regard to the quality of radiation protection performance in the countries addressed. More detailed discussion and analyses of dose trends in various countries can be found in Section 2.5 of this report.

Table 2. Evolution of average annual collective dose per unit, by country and reactor type, from 2001-2003 (man·Sv)

	PWR			BWR			CANDU		
	2001	2002	2003	2001	2002	2003	2001	2002	2003
Armenia	0.66	0.95	0.86						
Belgium	0.56	0.47	0.43						
Brazil	0.58	0.68	0.61						
Bulgaria	0.93	0.62	0.51						
Canada[4]							0.78	0.90	1.03
China	0.50	0.65	0.84						
Czech Republic	0.29	0.20	0.20						
Finland	0.56	1.31	0.47	0.59	0.56	0.52			
France	1.02	0.97	0.89						
Germany[5]	0.89	1.23	1.04	1.06	0.76	0.93			
Hungary	0.63	0.80	1.03						
Japan[6]	1.27	1.00	1.07	1.68	2.10	2.40			
Korea	0.67	0.52	0.51				0.67	0.63	0.79
Mexico				3.29	1.89	1.91			
Netherlands	0.52	0.34	0.27						
Pakistan		0.28	0.73				3.20	2.52	3.82
Romania							0.58	0.55	0.82
Russian Feder.	1.41	1.24	1.19						
Slovakia	0.37	0.29	0.31						
Slovenia	1.13	0.58	0.80						
South Africa	1.15	0.83	1.02						
Spain	0.43	0.50	0.47	0.93	1.52	2.16			
Sweden	0.35	0.52	0.57	0.71	1.33	1.24			
Switzerland	0.48	0.51	0.34	0.97	0.69	1.02			
Ukraine	1.29	1.54	1.45						
United Kingdom	0.19	0.30	0.35						
United States	0.91	0.87	0.92	1.38	1.75	1.60			

	GCR			LWGR		
	2001	2002	2003	2001	2002	2003
Lithuania				3.14	4.4	4.27
United Kingdom[7]	0.13	0.11	0.07			

4. Average annual dose is calculated for 17 operating CANDU reactors.
5. Average annual dose is calculated including KKS, which was shut down in November 2003.
6. Average annual dose for BWR is calculated including Hamaoka Unit 5, which is at pre-operational status.
7. Average annual dose is calculated for 28 reactors in 2001, 18 reactors in 2002, and 14 reactors in 2003.

Figure 2. 2003 PWR average collective dose per reactor by country

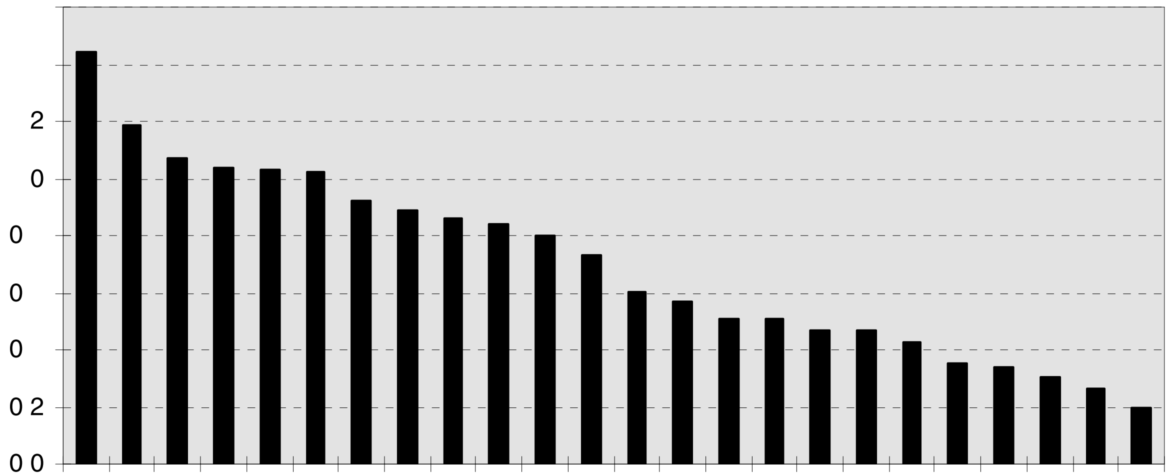


Figure 3. 2003 BWR average collective dose per reactor by country

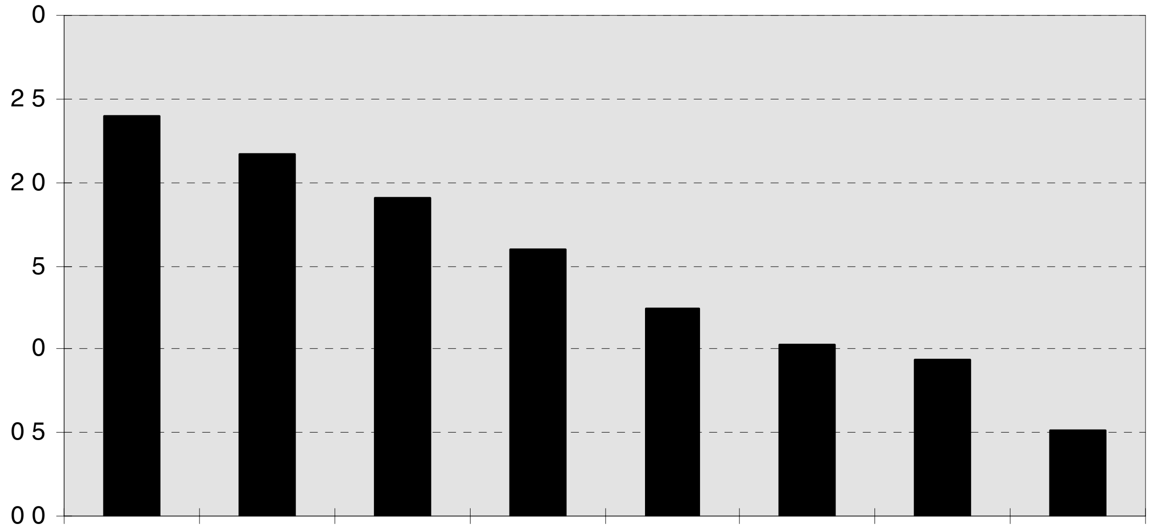


Figure 4. 2003 CANDU average collective dose per reactor by country

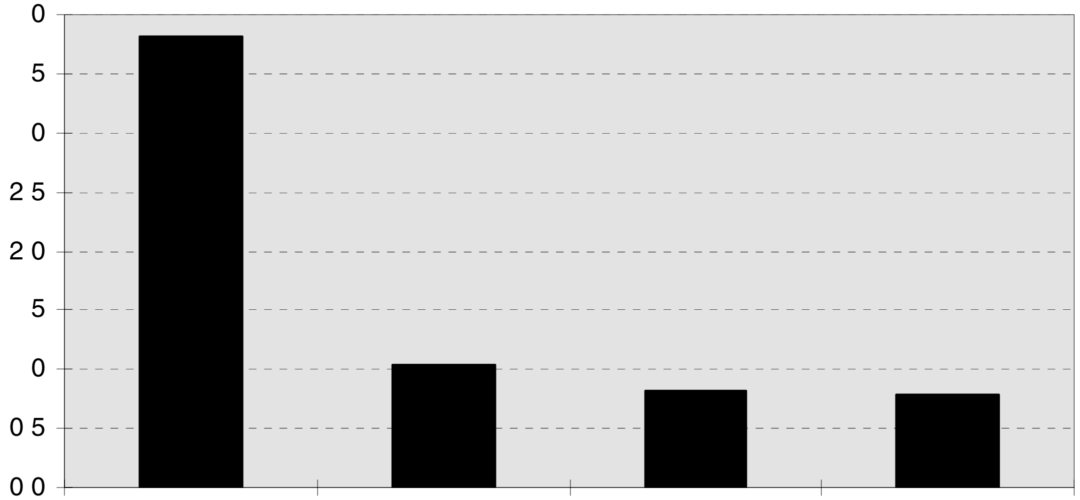


Figure 5. 2003 average collective dose per reactor type

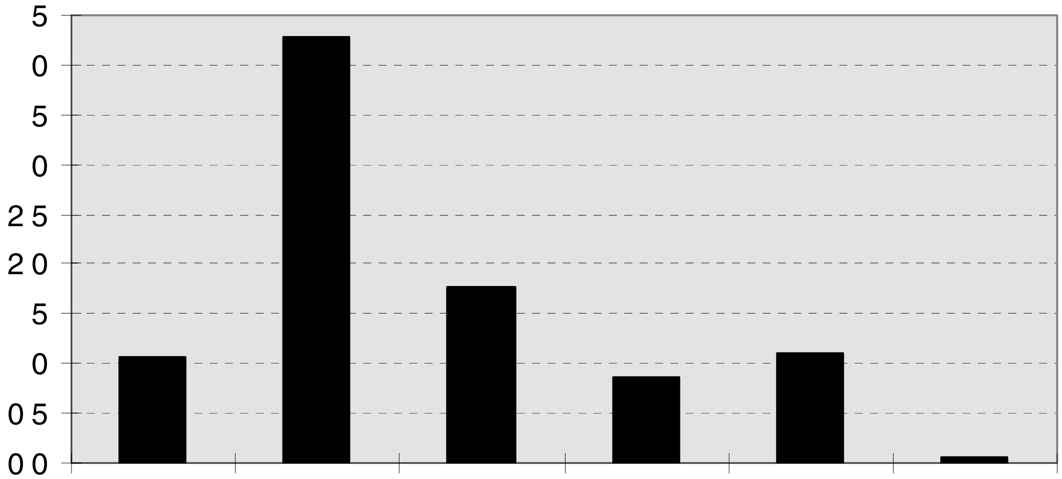


Figure 6. Average collective dose per reactor for operating reactors included in ISOE by reactor type (1993-2003)

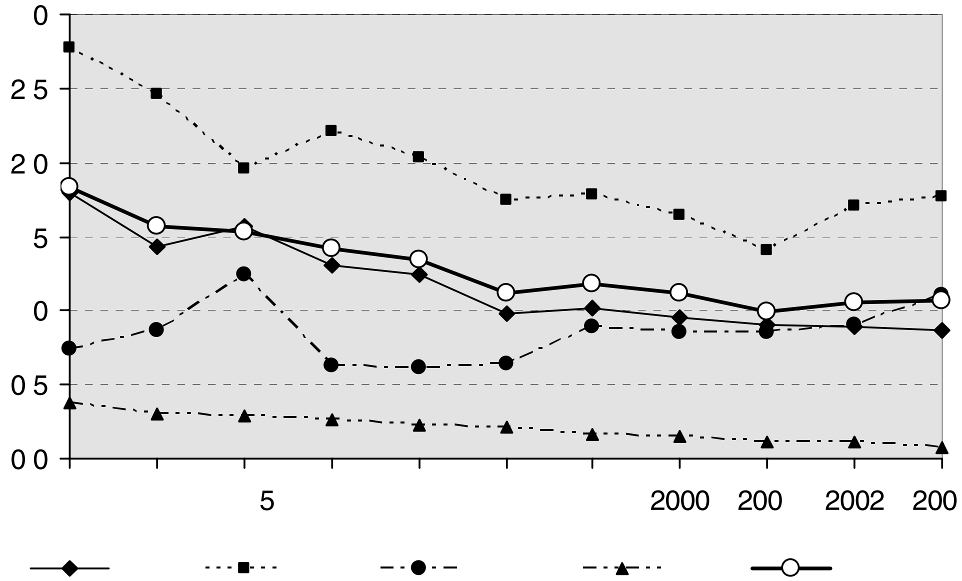
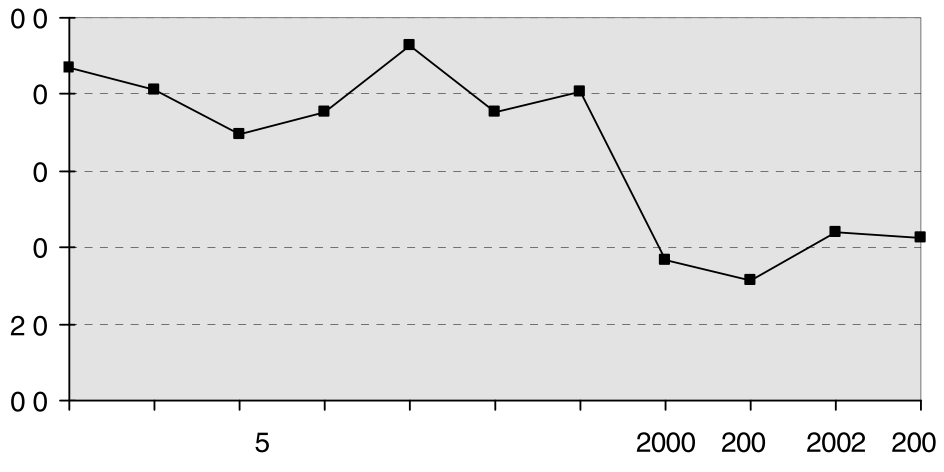


Figure 7. Average collective dose per reactor for operating LWGRs included in ISOE



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

The ISOE database contains dose data from 72 reactors which are shutdown or in some stage of decommissioning. The average collective dose per reactor for shutdown reactors saw a reduction over the years 1990 to 2003. 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 collective dose per unit by country and type of reactor for the years 2001 to 2003. Figures 8-11 summarise the average collective dose per reactor for shutdown reactors for the years 1993-2003 by type (PWR, BWR and GCR).

Table 3. Number of shutdown units and average annual dose per unit by country and reactor type for the years 2001-2003

	2001		2002		2003	
	No.	**Dose**	**No.**	**Dose**	**No.**	**Dose**
PWR doses (man·mSv)						
France	1	7	1	12	1	5
Germany	6	46	1	66	1	204
Italy	1	4	1	5	1	0.2
United States	8	306	8	284	–	No data
VVER doses (man·mSv)						
Germany	5	43	5	48	5	47
Russian Federation	–	–	2	313	2	340
BWR doses (man·mSv)						
Germany	4	269	1	816	1	273
Italy	2	38	2	20	2	43
Netherlands	1	95	1	22	1	92
Sweden	1	79	1	61	–	No data
United States	4	164	5	120	–	No data
GCR doses (man·mSv)						
France	6	11	6	7	6	6
Germany	1	19	1	33	1	41
Italy	1	44	1	43	1	47
Japan	1	20	1	178	1	20
Spain	1	197	1	33	1	47
United Kingdom	8	41	–	No data	–	No data
CANDU doses (man·mSv)						
Canada	–	No data	8	609	–	No data
LWGR doses (man·mSv)						
Ukraine	3	5 078	3	4 472	3	3 525

Figure 8: Average collective dose per shutdown reactor in ISOE: PWRs

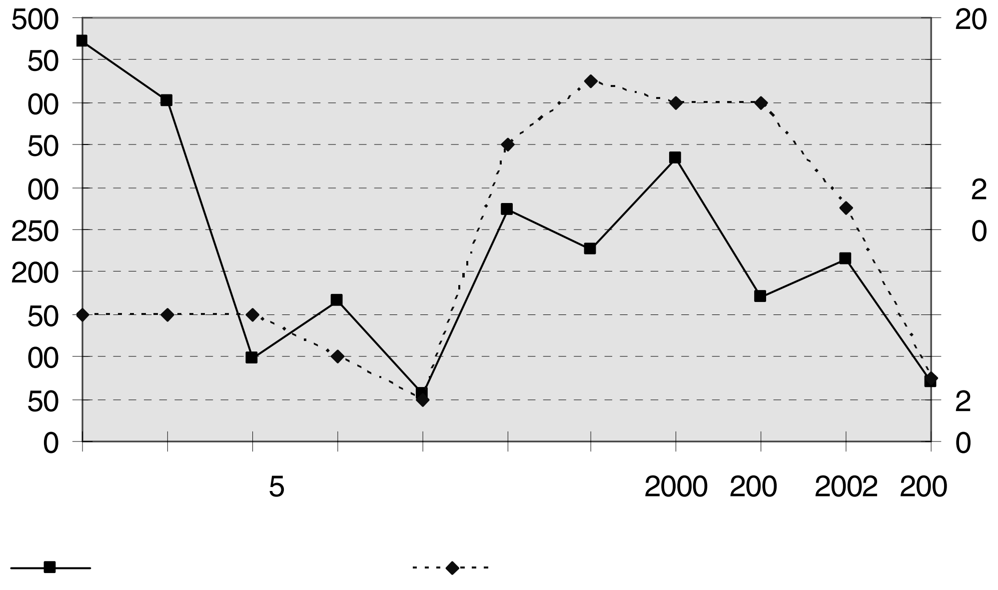


Figure 9: Average collective dose per shutdown reactor in ISOE: BWRs

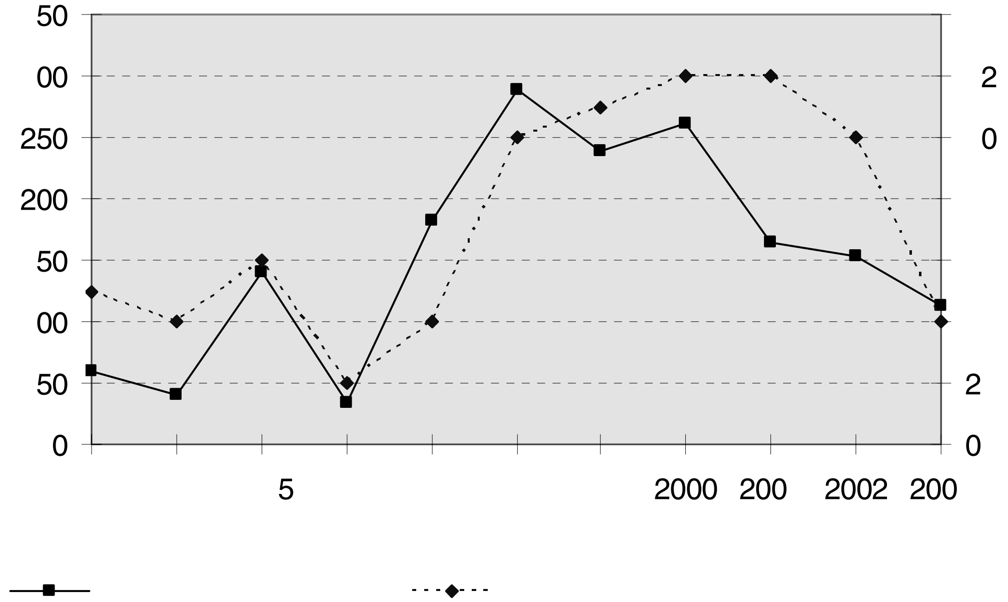


Figure 10: Average collective dose per shutdown reactor in ISOE: GCRs

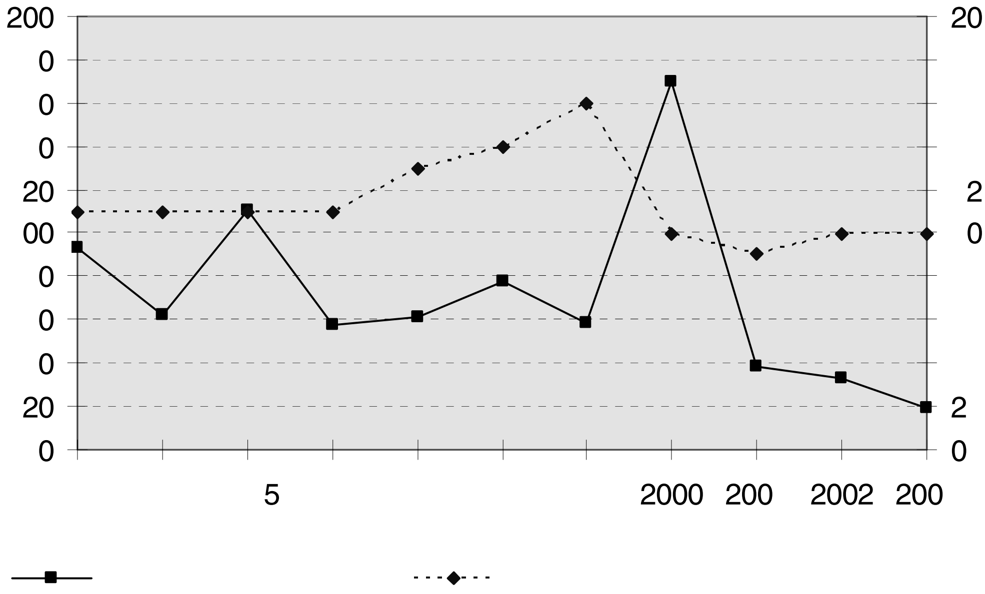
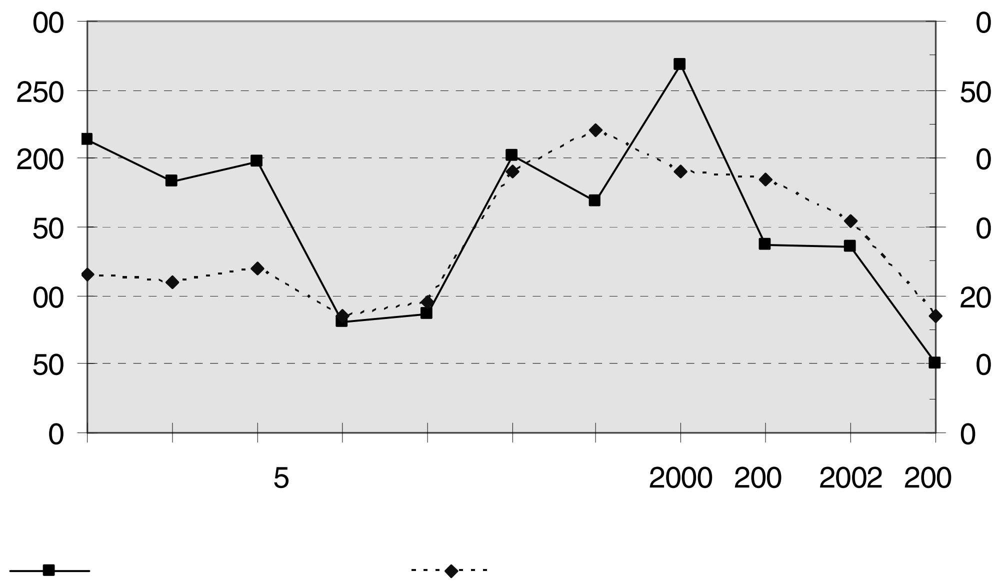


Figure 11: Average collective dose per shutdown reactor in ISOE: PWR, BWR, GCR



2.3 Operational views on the evolution of radiological protection

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

In this context, radiological protection professionals are very interested in the current development of new recommendations from the International Commission on Radiological Protection, ICRP. To assist in this development, the Information System on Occupational Exposure (ISOE) set up a Working Group on Operational Radiological Protection (WGOR). The objective of this work was to remind the international radiological protection community and the ICRP of the practical aspects of radiological protection that should be reinforced by any new ICRP recommendations, and to identify areas where further practical guidance would be useful. The work of the WGOR focused of seven key topics, all within the broad context of optimisation from the perspective of practical radiological protection. The results of this work are contained in the WGOR report *Optimisation in Operational Radiological Protection* (OECD/NEA, 2005). The key messages relating to these are summarised below.

- Optimisation of public exposure: The objective of radiological protection professionals is to optimise protection for the public, workers and the environment, rather than to minimise dose. Current optimisation practice applies the ALARA philosophy and the use of Best Available Technology, adapted to address each given situation.
- Optimisation of worker exposure: Optimisation is a key tool/process for the management of worker doses. Workers themselves contribute significantly to work planning, using their operational experience to improve work efficiency. Worker collective dose is a common and effective tool for worker exposure management. Flexibility in individual dose management is useful for controlling collective dose and for assuring that individuals are equally protected.
- Empowerment of the workforce: Current practice encourages and empowers workers themselves to contribute to optimisation of protection, and worker operational experience is a key basis for work efficiency improvement. The objectives of work management can be achieved by many approaches and will include the consideration of many more aspects of worker health and safety than simply radiological protection.
- The use of tools in optimisation: Many quantitative tools exist to assist in the assessment and management of radiation risks, and with the growing importance of stakeholder involvement, more qualitative and process-oriented tools are being developed. Due to the inherently case-specific basis of optimisation, flexibility in guidance for the application of optimisation is needed. However, the application of a generic level (a few 10s of μSv/a) below which the need for regulatory control, if any, would be reduced, would be welcomed by the nuclear industry.
- Old-plant ALARA versus new-plant ALARA: Optimisation of dose below a given dose constraint focuses on the process rather than the result. As such, the site-specific philosophies for optimisation and ALARA can be equivalent at different sites, while yielding different results.
- Optimisation of decommissioning: The optimisation of protection in decommissioning is framed within international guidelines and recommendations, and more specifically within

national policy objectives. Any levels that are eventually chosen for clearance, and their associated requirements for verification of compliance, should not result in excessive worker exposures. Worker exposures should be key elements in the developing national decommissioning policy.

- International aspects of optimisation: The nature of international recommendations implies some agreement on common approaches, the level of which should be discussed. The responsibility for worker dose management and the optimisation of worker radiological protection lies at all levels. Expanded use of practical tools, such as "dose passports" should be explored nationally and internationally.

The WGOR has suggested that these points be kept in mind by the ICRP in developing its new recommendations and by national radiological protection authorities as they modify their regulations, as may be necessary, following the issuance of the new ICRP recommendations.

2.4 Conclusions and recommendations from the 4th European ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants

The European ISOE Technical Centre co-organised with the NEA and the IAEA the 4th European ISOE Workshop on Occupational Exposure at Nuclear Power Plants, held in March 2004 at Lyon, France. The Workshop brought together 190 operational radiation protection experts from 26 countries in Europe (all countries from western and central Europe with nuclear power plants), North America (Canada and United States) and Asia (China, Japan, Korea), with a good balance between utilities, regulatory bodies and contractors. The IAEA supported participants from Central and Eastern European countries as well as from Eastern Asia. The workshop offered 35 oral presentations and 28 poster presentations. A very informative exhibition was held by vendors, providing participants useful information about vendor products.

Participants were split into small groups devoted to 10 pre-selected themes. Five main recommendations were agreed on by the participants:

- Regulations should be harmonised in order to maintain a high status of radiological protection at an international level in a deregulated context.
- The regulatory bodies should also harmonise the contents of training, particularly in the context of workforce ageing.
- The international organisations and regulatory bodies should take the lead to harmonise at the international level a dose passport for itinerant workers.
- Radiological protection indicators should be selected to help in optimising doses, provide indication for continuous improvement, estimate the effectiveness of radiological protection departments, provide means for benchmarking, and create consistency between sites.
- The radiological protection teams should increase their assistance "patrols" at workplaces.

A specific session on radiological protection at the design stage of installations was mainly devoted to the new European pressurised water reactor (EPR). The Finish operator (TVO) and regulatory body (STUK) described their expectations in terms of occupational radiological protection. The French operator EDF has established a reasonable target of not exceeding 0.5 man·Sv/year (averaged over the life time of the reactor).

Two topics of particular interest were selected by the participants, namely the setting up of radiological protection indicators (evaluation of the ALARA criteria), and the educational and training needs in radiological protection.

The setting up of radiological protection indicators

In a context of increasing industry competition, the establishment of radiological protection goals and indicators, increasingly used in plants, appeared to participants to be very important for dose management. Operational goals, however, must be measurable, realistic and challenging. They must be, and communicated to all stakeholders. Radiological protection specialists may propose these tools, according to pre-determined management objective, which should be then discussed with the regulatory body. Deviations from these goals should require post job reviews.

The needs in education and training in radiological protection

With respect to education, the participants pointed out that discrepancies exist between countries in terms of training both at initial and refresher levels, and that harmonisation is needed in this area. They stressed on the one hand the ageing of skilled workers, and on the other hand the fact that many workers are well trained and committed to dose reduction. They also stressed the importance of both practical training and experience in achieving workers' involvement and awareness.

Deregulation and radiological protection

The problem of the impact of deregulation on radiological protection was raised for the first time at Malmö in 1998 (1st European ISOE Workshop). At that time, it appeared not to be a real concern. Two years later in 2000 at Tarragona (2nd European ISOE Workshop), deregulation clearly appeared as a real challenge for the future for radiological protection. This led to a recommendation from the participants at the 2002 Portoroz workshop (3rd European ISOE Workshop) "to consider new radiation protection management techniques to avoid the potential negative impacts of deregulation on exposures, while keeping radiation protection independent from operation and maintenance of the plant". The Lyon workshop confirmed what appeared for the first time at Portoroz, namely an "important reduction in radiological protection staff sizing, and loss of skilfulness".

Distinguished presentations

Three technical presentations received awards for their high quality and interesting subjects, and were invited to repeat their presentations in 2005 at the Miami ISOE North American international ALARA symposium in the United States. These distinguished papers dealt with both technical and managerial problems and proposed very practical solutions:

- "Advantages of combining gamma scanning techniques and 3-D dose simulation in dose optimisation problems"; F. Vermeersch, SCK•CEN, Mol, Belgium

This paper presents a method for combining results from gamma scanning equipment with a 3-D dose simulation tool, with the aim of achieving a reliable work site dose characterisation in order to perform dose assessment and optimisation for work planned in the area.

- "Recent International Developments on Contamination Limits on Packages"; J. Hesse, RWE Power, Germany/B. Lorenz, GNS, Germany

This paper presents the results of the IAEA Co-ordinated Research Project on the Radiological Aspects of Package and Conveyance of Non-Fixed Contamination. The results of the model are presented in Bq/cm^2 corresponding for each nuclide to dose constraints of 2 mSv/year for the workers and 0.3 mSv/year for the public.

- "ALARA versus Reactor Safety concern – a practical case"; S. Hennigor, B. Ögren, Forsmark NPP, Sweden

This presentation is a very practical one describing the modification of the moist separator (upper part of the steam dryer) at Forsmark BWR that took place in 2003 due to cracks.

The success of the Lyon Workshop was largely due to the significant organisational support from EDF, particularly in providing translation support, and from FRAMATOME and COGEMA Logistics who provided the translations from German and Spanish to English.

2.5 Principal events of 2003 in ISOE participating countries

As with any "raw data", the information presented in Sections 2.1 and 2.2 above is only a graphical presentation of average numerical results from the year 2003. Such information serves to identify broad trends and helps 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 2003 and which may have influenced the occupational exposure trends. These are presented as reported by individual countries. Due to the various approaches in national reporting, no attempt has been made to standardise the dose units used by each country.

ARMENIA

Summary of national dosimetric trends

For the year 2003 the dosimetric trends at the Armenian NPP have decreased for collective dose, which is conditioned by ALARA implementation during certain works performed at the ANPP outage, in particular, transport-technological operations with spent fuel, non-destructive testing activities, isolation works.

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

Years	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Collective dose	4.18	3.46	3.41	1.51	1.57	0.96	0.66	0.95	0.86

Events influencing dosimetric trends

In-service inspections and decontamination works.

Number and duration of outages

One outage (~90 days). Maintenance and repairing works in safety systems (in-service inspections and etc.) were performed. The planned exposure doses were agreed with the regulatory body. The planned collective dose before outage was 1.46 man·Sv. The real collective doses were 0.86 man·Sv. For this stages the maximum individual dose equivalent was 19.2 mSv.

Major evolutions

No major evolutions are registered.

Component or system replacement

During the outage, no components or systems were replaced.

Unexpected events

For the year 2003 unexpected events were not registered.

2004 issues of concern

No one special activities which can impact on dosimetric trend are foreseen.

Regulatory plans

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

BELGIUM

Operating reactors

2003		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv]**
PWR	7	0.429

Summary of national dosimetric trends

Collective doses for the year 2003 (in man·mSv)

In Tihange	Tihange 1	Tihange 2	Tihange 3	Total
Plant personnel	33.7	157.5	97.3	288.5
Contractor's personnel	23.5	629.5	541.4	1194.4
Total	**57.2**	**787**	**638.7**	**1482.9**
In Doel	**Doel 1 and 2**	**Doel 3**	**Doel 4**	**Total**
Plant personnel	86.76	91.63	45.94	224.33
Contractor's personnel	425.70	409.99	207.58	1 043.27
Total	**512.46**	**501.62**	**253.52**	**1 267.6**

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

Collective doses in Tihange are stable compared to 2002. There were 2 outages in 2003 (Tihange 2 and 3) as in 2002 (Tihange 1 and 2). In 2003, there was a supplementary stop at Tihange 2 for pressuriser's leg welding inspection.

Events influencing dosimetric trends

The outages are responsible for the major part of the collective doses: more than 80% of the collective dose is due to outages.

Number and duration of outages

Unit	Outage information	Number of workers	Collective dose (in man·mSv)
Tihange 1	No outage this year. No exceptional work	–	–
Tihange 2	Outage duration 39 days. Pressuriser's leg welding inspection	1 048	656.00
Tihange 3	Outage duration 38 days. No exceptional work	974	561.00
Doel 1	Outage duration 27 days. No exceptional work	760	232.32
Doel 2	Outage duration 24 days. No exceptional work	939	204.41
Doel 3	Outage duration 24 days. No exceptional work	–	414.34
Doel 4	Outage duration 29 days. No exceptional work	849	195.34

Major evolutions

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

Implementation in 2003

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

Programme for 2004

Continuation of a workshop about the free release criteria (contamination) with Belgian Nuclear Authorities.

Component or system replacements

Tihange 3: Continuation of the replacement of BORAFLEX by BSS (Borated Stainless Steel) plates in the fuel racks of the spent fuel storage facility (3rd year).

Doel 2: Replacement of the two steam generator.

Plans for major work in the coming year

Tihange 1: Normal outage with fuel leakages problematic.

Tihange 2: No outage.

Tihange 3: Normal outage.

Doel 2: Special outage: steam generators replacement.

BRAZIL

Angra 1

Work	Collective dose (man·mSv)
Installation/Modification nozzle dam	371.6
Eddy current test	204.5
Refuelling/Decontamination	202.9
In-service inspection	84.9
Scaffolding	80.2
Insulation	72.0
Maintenance valves	48.2
Reactor coolant pumps – inspection	40.0

Angra 2

Work	Collective dose (man·mSv)
Refuelling/Decontamination	49.00
Decontamination	12.45
In-service inspection	8.55
Reactor coolant pumps – inspection	8.19
Insulation	7.29
Snubbers/supports – inspection	5.61
Tube sheet cleaning – steam generator	5.95
Maintenance valves	5.51
Scaffolding	5.07

BULGARIA

Summary of national dosimetric trends

Utility report

Trends and data are presented on the following table and graphs. The average individual effective dose was 0.5 mSv. The maximum individual effective dose (a person from external organisation) for 2003 was 18.21 mSv, for the person from the plant – 15.52 mSv. Unit 5 has had no refuelling.

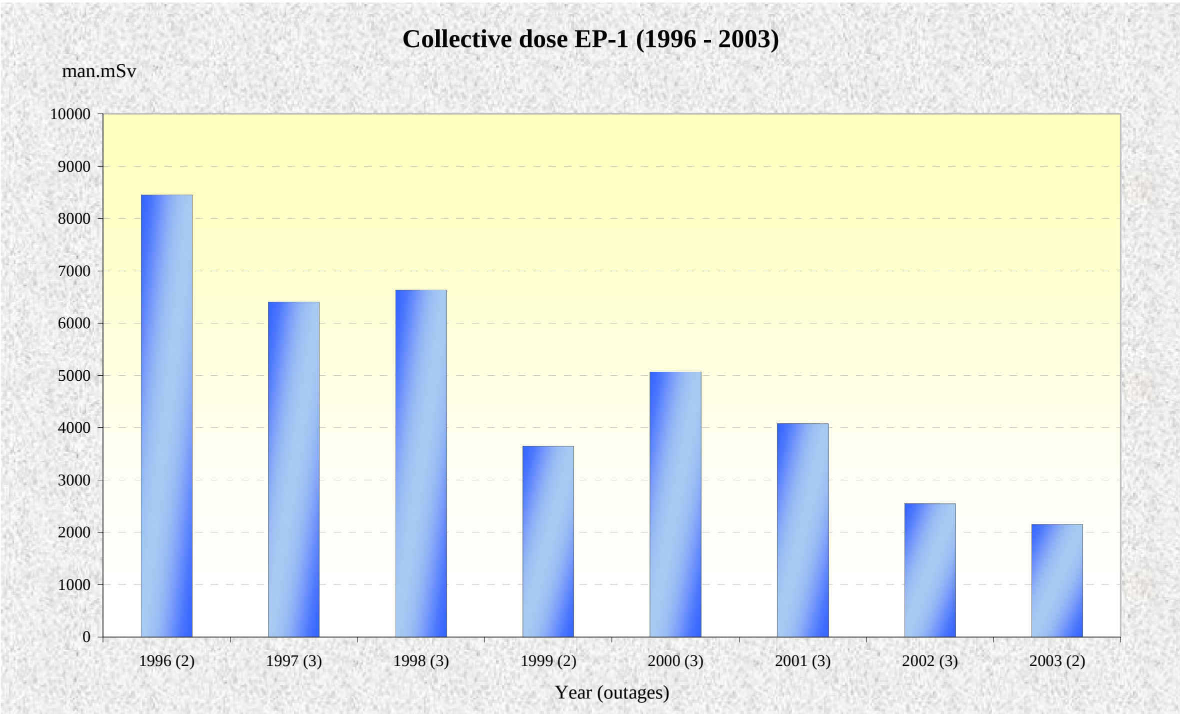
Collective dose per reactor for 2003 at Kozloduy NPP (KNPP)						
Site	**Reactor**	**Type**	**Outage duration [days]**	**Collective dose [man·mSv]**		**Comments**
				Outage	**Yearly**	
EP-1	Kozloduy 1	WWER 440	0	0	72.64	Shutdown
	Kozloduy 2	WWER 440	0	0	72.47	Shutdown
	Kozloduy 3	WWER 440	49	508.74	767.71	
	Kozloduy 4	WWER 440	84	980.21	1 240.50	+Modernisation
EP-2	Kozloduy 5	WWER 1000	7	10.84	82.90	Forced outage
	Kozloduy 6	WWER 1000	91	734.20	818.50	+Modernisation
Average/Unit	**Kozloduy NPP**				**509.12**	

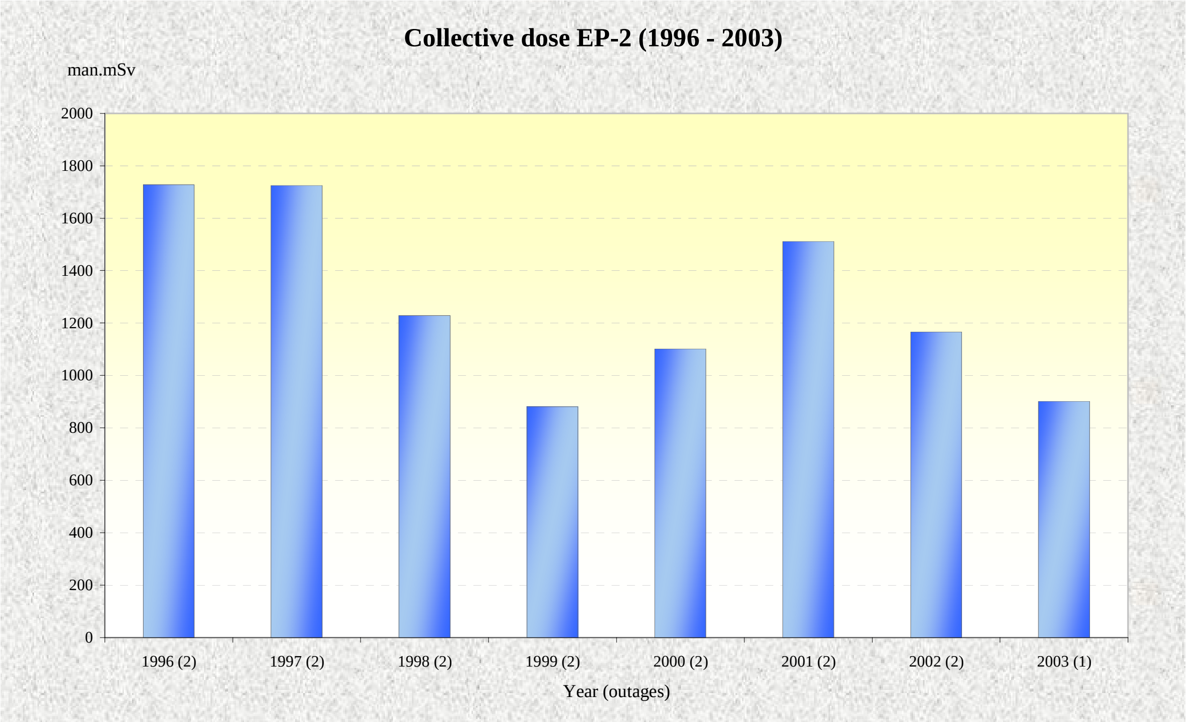
The prolonged duration of an outage is considered the only event influencing the collective dose. ALARA implementation continued and was performed as described in Safety Reports Series 21.

Some modernisations activities on Unit 4 were performed. No unexpected events and/or safety related issues during the operation of KNNP occurred.

During 2003 Units 1 and 2 were operated in state E (cold-shutdown). Maintenance activities on some safety systems have been performed.

Prolonged outage is foreseen for 2004 because of modernisation on Unit 5.


Collective dose EP-1 (1996 - 2003)
man.mSv
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1996 (2)
1997 (3)
1998 (3)
1999 (2)
2000 (3)
2001 (3)
2002 (3)
2003 (2)
Year (outages)


Collective dose EP-2 (1996 - 2003)
man.mSv
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1996 (2)
1997 (2)
1998 (2)
1999 (2)
2000 (2)
2001 (2)
2002 (2)
2003 (1)
Year (outages)

CANADA

Gentilly-2 ALARA programme

Dosimetric trend

2003 Total estimated collective doses (person·mSv)*

	January shutdown (1 day)	June shutdown (6 days)	Annual planned shutdown autumn (118 days)	Normal operation
External (gamma)	3.15	27.66	2 335.15	123.08
External (neutron)	1.84	0.10	0.31	38.23
Internal (tritium)	0.54	2.40	261.24	85.40
Total	**5.53**	**30.16**	**2 596.70**	**246.71**

*

In 2003, the total estimated collective dose was 2 879 person·mSv. Mainly, 90% of the annual collective dose is coming from the annual outage work.

Main events influencing dosimetric trends/results

One major work done during the annual planned shutdown contributed to around 50% of the collective dose. A small heat transport system leak appears on a feeder and the repair of this leak was added to the other activities normally planned for the annual shutdown. This was a complex activity and the location of the leak was in an area of high gamma dose rate (10 to 20 mSv/hr contact dose rate on adjacent feeders in the area).

The dose contribution from this work regarding all other activities of the planned shutdown is illustrated on the Table below.

Planned annual shutdown 2003 (person·mSv)

	Feeder leak repair	Other planned shutdown activities	Total estimated collective dose for shutdown
External	1 320	1 020	2 340
Internal	5	255	260
Total	**1 325**	**1 275**	**2 600**

Mockup training, temporary shielding (shielded cabinet and shelter), multibadging, cameras and remote dosimetry were extensively used to optimise collective dose for the leak repair activity.

Particularly, multibadging helps in reducing collective dose by 190 person·mSv and optimising the number of qualified workers needed to do the work.

Dose reduction programme evolution

There are two major source term reduction projects which are ongoing at Gentilly-2. They are first defining and choosing the best heavy water systems detritiation strategy and second bringing back to service the fuelling machine purification system.

Heat transport system and moderator system are the major contributors to internal doses. Chronic exposures to tritium are coming from heat transport system during normal operation and moderator system contributes to unplanned doses when a leak happens. We will closely follow the result of this study in 2004.

Fuelling machine purification system, which was never put in service since construction, could probably helps to reduce Cobalt-60 contribution. A benchmark activity with one of our sister plant identify this system as a potential contributor to our rising Co-60 contribution in the heat transport system.

Plans for major work in the coming year

There is no planned shutdown for 2004. The ALARA Committee approved the 2004 dose budget for normal operation at 292 person·mSv.

CZECH REPUBLIC

Dukovany NPP

Summary of dosimetric trends

The total collective effective dose (CED) at Dukovany NPP in 2003 was 0.785 man·Sv. CED for utility employees was 0.084 man·Sv, respectively 0.701 man·Sv for contractors. The total number of exposed workers was 2 016 (693 utility employees and 1 323 contractors). Dukovany NPP has installed four units of VVER-440, Model 213. The average annual collective dose per unit was 0.196 man·Sv. The total value of CED for 2003 year is at all the lowest value under whole time operation Dukovany NPP.

The maximal individual effective dose was 15.11 mSv, which was reached by one of the contractor workers during performing the SG internal equipment fittings and inspections at all outages.

Events influencing dosimetric trends

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

	Outage information	CED [man·Sv]
Unit 1	55 days, standard maintenance outage with refuelling	0.336
Unit 2	30 days, standard maintenance outage with refuelling	0.098
Unit 3	33 days, standard maintenance outage with refuelling	0.185
Unit 4	30 days, standard maintenance outage with refuelling	0.142

During outage Unit 1 the unplanned works on the steam generation number 2 were provided. This action included decontamination of SG, cutting off and welding ventilation line of collector and cutting off, exchange and welding of upper part of collector. The planned collective dose for this works was 75 mSv. The main works associated with exchange of upper part of collector were performed by workers of maintenance company, action duration 17 days. The true value of collective dose for this action including all the activities was 23.31 mSv, the highest individual dose 1.69 mSv, total number of personnel 76. The lower actual collective dose was due to very effective decontamination, using lead shielding and good skill of workers.

Unexpected events

There was no unusual or extraordinary radiation event in the year 2003 at Dukovany NPP.

Temelín NPP

Summary of national dosimetric trends

There are two units of WWER1000 reactor, model 230 in Temelín NPP. Both units are in a trail operation, unit one since June 2002, second unit since April 2003.

The total collective effective dose at Temelín NPP in year 2003 reached value 0.205 man·Sv. The average CED per unit was 0.1025 man·Sv. CED for utility employees was 0.031 man·Sv, for contractor workers 0.174 man·Sv.

The maximal individual effective dose in the year 2003 was 5.65 mSv for one radiation technician as a consequence of radiological supervision works in the containment of unit two on power.

There was no any occurrence of internal personnel contamination in the year 2003, thus the internal contamination contribution to collective effective dose rate is Zero.

Major evolutions

In Unit 1 there was the first standard maintenance outage with refuelling lasted 85 days in the year 2003. The outage collective dose was 0.14 man·Sv.

Unexpected events

There was no unusual or extraordinary radiation event in the year 2003 at Temelín NPP.

FINLAND

Olkiluoto

Summary of dosimetric trends

At Olkiluoto 1 the 2003 outage was a refuelling outage of duration of 9 days and at Olkiluoto 2 a 14 days service outage. The variation of annual doses (in man·Sv) of three past years can be seen in Table 1.

Table 1. Dose trends of Olkiluoto NPP

	2003	2002	2001
Olkiluoto 1	0.274	0.809	0.367
Olkiluoto 2	0.758	0.312	0.816
Average	0.516	0.560	0.592

Events influencing dosimetric trends

The most significant task in view of radiation protection was NDT inspections of reactor systems piping (OL2) with a collective dose of 0.071 man·Sv.

Component or system replacements

Replacement of the low pressure heat exchanger 2.441E1on OL2. Collective dose of the task was 0.042 manSv.

Issues of concern 2004

Replacement of all rigid and spring suspensions of one main steam line on both units.

Loviisa

Summary of dosimetric trends

Outage duration of Lo1 was 24 days and Lo2 17 days. The outage doses were 0.56 man·Sv and 0.28 man·Sv respectively. The trends of total annual doses (in man·Sv) are shown in Table 2.

Table 2. Dose trends of Loviisa NPP

	2003	2002	2001
Loviisa 1	0.609	1.041	0.760
Loviisa 2	0.332	1.573	0.367
Average	0.471	1.307	0.564

Events influencing dosimetric trends

Every other year the outage on one of the units is extended to make inspections on some of the main components. This can be seen in Table 2 as in even years the annual dose is significantly higher than in uneven years.

In year 2003 decontamination and cleaning in addition to tasks related to severe accident management project (hydrogen ignition plug installations) were the most important tasks in respect of dose accumulation on both units.

Outage dose on Unit 2 was all the time lowest in Loviisa operating history.

Component or system replacements

Installation of the new radiation monitoring system was completed as the equipment was taken into use at Unit 2.

Issues of concern 2004

The renewal project of personal contamination monitors was started in 2003. The project includes integration of access control and electronic dosimetry into the contamination monitoring system. The new system will be taken into use as complete by year 2006.

Regulatory issues

STUK issues detailed regulations concerning the safety of nuclear power plants. Those regulations are called YVL-guides. In 2002 STUK made a plan in which existing YVL-guides were evaluated. The guide concerning the radiation safety aspects in the design of NPPs was decided to be updated during 2003. In the new guide, accident situations including severe accidents and aspects of decommissioning of the plant will be taken into account in more detail.

FRANCE

Dose information

Collective doses

The average 2003 collective dose for the 3-loop reactors (34 reactors) was about 1.17 man·Sv. The average 2003 collective dose for the 4-loop reactors (24 reactors) was about 0.57 man·Sv. The average collective dose is 0.89 man·Sv per reactor in 2003 for a target of 0.95 man·Sv. The 2003 result is 8% lower than the 2002 result (0.97 man·Sv.). The number of short outages was 19 in 2003 and will be 22 in 2004. The number of standard outages was 23 in 2003 and will be 19 in 2004. There were 7 ten yearly outages in 2003 and will be 6 in 2004. One Steam Generators Replacement was realised in 2003 and one SGR is planned in 2004.

Individual doses

In 2003, the average individual dose of all exposed workers (EDF and contractors) is about 1.9 mSv on 12 months.

From October 2001 to September 2003, nobody has received an annual dose in excess of 20 mSv. In September 2003, due to an incident on a worksite in Bugey unit 2, a worker received 17 mSv in the month and his cumulated dose on 12 rolling months was 24.5 mSv.

At the end of 2003, only 53 workers from high exposed specialities (like insulation, scaffolding, welding, mecanicians) were recorded over 16 mSv on 12 rolling months.

Events influencing dosimetric trends, number of outages

EDF 3-loop reactors

The lowest collective dose for a short outage in 2003 was Tricastin 2 with 0.35 man·Sv. The lowest dose for a standard outage in 2003 was Blayais 3 with 0.80 man·Sv. The highest outage dose in 2003 was Saint Laurent B 2 with 2.37 man·Sv for a ten yearly outage and a steam generator replacement. In 2003, 2 reactors had no outage and the lowest annual dose was Fessenheim 1 with 0.17 man·Sv.

In 2004, the main contributors will be 15 short outages, 9 standard outages, 4 ten yearly outages and one steam generators replacement.

EDF 4-loop reactors

The lowest collective dose for a short outage in 2003 was Chooz 2 with 0.21 man·Sv. The lowest dose for a standard outage in 2003 was Civaux 1 with 0.29 man·Sv. The highest dose for an outage in 2003 was Flamanville 1 with 2.19 man·Sv for a standard outage. In 2003, 7 reactors had no outage and the lowest annual dose was Golfech 1 with 0.07 man·Sv.

In 2004, the main dose contributors will be 7 short outages, 10 standard outages and 2 ten yearly outages.

Dose incident

On 25 September 2003, at the Bugey NPP, at the end of a worksite on bolting of core internals, a piece of metal was blocked under the tool carriage and thus generated, out of the water, a high dose rate. A dose rate measure was required in the procedure before drawing the carriage out of the water, but not done. There were no beacon alarm and no dosimeter alarm, but at the reactor building exit, a worker saw a high dose of 7.5 mSv on his electronic personal dosimeter. This worker received 17 mSv on the month recorded on the filmbadge and 24.5 mSv on 12 months.

Future activities

The new targets in the field of collective doses are obtained with a yearly 5% decrease, i.e. 0.90 man·Sv per reactor in 2004, 0.85 in 2005 and 0.80 in 2006.

In the field of individual doses, the target is to reduce by 10% the number of workers exceeding 16 mSv on 12 months.

GERMANY

Dose information

Operating reactors

2003		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv]**
PWR	13	1.04 (incl. KKS)
BWR	6	0.93

Reactors in cold shutdown or in decommissioning

2003		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv]**
PWR	7	0.05 (incl. KKR, MZFR)
BWR	4	0.16 (incl. KWL, VAK)
GCR	2	0.02 (incl. AVR, THTR)
LMFB	1	0.02 (KNK-II)

Principal events

The number of operating PWRs has been decreased by the final shutdown of NPP Stade on 14 November 2003. The annual collective dose of NPP Stade (KKS) amounts to 0.2 Pers·Sv. Due to the late date (14.11.2003) of the shut down KKS is still considered in the summary in Table 1.

For the remaining 12 PWR units the annual collective doses range from 0.1 to 0.7 Pers·Sv, except NPP Biblis, which doses amount to 5.0 Pers·Sv for both units. In the past, the results for Biblis to a certain extent were significantly influenced by the special situation created by the former anti-nuclear authority. The policy of this authority led to a non-ALARA status and a blockage of numerous retrofit measures. After the federal government and the management of the local authority had changed, the realisation of these retrofit measures was started. Therefore, the unit capability factor of Biblis Units A and B amounts to 27% and 75%, respectively. The unit capability factor of all other PWRs ranges from 88.9% to 96.7%.

For the BWR units the annual collective doses range from 0.9 to 1.2 Pers·Sv, except NPP Brunsbüttel, which dose amounts to 0.3 Pers·Sv. This result is caused by an incident in 2002 and a subsequent longer shut down period which ended in March 2003.

The discussion about the installation of a dose monitoring system with EPD as a legal system is still ongoing, but the procedure has reached some agreement between different stakeholders (Federal Ministry, local authorities, official monitoring institutes), and a final concept of implementation is expected until autumn this year.

With respect to new German Radiation Protection Ordinance and its connected regulations, the utilities organised in the VGB elaborated further papers to clarify and harmonise the understanding of the new regulations for an application oriented at practical needs.

Under these aspects also a process may be of interest. Most German utilities are in discussion with their competent state authorities to get a licence for the procedure of the clearance of material from the plants (mainly from the RCA) to free release or restricted release. The procedures are restricted by settlements of the new Radiation Protection Ordinance and follow the nuclide specific limits, initiated by the European Directive on Radiological Protection.

HUNGARY

Paks NPP, Hungary

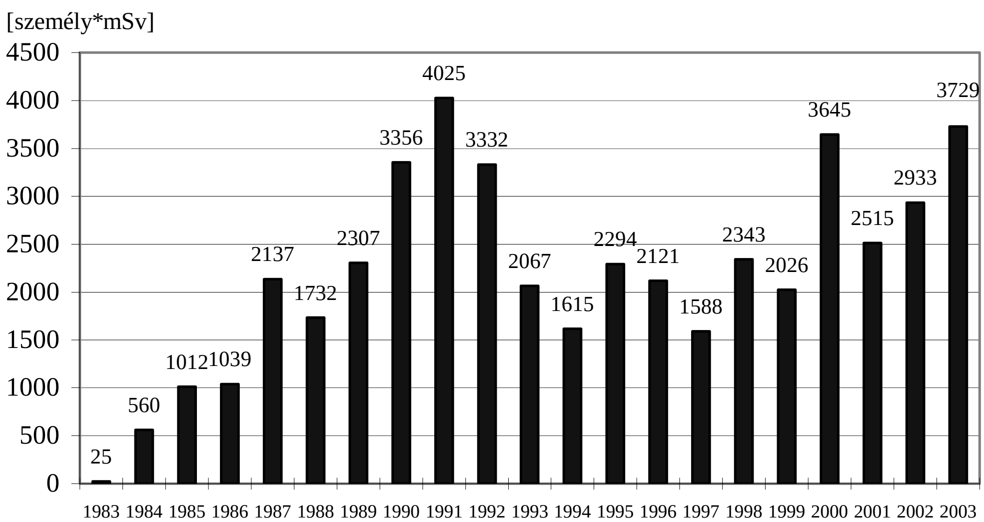
Dose information

Operating reactors

2003		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv]**
PWR	4	1.031 (with electronic dosimeters), 0.932 (with film badges)

Principal events

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



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

The collective dose significantly increased in comparison to the previous year. The higher collective exposures were mainly ascribed to the prevention and recovery work after the incident at

Unit 2, and the maintenance work performed at Unit 1. It can be stated upon considering the additional work – whether planned or unplanned – that the collective dose received in 2003 was justified.

Number and duration of outages

- A general overhaul (long maintenance outage) with a total duration of 57 days and 20 hours was carried out at Unit 1 in 2003.
- The general overhaul of Unit 2 was performed from 19 March to 15 October (because of the incident).
- There were two maintenance outages at Unit 3, with a total duration of 46 days and 14 hours.
- The maintenance outage of Unit 4 was carried out during a period of 25 days and 18 hours.

Component or system replacements

The replacement of the feedwater collector of two steam generators has taken place at Unit 1 in 2003. These two feedwater collectors had already been replaced in 2000 with ones of carbon steel material. The latter ones were replaced with feedwater collectors of austenitic material in 2003. To provide the optimisation of the radiation exposures, the replacement work was performed under the control of specific radiation protection arrangements.

- Filling the steam generators with water (primary side, secondary tube bundle + 100 mm),
- Shielding (Radishield, Flexshield shielding blanket).

The water level in the secondary side of the steam generator was tube bundle + 100 mm, as allowed by the work being performed.

The collective dose received during the replacement of the steam generator feedwater collectors was 246 person·mSv.

Unexpected events

There was a serious incident occurred at Unit 2 on 10 April 2003. On 10 April 2003, Unit 2 was under annual maintenance. The cleaning of the internal equipment of the reactor was in process, and in addition, the cleaning of 30 irradiated fuel assemblies from magnetite deposit was being performed by FANP personnel in Shaft 1, in a cleaning tank manufactured and supplied by FANP.

The damage of the fuel assemblies was caused by the overheating of the assemblies, due to insufficient cooling, followed by a thermal shock produced by the inrush of cold water into the tank after opening the tank lid. The water of Shaft 1 was contaminated with a large amount of radioactive isotopes, a part of which – first of all radioactive noble gases, iodine isotopes of organic and aerosol forms, and other fission products – was discharged into the air space of the reactor hall by bubbling through the water, and into the environment via the ventilation system and the ventilation stack.

The collective dose received during the incident prevention and recovery work between 10 April and 10 May was 166.8 person·mSv. The number of electronic dosimeters issued to the staff under 461 dosimetry work permits was 1882.

JAPAN

Summary of national dosimetric trends

Collective doses

The dosimetry level in the fiscal year 2003 was up about 12 man·Sv from the previous year for all operating units. The average annual collective doses per unit for all operating units, BWRs, and PWRs were 1.79 man·Sv, 2.40 man·Sv, and 1.07 man·Sv respectively.

The increase in dosimetry was mainly due to several modification works under high radiation dose rate during the periodical inspections for BWRs.

Reactor type	Number of units	Total collective dose (man·Sv)	Average collective dose (man·Sv)
PWR	23	24.52	1.07
BWR	30*	71.86	2.40

* Note: This number includes Hamaoka Unit 5, which is at pre-operational status, because, due to technical reasons, it is impossible to give the exact dose for the individual units of Hamaoka NPS.

Individual doses

The annual average exposure of radiation workers was 1.4 mSv and this exposure tends to be increasing from the fiscal year 2002. The highest annual individual exposure per nuclear power station was 19.8 mSv, which was well below the dose limit of 50 mSv/y. Although annual individual exposure of 6 workers who worked at several nuclear power stations and other nuclear facilities exceeded 20 mSv, this exposure was well below the limit as well.

The number of workers whose annual individual doses range from 15 mSv to 20 mSv was 1.038, which was about 83 more than the previous year.

Status of outage and periodical inspection

Periodical inspections were completed at 16 BWRs and 16 PWRs. The average duration for periodical inspection was 215 days for BWRs and 61 days for PWRs. The long duration of BWRs was due to the inspections and repairs of the reactor recirculation pipes and shrouds.

For the following year

In the fiscal year 2004, the modification works, the inspections and repairs of the PLR pipes are scheduled, is expected that the dosimetry level in the fiscal year 2004 is as same as the one in the fiscal year 2003.

KOREA, REPUBLIC OF

Summary of national dosimetric trends

For the year of 2003, 18 NPPs were in operation; 14 PWR units and 4 CANDU units. A new PWR, Ulchin Unit 5 (1 000 MWe) had done the test operation in 2003. The average collective dose per unit for the year 2003 was 0.57 man·Sv slightly higher than 0.55 man·Sv in 2002.

As in previous years, the outages of units in 2003 contribute the major part to the collective dose, 71.5% of the collective dose was due to works carried out during the outages. The average annual collective doses of both reactor types for 5 years and average annual collective doses per unit in 2003 are shown in the following tables:

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

Year	1999	2000	2001	2002	2003
PWR (number of reactors)	0.84 (11)	0.77 (12)	0.67 (12)	0.52 (13)	0.51 (14)
CANDU (number of reactors)	0.85 (4)	0.55 (4)	0.67 (4)	0.63 (4)	0.79 (4)

Average annual collective and individual doses per unit for the year of 2003

NPP	Type	Outage duration (days)	Collective doses (man·Sv)	Average individual doses (mSv)
Kori 1	PWR	31	0.75	0.97
Kori 2	PWR	37	0.64	
Kori 3	PWR	–	0.23	0.88
Kori 4	PWR	31	0.98	
Yonggwang 1	PWR	39	0.98	1.38
Yonggwang 2	PWR	35	0.96	
Yonggwang 3	PWR	32	0.28	0.28
Yonggwang 4	PWR	–	0.02	
Yonggwang 5	PWR	84	0.38	0.46
Yonggwang 6	PWR	43	0.31	
Ulchin 1	PWR	55	0.94	1.11
Ulchin 2	PWR	45	0.24	
Ulchin 3	PWR	–	0.05	0.36
Ulchin 4	PWR	27	0.36	
Wolsong 1	CANDU	44	1.36	1.62
Wolsong 2	CANDU	29	0.64	
Wolsong 3	CANDU	24	0.66	0.97
Wolsong 4	CANDU	19	0.51	

There were total 8 741 people involved in radiation works in 18 operating units and one commissioning reactor, and the total collective dose was 10 288 man·mSv. The outage duration was 575 days in 2003 and 438 days in 2002. As the outage duration is longer than the one in 2002 the total collective dose is also higher as well. Korea has applied a strategy to lengthen the NPPs operational period, which is counted from previous outage to the new one, and many NPPs have already extended the length from 12 month to 18 month. Because of this extension, the outage frequency in a year is different from one to the other calendar year as shown in the following table.

For the individual dose, there has been no worker who received radiation dose in excess of 20 mSv a year since 1999.

Collective doses and outage duration in 2001/2002/2003

Year	Number of reactors	Collective doses (man·Sv)		Outage duration	
		Total	Average doses per unit	Number of outage reactors	Duration days
2001	16	10.75	0.67	13	510
2002	17	9.32	0.55	11	438
2003	18	10.29	0.57	15	575

Principal events

In January 2003 the regulations on the occupational dose limits that are in accordance with the ICRP 60 recommendations came into force. Also the regulatory requirements on internal dose assessment and reporting came into force in January 2003.

In an effort to maintain the occupational exposures ALARA, the Korea institute of Nuclear Safety (KINS) under the support of the Korean government has been developing the Korean Information System on Occupational Exposure (KISOE) since the establishment on 27 November 2002. The system is an internet-based network system that includes the information of occupational exposure as well as associated information such as work categories for all radiation workers.

LITHUANIA

The average annual collective dose per unit in 2003 for the Ignalina nuclear power plant (INPP) [2 units with LWGR (RBMK) reactors]: INPP personnel – 3.33 man·Sv, outside workers – 0.94 man·Sv. Total collective dose per unit was 4.27 man·Sv. In comparison to 2002, the collective dose has decreased in 2003.

Planned annual collective dose for INPP personnel was 7.59 man·Sv, for outside workers – 2.57 man·Sv. Total planned annual collective dose was 10.15 man·Sv or 5.08 man·Sv per Unit. Total number of workers wearing individual dosimeters was 4 458 (2 957 INPP personnel, 1 501 outside workers). The maximal effective dose was 20.52 mSv (average effective individual dose: for INPP staff – 2.25 mSv, for INPP staff and outside workers – 1.92 mSv). As a result of maintenance works during the unplanned outage of the Unit 2 in November 2003, three workers of the Central Maintenance Department have received individual doses higher than 20 mSv.

In 2003 the assessment of internal exposure for 2 659 workers was carried out. There was no internal overexposure detected.

In 2003 the outage of Unit 1 was 102 days, outage of Unit 2 took 58 days.

During 2003, the collective dose was distributed as following: normal operation – 1.40 man·Sv (17% of annual collective dose), outage of Unit 1 – 4.64 man·Sv (54% of annual collective dose), outage of Unit 2 – 2.50 man·Sv (29% of annual collective dose).

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

	Works contributed to collective dose	Unit 1 (man·mSv)	Unit 2 (man·mSv)
1.	Reactor vessel. (maintenance, repairs, inspection of the reactor fuel channels)	1 509.2	178.1
2.	Main circulation circuit		
	2.1 Preparing for the inspection of the primary system pipes (d=300mm, d=800 mm)	70.9	103.8
	2.2 Inspection of the Primary System Pipes (d=300mm, d=800 mm)	100.8	157.4
	2.3 Repairing of the primary system pipes (d=300mm, d=800 mm) and pipeline valves	530.1	292.7
	2.4 General works	126.6	292.7
3.	Repairing of the reactor equipment and refuelling	137.5	170.9
4.	Insulation works	190.8	237.4
5.	Installation of the temporary shielding	67.8	43.0
6.	Scaffolding and tents	82.9	32.0
7.	Rooms decontamination	189.1	66.4
8.	Monitoring of radioactive contamination	84.0	65.6
9.	Routine inspections	79.0	55.6
10.	Other works	474.7	397.7

The overall dose after implementation of the works during outage period of Unit 1 was 3.65 man·Sv, that means 96% of the total dose during outage of Unit 1 in 2003 and 54% of the annual dose of the INPPs personnel including contractors.

The overall dose after implementation of the works during outage period of Unit 2 was 2.09 man·Sv, that means 84% of the total dose during outage of Unit 2 in 2003 and 29% of the annual dose of the INPPs personnel including contractors.

Goals for the INPP for the year 2004:

- The maximal individual dose for Reactor Department and Central Maintenance Department has to be below 30 mSv, with condition that effective dose will be below 20 mSv per year averaged over defined periods of 5 years.

- Doses of INPP personnel were defined in regard of possible maintenance of the collectors in Reactor Emergency Cooling System and taking into account the measures to reduce gamma radiation causing doses in workplaces.

- The collective dose of the personnel has not to exceed 12.30 man·Sv, that is determined by the dose budget for the year 2004 and approved by the Radiation Protection Centre (RPC).

- Further implementation of the ALARA principle will be continued by conducting appropriate activities, such as: proper management of jobs, additional training of personnel, improving of working conditions, improving of technological processes, strengthening of quality assurance, safety culture, avoiding influence of human factor. The measures foreseen for implementation of ALARA principle are included in the Ignalina NPP ALARA programme, which results showed it is effectiveness.

- In 2003, the RPC performed inspections at the INPP with following main tasks:

  – controlled how the requirements of legal radiation protection acts were implemented at the INPP;
  – evaluated trends of the occupational exposure of INPP personnel and outside workers;
  – controlled how the radiation protection requirements were implemented at the spent nuclear fuel storage and during the waste management;
  – evaluated the implementation of optimisation principle at the plant.

The RPC also took part in the licensing of INPP Unit 2. With regard to coming closure of INPP, the RPC with other regulatory authorities revised the Draft Final Decommissioning Plan of INPP and the Decommissioning Environmental Impact Assessment Programme. Jointly with support from Sweden, the workshop on decommissioning planning issues of nuclear facilities has been arranged. Also RPC took part in preparation of information brochure for general public on planning and implementation of measures related to decommissioning issues of INPP.

MEXICO

Laguna Verde NPP (LVNPP): Two units BWR rated 684 MWe each

Dose information – 2003

Operating reactors

Reactor type	Number of reactors	Average annual collective dose per unit and reactor type [man·Sv]
BWR	2	1.91

Principal events

Main events influencing dosimetric trends/results

Unit 2 – 6th refuelling outage, top dose jobs:

- In-service inspection in the drywell: 0.46 man·Sv.
- Control rod drives (32) change/maintenance: 0.30 man·Sv.
- Thermal insulation removal/replacement: 0.12 man·Sv.

This was the only refuelling outage of 2003 and lasted 48.68 days.

Component or system replacements

An interconnection between Residual Heath Removal (RHR) and Spent Fuel Pool Cooling and Cleanup (FPCC) systems in both Units is in progress. This modification has the purpose of giving plant operations more flexibility regarding cooling systems resources. The whole job, started in 2003 and scheduled to finish by the end of 2004, will consume about 0.2 man·Sv per Unit.

Unexpected events

During the U2 seventh refuelling outage, problems were detected with the internals of the Suction Valves of both recirculation loops (2B35B-MV-8827 A/B). These valves had to be dismantled and subject to a major corrective maintenance. This contingency alone consumed 57 man·mSv and made longer the outage by 6 days.

Dose reduction programmes

In 2003, Laguna Verde Units LVNPP continued among the best performers regarding the BWRs GE fleet, with a remarkable low cobalt concentration in reactor water. To take full advantage of the relatively good radioactive source term, the utility will continue working on the reduction of collective time that personnel spent into the radiation fields, which is higher than in similar utilities.

Issues of concern – 2004

The Unit 1/10th refuelling outage that started on 10 April, was subject to two major contingencies:

- Unexpected crackings were found in the blades of the low pressure turbines. All the blades of these turbines had to be replaced. This lead to a 74 days outage, originally scheduled for 35 days.

- Internals of five out of the six recirculation valves needed repair. The original programme had only included two of them. This became a 0.47 man·Sv contingency.

Technical plans for major work

2004 was planned as a "high dose – refurbishing year". This means that, besides the two refuelling outages that L. Verde will have this year, several high-dose activities will be achieved. The idea is to tie planning needs with collective dose in such a way that average collective dose per year and per unit. An average collective dose per unit in the order of 3 man·Sv is expected for this year.

On account of the contingency with the recirculation valves occurred during U1/10th refuelling outage, all the six recirculation valves of Unit 2 will be opened and reviewed to make corrective maintenance to possible damages that could be found during its 7th refuelling outage that will start in October 2004. Since also the change of rotors of the recirculation pumps were already in the programme, this is expected to be the most intensive refuelling outage work regarding the recirculation system.

NETHERLANDS

Dose information

Operating reactors

2003		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv]**
PWR	1	0.265

Reactors in cold shutdown or in decommissioning

2003		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv]**
BWR	1	0.092

Principal events

The Netherlands has 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. Transports of fuel to the BNFL reprocessing plant have been completed by April 2003. The plant is the process of modification into a 40-year "safe enclosure" status, before full decommissioning and return to green field conditions. Several decontamination and decommissioning activities have been carried out in 2003. Highest individual dose was 4.8 mSv. Decommisioning activities are planned for next year, for which the collective dose is planned not to exceed 0.1 man·Sv.

The **Borssele plant** (450 MWe), operated by NV EPZ, is a baseload unit. Up to this year it has enjoyed 30 years of commercial operation. Major backfittings were completed in the plant in 1997. The unit capability factor in 2003 was 96.3%.

The annual outage in September was a short refuelling outage which lasted 10.5 days. The outage dose was 0.195 man·Sv, which was 15% lower than planned before.

In 2003, 78% of the plant personnel and 73% of the contractors received a dose less then 0.5 mSv, the highest individual dose was 4.6 mSv for plant and 3.6 mSv for contractor personnel.

Nuclear waste facility

The government-owned organisation COVRA charged with the management of all Dutch waste, is located in Vlissingen near the Borssele NPP.

An intermediate storage facility for high radioactive waste has been built and has formally been inaugurated on 30 September 2003. This new HABOG facility will contain irradiated fuel from research reactors and residues from reprocessing of the Dodewaard and Borssele fuel in Sellafield and La Hague. The nuclear waste policy of the Dutch government is based on the concept of 100-year storage above ground at the COVRA site and investigation of the options for retrievable final geological storage.

PAKISTAN

The data of collective dose at KANUPP and CNPP for the year 2003 is submitted herewith.

Year	Plant	Reactor type	Collective dose
Jan-Dec. 2003	KANUPP	CANDU	3.815 man·Sv

Year	Plant	Reactor type	Outage dose	Collective dose
Jan-Dec. 2003	CNPP	PWR	No outage during 2003	72.64 man·mSv (0.73 man·Sv)

ROMANIA

SNN CNE-PROD Cernavoda operates a single unit Nuclear Power Plant CANDU-600 type. 2003 was the seventh full operation year.

In 2003 the collective dose was 818.28 man·mSv, higher than 2002 value.

Summary of CNE-Prod dosimetric trends

Occupational exposure at Cernavoda NPP, February 1996 – December 2003

	Internal effective dose man·mSv	External effective dose man·mSv	Total effective dose man·mSv
1996	0.60	31.70	32.30
1997	3.81	244.48	248.28
1998	54.37	203.25	257.62
1999	85.42	371.11	469.89
2000	110.81	355.39	466.20
2001	141.42	433.44	574.86
2002	206.43	344.04	550.48
2003	298.02	520.27	818.28

Events influencing dosimetric trends

In 2003 the planned outage was long (46 days) having a 62% contribution to the collective dose, higher than previous years.

Number and duration of outages

During 2003 there were:

1. one 27 days forced outage between 24 August-19 September, due to low levels of water in the distribution bay, without any special radiological impact;
2. one 46 days planned outage, between 17 May and 1st July.

Major evolutions

In 2003 CNCAN continued to issue new regulations:

- Law no. 193/2003 for modification and completion of Law 111/1996 for safety development of nuclear activities.
- Ord. 74/2003 "Regulations for specific requirements for quality management systems in operating of nuclear installations".
- Ord. 69/2003 "Regulations for specific requirements for quality management systems in design of nuclear installations".
- Ord. 70/2003 "Regulations for specific requirements for quality management systems in supplying activities for nuclear installations".
- Ord. 682003 "Regulations for specific requirements for quality management systems in research-development activities in nuclear domain".
- Ord. 66/2003 "Regulations for generic requirements for quality management systems in constructing, operating and decommissioning of nuclear installations".
- Ord. 67/2003 "Regulations for specific requirements for quality management systems in evaluating and choosing the site for nuclear installations".
- Ord. 75/2003 "Regulations for specific requirements for quality management systems in making and using the software for research, design, analysis and calculations for nuclear installations".
- Ord. 72/2003 "Regulations for specific requirements for quality management systems in constructing-mounting activities for nuclear installations".
- Ord. 73/2003 "Regulations for specific requirements for quality management systems in commissioning of nuclear installations".
- Ord. 71/2003 "Regulations for specific requirements for quality management systems in goods producing and services supplying for nuclear installations".
- Ord. 65/2003 "Regulations for authorisation of quality management systems in constructing, operating and decommissioning of nuclear installations".
- Ord. 155/2003 "Regulations for operational radiation protection for non-destructive examinations activities with ionising radiations".

In 2003 continued the implementation of the latest CNCAN regulations related to: personnel dosimetry, radiation protection training and qualification of workers, authorisation/acceptance of external companies and dosimetric surveillance of external workers.

In 2003 became operational the intermediate dry spent fuel storage and 3 600 spent fuel bundles were successfully transferred. The radiological impact for personnel involved in these operations was lower than expected.

Safety related issues

In order to prevent the exit of any radioactive material (sources, contamination) from the controlled area of the site, at the main gate were installed three (3) Portal Monitors PM7 from Thermo-Eberline Instruments.

New/experimental dose-reduction programmes

In order to decrease the doses related to mounting/dismantling scaffolds and access platform inside steam generators' cabinets each outage, during the planned outage 2003 permanent metallic access paltform were installed here.

Relevant issues for 2004

Technical plans for major work in 2004

The major activities planned for 2004 outage having a potential impact on the collective dose are: feeders inspection/repair, "eddy current" inspection of 2 boilers with workers inside the boilers on primary circuit side, moderator purification system's "spool piece" repositioning, activities included in preventive/corrective maintenance programme, replacement of VFDs assemblies.

Regulatory plans for major work in 2004

CNE-PROD ALARA committee will be established during 2004.

RUSSIAN FEDERATION

Dose information

Operating reactors

2003		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv]**
PWR (WWER)	14	1.185

Reactors in cold shutdown or in decommissioning

2003		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv]**
PWR (WWER)	2	0.340

Summary of national dosimetric trends

Collective doses

Collective doses for all operational WWERs are shown in the following Table.

Nuclear Power Plant		Normal operation, man·Sv/unit	Outages, man·Sv/unit	Total, man·Sv/unit
Balakovo	Unit 1, WWER-1000	0.100	0.477	0.577
	Unit 2, WWER-1000	0.095	0.874	0.969
	Unit 3, WWER-1000	0.090	0.487	0.577
	Unit 4, WWER-1000	0.095	0.366	0.461
Kalinin	Unit 1, WWER-1000	0.135	0.650	0.785
	Unit 2, WWER-1000	0.135	0.820	0.955
Kola	Unit 1, WWER-440	0.252	1.031	1.283
	Unit 2, WWER-440	0.197	1.555	1.752
	Unit 3, WWER-440	0.103	0.914	1.017
	Unit 4, WWER-440	0.108	0.295	0.403
Novovoronezh	Unit 3, WWER-440	0.460	3.141	3.601
	Unit 4, WWER-440	0.514	2.631	3.145
	Unit 5, WWER-1000	0.383	0.429	0.812
Volgodonsk	Unit 1, WWER-1000	0.007	0.243	0.250

In comparison with 2003, the average annual collective dose (personnel and contractors) per unit for operational WWER type reactors decreased at 5%. Main parts of total annual collective doses were registered during outages.

The highest collective doses had Novovoronezh 3 and Novovoronezh 4. These results came out from a lot of maintenance and repair works, connected with Units 3 and 4 life time extension, and insufficient implementation of radiation protection organisational and technical activities.

Individual doses

In year 2003 there were no events of exceeding 20 mSv of annual individual dose. The highest individual effective doses were:

- Balakovo – 15.6 mSv;
- Kalinin – 18.4 mSv;
- Kola – 19.5 mSv;
- Novovoronezh – 16.9 mSv;
- Volgodonsk – 2.9 mSv.

All these workers are from the plant central repair department and doses were caused by maintenance and repairing activities (main coolant pump, primary circuit, reactor vessel and internals, valves, SG primary and secondary sides). Doses were gradually received during 2003.

It is necessary to note some modification in the distribution of annual individual external doses at Kalinin NPP. The number of the plant and outside personnel in the dose interval 0.0-0.1 mSv increased at 840 persons in 2003, compared with 2002. The reason is the hiring of new staff for Kalinin 3 (Kalinin 3 is planed to put into operation in 2004). This personnel had preliminary training and pre-starting procedures at Kalinin 1 and 2 over the last year.

Number and duration of outages

Name of reactor unit	Since	Duration, days
Balakovo 1	08.02.03	52
Balakovo 2	08.03.03	88
Balakovo 3	01.09.03	54
Balakovo 4	01.06.03	65
Kalinin 1	22.06.03	45
Kalinin 2	11.04.03	49
Kola 1	15.02.03	87
Kola 2	16.05.03	116
Kola 3	20.07.03	56
Kola 4	03.10.03	28
Novovoronezh 3	02.06.03	90
Novovoronezh 4	14.09.03	72
Novovoronezh 5	19.07.03	52
Volgodonsk 1	05.05.03	55

Component or system replacements

In the context of Kola 1 and 2 specific modification and modernisation aimed at units life time extension, the most high collective doses were registered for the next jobs:

- At Kola 1 – renovation of boric acid emergency system. Total collective dose was 93.4 man·mSv.
- At Kola 2 – modernisation of the Accident Localisation System with construction of jet-vortex condenser instead of the relief valves. The same activity was performed at Kola 1 in 2002. The use of ALARA feedback reduced collective dose from 147.9 man·mSv at Kola 1 in 2002 to 124.8 man·mSv at Kola 2 in 2003.

New dose-reduction programmes in 2003

- Technical testing of personnel dosimetric control computer based system was performed at all WWERs.

Issues of concern for 2004

- Kalinin 3 is planned to put into operation.
- Preparation of the programme for modernisation of automated radiation control system.
- Further activities aimed at practical implementation of personnel dosimetric control computer based system.
- Implementation of electronic personnel dosimeters, produced in the Russian Federation.

SLOVAK REPUBLIC

The average annual collective dose per unit and reactor type PWR–VVER in Slovak Republic for 2003 is 306.876 man·mSv

Bohunice Nuclear Power Plant (4 units)

The total annual effective dose in Bohunice NPP in 2003 calculated from legal film dosimeters was 1 404.328 man·mSv (employees 751.604 man·mSv, outside workers 652.724 man·mSv). The maximum individual dose was 11.275 mSv (contractor).

Events influencing dosimetric trends in 2003

The main contributors to the total collective dose at Bohunice NPP were the outages at Units 2 and 3. The major maintenance outage was at Unit 2 and the standard maintenace outage at Unit 3 was combined with the modifications – modernisation works. The higher dose rates at Unit 2 due to the historical contamination of the primary loops also played the important role in higher occupational exposures. All activities performed in radiatiation-controlled zones had been optimised.

Number and duration of outages

Unit 1 – 39 days standard maintenance outage. Total collective dose was 317.54 man·mSv.
Unit 2 – 70 days major maintenance outage. Total collective dose was 526.81 man·mSv.
Unit 3 – 77 days standard maintenance outage. Total collective dose was 330.91 man·mSv.
Unit 4 – 42 days standard maintenance outage. Total collective dose was 127.31 man·mSv.

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

Component and system replacement

Several important modernisations of old radiation protection instrumentation had been performed in 2003:

- finishing of the modification of RP calibration facility;
- beginning of the exchange of portal personal contamination monitors at all exit points from RCA for women;
- modernisation of gas discharge monitors in the ventilation stack V2 NPP (Units 3 and 4);
- installation of accident monitors on live steam pipelines from steam generators at Units 3 and 4;
- beginning of the modernisation of the main radiation control room at Units 3 and 4;
- modernisation of release counting and spectrometry laboratory as well as the environmental laboratory;
- upgrading of electronic personal dosimetry system software.

Organisational evolutions

Beginning of the privatisation process of Bohunice NPP caused again the lowering of the number of NPP RP employees.

Expected principal events for 2004

Plans for major works in the coming year

Unit 1 – 36 days standard maintenance outage.
Unit 2 – 36 days standard maintenance outage.
Unit 3 – 65 days major maintenance outage combined with the modernisation works.
Unit 4 – 85 days standard maintenance outage combined with the modernisation works.

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

Technical issues of concern from radiation protection point of view

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

- finalising of the improving of contamination measurement at all exit points from RCA for women;
- finishing of the modernisation of the main radiation control room at Units 3 and 4.

Mochovce Nuclear Power Plant (2 units)

Total collective effective dose (CED) for the two units was 436.933 man·mSv (CED was evaluated from legal film badge and TLD neutron personal dosimeters), maximum individual effective dose was 6 693 mSv (EMO worker).

Events influencing dosimetric trends in 2003

The main contributors to the total CED at Mochovce NPP were planned outages at Units 1 and 2. The total CED for both units from normal operation was 94 873 man·mSv and CED from outages was 342 060 man·mSv (CED were evaluated on a base of results of operational electronic personal dosimeters).

Number and duration of outages

Unit 1 – 42 days long planned standard outage. Total CED was 220 857 man·mSv (plant personnel 103 028 man·mSv, contractors 117 829 man·mSv).
Unit 2 – 42 days long planned major outage. Total CED was 121.203 man·mSv (plant personnel 54 864 man·mSv, contractors 66 339 man·mSv).

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

Component and system replacement

IC system of air sampling system.

Expected principal events for 2004

Plans for major works in the coming year

Unit 1 – 42 days standard maintenance outage.
Unit 2 – 41 days standard maintenance outage.
Units 1 and 2 – 21 days standard maintenance of common equipment.

Technical issues of concern from radiation protection point of view

Clearance of radioactive material to the environment according Slovak legislation in order to decrease amount of radioactive waste.

Regulatory plans for major work in the coming year

- Implementation of EC legislation.
- Assessment of upgrading of both units of NPP V2 in Bohunice.
- Inspections of outages in all operated units.

SLOVENIA

Radiological performance indicators of Krško nuclear power plant (PWR) for the year 2003 were:

- Collective radiation exposure was 0.80 man·Sv (0.16 man·mSv per GWh electrical output). Maximum individual dose was 11 mSv, average dose per person was 0.95 mSv.
- Planned outage (10.5.03-4.6.03), 26 days.
- Refuelling outage collective dose was 0.72 man·Sv. Main additional activities were steam generators tubes and reactor vessel head penetrations eddy current testing.

Other

Third IAEA OSART mission was in Krško NPP in the year 2003.

Major evolution

Besides the existing regulatory body concerning radiation and nuclear safety, the *Slovenian Nuclear Safety Administration (SNSA)*, the new regulator body, the *Slovenian Radiation Protection Administration (SRPA)* was established in 2003. The new regulatory body is within the Ministry of Health and its scope is protection of radiation workers and the public against ionising radiation.

The preparation of legislation related to radiation and nuclear safety based on the *Act on Protection Against Ionising Radiation and Nuclear Safety*, which was put into force in 2002 and updated in 2003, took place. It follows the EU regulations of the Euratom.

Two experts councils were established:

- expert council providing advice to SNSA on issues related to radiation and nuclear safety, to the physical protection of nuclear substances and facilities, to the protection of nuclear materials, to radiation levels in the environment, to the protection of the environment against ionising radiation, to intervention measures, to emergency events, and to the use of radiation sources in industry; and

- expert council providing advice to SRPA on issues relating to the protection of people against ionising radiation, to radiological procedures and to the use of radiation sources in health and veterinary care.

SOUTH AFRICA

Summary of national dosimetric trends

During the year, 2 049 people were occupationally exposed at Koeberg Nuclear Power Station. The total collective dose for the workforce was 2044.3 man·mSv versus a target of 2420 man·mSv. The annual average dose for the occupationally exposed work force was 0.998 man·mSv. The highest individual dose was 17.29 mSv.

Events influencing dosimetric trends

Koeberg Nuclear Power Station successfully completed two refuelling outages during 2003 which contributed 80% of the collective dose for 2003. The refuelling outage on Units 1 and 2 contributed 802.44 man·mSv and 835.66 man·mSv to the collective dose respectively.

Number and duration of outages

Two refuelling outages were successfully completed. The duration of the refuelling outage on Unit 1 was 50 days and on the duration of the Unit 2 refuelling outage was 62 days.

Unexpected events

The Ag-110m activity increased in the primary system during the refuelling outage on Unit 2. This resulted in slightly higher ambient dose rates in the reactor building than anticipated.

New dose-reduction programmes

A Hotspot reduction programme was implemented to reduce the number of hotspots in radiological controlled zones to a minimum.

Technical

The following dose reduction initiatives are in progress:

- A feasibility study is in progress to assess radiological protection advantages in terms of dose reduction associated with depleted zinc injection.
- Improvement to the design of primary system lagging is in progress to facilitate easy removal and replacement.
- The management of liquid waste is optimised to reduce public dose.

Plans for major work in the coming year

Dose assessments have been conducted for all major tasks. The dose target for 2004 at Koeberg Nuclear Power Station is set at 1 320 man·mSv as per the Nuclear Cluster General Manager's challenge.

SPAIN

In the year 2003 the average dose per outage has been 0.417 person·Sv for PWR (6 units) and 1 787 person·Sv for BWR (2 units).

Per plant, the annual and outage collective doses are shown in the following table:

NPP	Type	Outage coll. doses (person·Sv)	No. Days	Annual coll. doses (person·Sv)	Comments
J. Cabrera	PWR	0.455	60	0.652	
Almaraz I	PWR	0.425	22	0.454	
Almaraz II	PWR	0.334	31	0.363	
Ascó I	PWR	0.543	35	0.669	
Ascó II	PWR	–	–	0.301	No outage
Vandellos II	PWR	0.515	25	0.591	
Trillo	PWR	0.230	20	0.249	
S.M Garoña	BWR	0.949	24	1.240	
Cofrentes	BWR	2.625	32	3.085	

Relating the total annual collective dose in PWRs, these values continue decreasing in all the Plants. The PWR average for this year is 0.468 person·Sv and the 3 year rolling average is 0.48 person·Sv. This last value indicates that the downward trend continues (decreasing from 0.53 to 0.48), with values in line with those of the previous years.

Regarding the total annual collective dose in BWRs, the total collective dose average for this year is 2 163 person·Sv and the three-year rolling average is 1.55 person·Sv. In this case, there has been an increment comparing the previous value (increasing from 1.32 to 1.55) due to the contribution of Cofrentes dose values.

Relating Cofrentes NPP, during the RFO 14, an unexpected dose rate increase in the Drywell was experienced. This phenomenon caused that the initial estimate of the collective dose for the outage was changed from 1.8 person·Sv to 2.8 person·Sv. The final collective dose of the RFO 14 was 2.6 person·Sv. The dose rate increase was 3 times in contact with the recirculation loops and in general areas was a 2 times increase, from the historical values.

The current hypothesis is that the elevated shut down dose rate observed in the Drywell were due to corrosion film restructuring process in the piping. This effect occurred early in Cycle 14 when the ECP values finally dropped as copper concentration decreased to low levels. The resulting restructured corrosion films are believed to have grown to a higher thickness than normal because of the effect of copper compounds deposited on and in the legacy oxide. Plant chemistry control during Cycle 14 was excellent and no change in the operation of the plant during Cycle 14 could have prevented the observed phenomenon from occurring.

Regarding Santa María de Garoña, this Plant has achieved the best outage dose and duration record in its life.

Relating Ascó 1, this plant has had an outage dose of 543 person·mSv, of which 102 person·mSv has been due to design modifications (mainly to the new access platforms in loop B) and 71 person·mSv due to head vessel replacement. Besides, the replacement of the SVR (Radiological Surveillance System) has been performed.

Vandellós 2 achieved its best result due mainly to dose rates reduction as a consequence of improvements in primary water chemistry, improvement of the Filter System and the use of new fuel elements.

In Almaraz site both units has had standard refuelling outages. In Unit 1 radiation dose rates keep on diminishing as the remaining antimonium has finally disappeared.

José Cabrera, with an outage dose of 455 person·mSv, suffered and important delay in resuming power operation, but without consequences in collective doses.

Trillo, with a standard refuelling outage (230 person·mSv) had its shorter outage duration of 20 days. Four new Dry Spent Fuel Containers have been stored in the Interim Storage Building , with a reduction of the 300% in the maximum individual dose and a reduction of the 65% in the collective dose of the workers involved, comparing with the last year.

Relating Vandellós I, the main decommissioning labours under the radiological point of view have been carried out: the transport of the graphite containers to the Temporary Waste Storage building, where they will spent the next 25 years, the dismantling and demolition of some more buildings and the conditioning of radiological wastes.

The new Regulation on training in radiation protection issued on 3 July 2003, came into force. The aim is to set the scope for training programmes of outside external workers, both for specific site related information and basic radiation protection education. At the same time, UNESA (electric companies group) has developed a basic training course freely available upon request to external companies.

SWEDEN

Summary

During 2003 the total collective dose at the Swedish NPPs was 11.7 man·Sv, which is less than previous year. Due to unplanned repair work the outage period was prolonged at several units. The highest individual dose was 27 mSv. Eight workers received a dose greater than 20 mSv.

The average collective dose per PWR unit (3 units) was 0.57 man·Sv and the average collective dose per BWR unit (8 units) was 1.24 man·Sv.

Collective dose and dosimetric trends

Barsebäck

The total collective dose was 1.2 man·Sv. The collective dose for Unit 1, which is finally closed down, was 0.06 man·Sv. Unit 2 was stopped in January during 7 weeks for repair of a water mixer in the feed water system.

During the planned outage, besides replacement of fuel and normal maintenance, inspections of the reactor pressure vessel were performed. A suspected crack in the feed water system resulted in enlarged inspections. A water leakage from the condensation pool was found. It was very time consuming to find the leakage and to perform the repair work. Mostly due to this the outage was prolonged 17 weeks.

Forsmark

The total collective dose was 2.4 man·Sv. The dose rates at Units 1 and 2 have increased, but at Unit 3 the dose rates are still low.

The core spray was removed at Units 1 and 2 during the outages.

At Unit 2 modifications of the moist separator were performed. Due to extensive cracking in the welds of the supporting consoles to the steam dryer repair work had to be done. The collective dose for this job was 165 man·mSv.

The outage at Unit 3 lasted for only 13 days. The dose rates on the shut down cooling system, which was decontaminated in 2001, are now recontaminated to 50% of the dose rates before the system decontamination.

Oskarshamn

The total collective dose was 3.64 man·Sv.

The outage at Unit 1 was planned for 6 weeks but was prolonged for another 3 weeks because flakes from the fuel boxes were found in the CRD's and in the RPV. Due to this maintenance had to be performed on 60 CRD's instead of planned 17 CRD's.

At Unit 2 the modernisation of the plant was started. It will be performed in several smaller stages during a prolonged time. Pipes and valves of the main recirculation loops and the spray system for the RPV were replaced because of IGSCC. Before the performance a chemical system decontamination was performed very successfully.

The outage was prolonged with 12 weeks because of unplanned repair work of 8 of totally 15 reactor water measuring nozzles and in connection to that repair of a damaged core grid.

An incident with a potential risk for high personnel doses occurred short after the start up after the outage of Unit 2. The door to the TIP room was found unlocked, the radiation shield was not in place and the radiation alarm was not activated. The incident was thoroughly investigated and measures have been taken to prevent repetition.

When starting up Units 1 and 2 after outage zinc injection was started in order to reduce the dose rates and doses as well as the discharges to the environment.

Ringhals

The total collective dose was 4.3 man·Sv.

During the outage of Unit 1 a water level measuring nozzle had to be repaired because of leakage. This resulted in a prolonged outage period by 12 days. Replacement of the feed water pipes, close to the reactor, resulted in a collective dose of 0.8 man·Sv and was the highest dose requiring job.

The outage at Unit 2 lasted for 23 days and was of normal extent. During the outage of Unit 3 a repair work of the safe-ends were performed due to cracks. Another big job was the replacement of the pressure relief pipes of the pressuriser. At Unit 4 the dose rates are still low, however there were a small raise during the last year.

Number and duration of outages

Plant	Type of reactor	Length of outage (days)	Collective dose (man·Sv)	Comments
Barsebäck 2	BWR	150	0.91	Prolonged with 17 weeks due to looking for a leakage from the condensation pool and repair.
Forsmark 1	BWR	27	0.76	
Forsmark 2	BWR	36	1.00	
Forsmark 3	BWR	13	0.15	
Oskarshamn 1	BWR	43	0.71	Prolonged with 20 days due to larger extent of CDR maintenance.
Oskarshamn 2	BWR	139	2.27	First step of modernisation. Restart 85 days later than planned, due to damaged core grid.
Oskarshamn 3	BWR	24	0.28	
Ringhals 1	BWR	52	1.93	
Ringhals 2	PWR	23	0.37	
Ringhals 3	PWR	52	0.61	
Ringhals 4	PWR	36	0.48	
Total			**9.47**	

Authority

The Swedish Radiation Protection Authority (SSI) will in the nearest future concentrate on radiation protection concerning plant modifications, follow up of the dose rates and internal dosimetry.

SSI will follow up the results of the organisational modifications made during the last years. Their inspections will aim at an early identification of possible effects on the quality in the radiation protection. SSI will also focus on resources and competence in connection to personnel retirement and the use of external resources.

Plans for 2004

The reactor vessel head will be replaced at Ringhals 4 in 2004. At Forsmark 1 and 2 the low pressure turbines will be replaced during the 3 coming years, starting in 2004. At Oskarshamn 2 the modernisation will continue during the coming years. At Oskarshamn 3 a project is running in order to raise the electric output by 25% starting in 2006.

SWITZERLAND

Dose information

Operating reactors

2003		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv]**
PWR	3	0.336
BWR	2	1.021

Principal events

Summary of national dosimetric trends (TL-Dosimeters)

Facility	**Number of monitored workers 2003**	**Years' collective dose (man·mSv)**		
		2003	**2002**	**2001**
NPP Beznau I + II	783	454	595	907
NPP Gösgen	821	555	931	540
NPP Mühleberg	955	1 180	944	922
NPP Leibstadt	1 298	862	428	1 010

Events influencing dosimetric trends

NPP Beznau I and II

As a response to the higher activity concentrations in the reactor water of previous years (see the Inspectorate's Annual Report 2002) optimal water chemistry during plant shutdown (shutdown chemistry) was used and again proved its worth. Most of the isotope cobalt-58 (^{58}Co) was in a soluble phase in the primary water and therefore possible to remove using cleaning filters. Consequently the ambient dose rate during the shutdown was low and the monitored collective dose for in NPP Beznau Units I and II was 20% lower as the scheduled collective dose.

NPP Gösgen and NPP Leibstadt

No significant changes.

NPP Mühleberg

Since the year 2000 Hydrogen Water Chemistry (HWC) and Noble Metal Chemical Addition (NMCA) have been used to reduce the incidence of stress corrosion cracking. This has resulted in the formation and deposition of activated corrosion products, in particular ^{60}Co. From the initial decrease and the subsequent increase in ^{60}Co deposits, it is clear that the characteristics and structure of the surface layers of components are still not in balance and have an impact on the dose rates from these components. The dose rate in the middle of the RPV closure head was up some 13% on last year and the average dose rate at re-circulation loops up some 20%. The average dose rate in other parts of the plant (steam dryer, water separator) also increased slightly. The nuclide-specific measurements of contamination in the re-circulation loops indicate that the build-up in activity and the associated dose rate is caused primarily by nuclide cobalt 60 (^{60}Co). Despite the higher dose rate in the drywell, the collective dose of 0.76 man·Sv estimated for the 2003 outage period was only slightly exceeded showing that radiation protection measures were effective during this period.

Number and duration of outages

NPP Beznau I	1 outage, 10 days (planned 10 days, last year 31 days).
NPP Beznau II	1 outage, 27 days (planned 26 days, last year 18 days).
NPP Gösgen	1 outage, 20 days (planned 20 days, last year 29 days).
NPP Leibstadt	1 outage, 22 days (planned 22 days, last year 17 days).
NPP Mühleberg	3 outages, 30 days (planned 1 outage 23 days, last year 19 days).

Component or system replacements

In KKL one of the main modifications during the year 2003 was the replacement of two low-pressure pre-heaters after a thinning had been identified in the cladding in 1999. The cladding for the new pre-heaters is made of erosion-resistant austenitic material. Job doses during replacement were low thanks to declined dose rates in the last five years in the secondary loop.

Safety-related issues

The ongoing procedure to reduce the incidence of stress corrosion cracking generates problems in the BWR. See report on KKM Mühleberg above.

Unexpected events

None event occurred in connection with occupational exposure above 1 mSv individual dose.

During the outage in KKG, one person registered contamination in the chest area that could not be removed immediately. The effective dose was well below 1 mSv. Until the contamination was removed, the individual concerned was not allowed by the utility to enter the controlled aera.

Two events in KKM gave rise to short outages resulting in 60 man·mSv.

In KKL, in contrast to most jobs, the job doses resulting from the replacement of control rods and the remote-control ultrasound testing of the RPV primary housing was significantly higher than the planned doses. In future, KKL will monitor the workstations even more carefully and take remedial action as required.

New/experimental dose-reduction programmes

KKB II

The upper seals on the thermocouple penetrations of the RPV head were replaced (similar to the work done on Unit KKB I in 2002). The new, improved design will greatly reduce the time required to dismantle and reassemble the penetrations and will also significantly reduce the exposure of staff to radiation during this work.

KKG

In connection with the containment evacuation alarm, a manual initiation was fitted to the fuel-charging machine. In case of incident happens during handling of fuel assemblies, the containment could be evacuated without delay.

Years 2004 and 2005

Issues of concern 2004

KKG improved the housing for the cables connected to eddy-current-sensors and ultra-sonic-sensors used inside steam generators to inhibit contamination spread outside steam generators.

Regulatory plans for major work in the coming year 2004

A new law and ordnance about nuclear energy is being prepared this year. The enactment is planned for early 2005.

Plans for major work in the coming year 2005

In KKG the spray valves and needles of the pressuriser have to be changed, which will result in a job dose of about 750 man·mSv.

KKL plans to start with Hydrogen Water Chemistry (HWC) in 2005 thus rising the dose rate due to higher ^{60}Co in the primary loops and ^{16}N in the secondary loops. First constructional jobs preparing additional shielding have been planned in 2004.

UKRAINE

Principal events in Ukraine NPPs in 2003

The average collective doses for operational reactors in 2003 are as follows:

2003		
Reactor type	**Number of units**	**Collective dose/unit (man·mSv)**
VVER	13	1 445

Summary of national dosimetric trends

In 2003, the collective occupational exposure dose of NNEGC "EnergoAtom" NPP personnel was 18.77 man·Sv, that is 1.23 man·Sv less in comparison with 2002.

Reactors	Total collective doses (man·Sv)	Annual collective dose: plant personnel (man·mSv)	Annual collective dose: outside personnel (man·mSv)	The outside personnel dose contribution into the NPP annual collective dose (%)
Zaporozhe	6.74 (1.37/unit)	1.37	0.44	4
Rovno	5.14 (1.54/unit)	1.54	0.71	5
South Ukraine	5.42 (1.67/unit)	1.67	1.53	22
Khmelnitski	1.46/unit	1.46	0.45	14

The greatest contribution into the collective dose by outside personnel was recorded at SU NPP (22%) due to works carried out during steam generator replacement and on the primary circuit.

For the year of annual report (2003) overwhelming majority of personnel obtained individual annual doses less than 2 mSv. Within 15-20 mSv only105 workers were registered, that is 1% from the total number of personnel.

Number and duration of outages

Planned unit outages took place at all NPP units in 2003.

NPP	Duration of the outage, days	Duration of the outage per unit, days	Annual collective dose, mSv
Zaporozhe NPP	354	59	4.21
Rovno NPP	171	57	3.95
South Ukraine NPP	290	97	3.63
Khmelnitski NPP	49	49	0.57

In 2003 average duration of outage was 66.5 days that is 3.6 days less that in 2002; average collective dose per unit was 0.95 mSv, that is more by 0.09 mSv (9.5%) in comparison with 2002 .

Major evolutions

Following the ALARA principles the utility organisation NNEGC "Energoatom" for 5 years has been carrying out systematic work in the area of radiation protection and radiation safety: ALARA groups were created at all Ukrainian NPPs.

By the end of 2003, "The Programme on Decreasing the NPP Staff Exposure" was developed and entered into force in which organisational and technical evolutions at each NPP and funds needed for its implementation are specified. With the purpose of decreasing radiation protection at each NPP a new lower managerial levels of working clothes and skin contamination were put into practice.

Organisational evolutions

Some of ALARA groups functions are as follows

- carrying out analysis and work planning with the purpose of achieving the highest possible personnel dose reduction and not exceeding the individual effective dose exposure of more than 20 mSv /year;
- putting into practice such organisation of labour and method of work performance in "a stringent operation condition zone" when exceeding dose limits is not practically possible as prescribed by a job instructions for these procedures; and when all personnel in a work management link (head of division – head of section – foreman – superintendent of work – member of crew) understand and realise their personal responsibilities and duties while performing such particular jobs.
- ALARA programme acceptance and review;
- establishing and approval of annual exposure indicators;
- preparation, consideration and approval of annual and prospective measures to decrease exposure and increase radiation protection level;
- consideration during their meetings of ALARA programme performance, collective dose level and decision-making to improve the programme's efficiency;
- preparing information (data) in order to approve the doses planned for NPPs as a whole for a year, for a planned unit outage, for separate divisions, and if necessary – for the most dangerous jobs;
- analysis of repair documents, job programmes, safety aids, maintenance regulation with regards to adequacy of radiation protection measures, measures performance control.

- analysis of prospective works during unit outage, radioactive-dangerous jobs specifying, outage documentation checking for the purpose of organisational and technical evolutions to ensure not exceeding of the planned dose exposure for these jobs and development of measures for decreasing dose exposure;
- participation in the newly performed radiation dangerous jobs.

As a result of the activity carried out and comprehensive approach during the outage's work planning the forecasting based on the previous works analysis of division's collective dose exposure has been put into practice. Division heads were made responsible for workers' individual doses; the list of the organisation measures to decrease the dose input is being made for each planned outage.

At each NPP were created ALARA programmes. In 2003 according to programmes measures:

- Zaporozhe NPP – for all planned outages well-founded forecasts of the collective and individual doses of personnel exposure were made;
- Rovno NPP – during 2003 planned outages, new approaches for radiation-dangerous jobs were taken. That means that the criteria for necessity of the special programmes development for above jobs were recognised; at the plant, 12 special programmes were created and that led to decreasing of the collective doses during dose consuming (radiation-dangerous) jobs performance.
- South Ukraine NPP – in personnel training programmes ALARA principle learning was included;
- Khmelnitski NPP – all planned measures in concordance with ALARA programmes were performed.

Issues for the year following the year of the Annual Report (2004)

In 2004, the commissioning two new units – Rovno 4 and Khmelnitski 2 has been planned. Currently there are common problems for all NPPs connected with personnel exposure control. Thus lack of modern electronic dosimeters leads to additional mistakes in exposure dose definition and defining work expenditure for individual radiation dangerous activities, therefore utility company is planning to buy some quantity of electronic dosimeters.

UNITED STATES

Summary of United States occupational dose trends

The US PWR occupational dose averages for 2003 experienced an increasing occupational dose trend for the 69 PWRs. The US BWR occupational dose averages for 2003 achieved a decreasing occupational dose trend for the 35 BWRs.

Reactor type	Number of units	Total collective dose	Average dose per reactor
PWR	69	63 417 person·Sv	0.92 person/unit
BWR	35	56 139 person·Sv	1.60 person/unit

The total collective dose for the 104 reactors in 2003 was 119 556 person·Sv, a decrease of 1% from the 2002 total. The resulting average collective dose per reactor for US LWR was 1.15 person/unit: the second lowest average collective dose ever recorded for US light water reactors.

The total collective dose for US PWRs in 2003 was 63.417 person·Sv for 69 operating PWR units. The 2003 average collective dose per reactor was 0.92 person·Sv/ PWR unit. The average 2003 PWR dose represents a 5.6% increase from the 2002 value: the fifth time since the first commercial reactor commenced operations in 1969 that the average PWR annual dose has been under 1.00 person·Sv/unit.

The total collective dose for US BWRs in 2003 was 56 139 person·Sv for 35 operating BWR units. The 2003 average collective dose per reactor was 1.60 person·Sv/BWR unit.

The average 2003 BWR dose represents a 9% decrease from the 2002 value. The BWR average collective dose for 2003 is the third lowest recorded average dose per unit for US BWRs since 1969.

In the year 2003, US nuclear power plants generated 21% of the electricity generated by US utilities. Net capacity factors for all units have increased from 70% in 1991 to 90% in 2003. Shorter refuelling outages were a significant factor in achieving higher annual megawatt output. The average/mean outage duration for US LWRs have decreased from 105/76 days in 1990 to 37/34 days, respectively, in 2003.

Occupational dose goals

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

US PWR reactor head replacements

A significant contributor to PWR dose has been the discovery of boric acid corrosion of PWR reactor heads starting with the Oconee plant in May, 2001. Regulatory mandated PWR reactor head inspections were required. Significant repairs were necessary on the Palisades reactor head. Significant wastage of the reactor head at Davis Besse has resulted in extensive engineering analysis and regulatory attention. ISOE information sharing on the French 1994-97 experience with PWR reactor head replacements has been beneficial to the current US PWR industry efforts. In 2003, PWR Reactor Heads were replaced at TMI 1, Ginna, Crystal River, North Anna 1 and 2 and Surry 1 and 2.

Plant life extensions

The plant life extensions achieved by US nuclear power plants from the US Nuclear Regulatory Commission allows an additional 20 years of operations for the nuclear units.

This has become an important opportunity for US Radiation Protection Managers to justify plant ALARA capital improvements due to the longer plant operating life for cost recovery. For example, permanent work platforms, permanent shielding and remote monitoring systems (video cameras, dose telemetry and communications) have been justified as ALARA improvements at many US nuclear power plants. The license extensions granted by the US NRC in 2003 are as follows.

1.	North Anna 1 and 2	20 March 2003	Unit 1 extended to 1 April 2038 Unit 2 extended to 21 April 2040
2.	Surry 1 and 2	20 March 2003	Unit 1 extended to 25 May 2032 Unit 2 extended to 29 January 2033
3.	Peach Bottom 2 and 3	7 May 2003	Unit 2 extended to 8 August 2033 Unit 3 extended to 2 July 2034
4.	St. Lucie 1 and 2	3 October 2003	Unit 1 extended to16 March 2036 Unit 2 extended to 1 April 2043
5.	Fort Calhoun	4 November 2003	Unit 1 extended to 9 August 2033
6.	Catawba 1 and 2	5 December 2003	Unit 1 extended to 5 December 2043 Unit 2 extended to 5 December 2043

US industry focus

The overall mission of US RP programmes has been refocused to achieve significant improvements in safety performance and cost effectiveness at nuclear power plants. The nationwide approach is to achieve increased management attention to the following areas:

1. Improved execution of Radiation Protection Fundamentals.
2. Reduce impacts of workforce turnover due to retiring staff and retaining plant knowledge.
3. Standardise radiation protection practices.
4. Improve RP technologies utilisation.
5. Evaluate new ICRP recommendations.

The industry RP managers are improving site programmes to control access to locked high and very high radiation areas. Also, the control of unplanned or unintended dose is being addressed.

Future issues

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

Regulatory issues (Nuclear Safety Commission)

All commercial nuclear power reactors operating in the United States must be licensed and monitored by the Nuclear Regulatory Commission (NRC). There are as of June 2004, 104 commercial nuclear power reactors licensed to operate in 31 States. Nuclear Plant operators are subject to continual inspections by the NRC inspectors permanently stationed at each facility. Regional inspectors also make several visits annually to conduct routine inspections.

A. Strategic plan

The NRC has developed a new strategic plan for FY 2004-2009 to replace the agency's earlier version. The strategic plan has been restructured to improve its focus and readability. The strategic plan focuses on five general goals: safety, security, openness, effectiveness, and excellence in agency management.

B. US electricity generated by commercial nuclear power

In 2003, net nuclear-based electric generation in the United States produced a total of 766 billion kilowatt-hours. Since 1992, the average capacity factor has increased 18% (capacity factor is the ratio of electricity generated to the amount of energy that could have been generated).

C. NRC reactor oversight

The NRC does not operate nuclear power plants. Rather, it regulates the operation of the nation's 104 nuclear power plants by establishing regulatory requirements for the design, construction and operation of such plants. To ensure that the plants are operated safely within these requirements, the NRC licenses the plants to operate, licenses the plant operators, and establishes technical specifications for the operation of each plant.

The NRC provides continuous oversight of plants through its reactor oversight process (ROP) to verify that they are being operated in accordance with NRC rules and regulations. The NRC has full authority to take whatever action is necessary to protect public health and safety and may demand immediate license actions, up to and including a plant shutdown.

The ROP is described on the NRCs Web site and in NUREG-1649, Revision 3, "reactor oversight process". In general terms, the ROP uses both inspection findings and performance indicators (PIs) to assess the performance of each plant within a regulatory framework of seven corner stones of safety. The ROP recognises that issues of very low safety significance inevitably occur, and plants are expected to effectively address these issues.

The ROP is risk-informed, objective, predictable, understandable, and focused on the areas of greatest safety significance. Key features of the ROP are a risk-informed regulatory framework, risk informed inspections, a significance determination process to evaluate inspection findings, performance indicators, a streamlined assessment process, and more clearly defined actions the NRC takes for plants based on their performance. The NRC began implementation of the ROP in April 2000 and continues to refine the ROP as experience is gained.

D. International activities

NRC has statutory responsibility for licensing the exports and imports of nuclear facilities, major components, materials, and related commodities. In 2004, NRC enhanced its controls on the export and import of high risk radioactive sources as part of the Commission's comprehensive review of nuclear material security requirements.

E. NRC Performance Indicators

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

3. ISOE PROGRAMME OF WORK

3.1 Achievements of the ISOE Programme in 2003

The Information System on Occupational Exposure made the following achievements in the year 2003.

Data collection and management

Collection of ISOE 1 data

ISOE participants provided their 2002 data using the ISOE Software under Microsoft ACCESS. ETC integrated all data received into the ISOE database. Korea used for the first time the ISOE Software (ISOEDAT) to collect ISOE data. To achieve this, the software had been translated into Korean and adapted to the Korean software environment.

Collection of ISOE 2 data

In 2003, ISOE 2 data were collected for the first time.

Collection of ISOE 3 reports

The ISOEDAT database contains currently around 193 ISOE 3 reports, including historical ISOE 3 (NEA 3) reports.

Data release

The first release of the ISOEDAT database with data from 1969 to 2002 was made available to the European Utilities and to the Technical Centres for distribution on password protected ETC FTP server in July. Since then, several updates have been performed.

The database and the ISOE Software will be provided on CD-ROM to all participants after the Steering Group meeting (end of November).

Documents and Reports

ISOE Annual Report 2002

The report was published and distributed in February 2004.

Information sheets issued in 2003

The ISOE Technical Centres performed in 2002 a series of analyses, which were published as Information sheets. A complete list of information sheets can be found in Annex 1 – List of publications.

International ISOE Workshop on occupational exposure in nuclear power plants

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

The 2003 International ALARA Symposium was held 12-15 January 2003 in Orlando, Florida (USA). The symposium, with the theme “Radiological Work Management Techniques during Shortened Refuelling Outages”, was organised by the North American Technical Centre (NATC) in order to provide a global forum to promote the exchange of ideas and management approaches to maintaining occupational radiation exposures “as low as reasonably achievable” (ALARA). The symposium was co-sponsored by the NATC, the OECD/NEA and the IAEA.

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

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

Interaction with international organisations

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

The ***ISOE Working Group on Operational Radiation Protection (WGOR)*** met four times to prepare the occupational radiation protection specialists’ views on the development of new International Commission on Radiological Protection (ICRP) recommendations. A draft report was prepared and presented to the ISOE Steering Group for review, comments and approval for publication. The report will be published in 2005.

WANO/INPO

In order to improve collaboration and synergy with WANO, the ISOE Steering Group agreed during its meeting in 2000 to send a letter to WANO, suggesting a close co-operation in the field of occupational exposure at nuclear power plants (letter was sent 28 November 2000). On 25 March 2003, WANO’s co-ordinating centre replied that they “*believe that the distribution of operating experience related products, including reports and best practices, developed by the two organisations should remain separate*” in order to avoid unintentional releases of information.

With a similar intention, the Chair and Chair-elect of the ISOE Steering Group sent in February 2003 a letter to INPO. ISOE did not yet receive an official answer from INPO. In 2003, the North American Technical Centre (NATC) organised together with INPO Radiation Protection Managers ISOE software training courses for INPO radiation safety staff members.

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

The Working Group on Data Analysis (WGDA), which was reconstructed, reviewed the status of data in the ISOEDAT database. WGDA proposed the structure and content of the ISOE Annual Report 2002.

Software maintenance

General

ISOE software development was finalised in the beginning of 2003, including the implementation of the modified structure of data codification. The ISOE 1 Table E has been modified to allow the input of several reasons of work for the same task. The Working Group on Software Development was disbanded with acknowledgements and thanks for their efforts to complete the ISOE software. Collection of 2002 data took advantage of the new software package.

The ISOEDAT database and the data input software have been successfully translated into various languages, including Japanese, Korean and Russian (test version used for collection of the 2002 data).

A draft User Manual in English was distributed electronically, together with the database and input software.

Further development of data analysis software

In 2003, further development of the data analysis software (MADRAS) was started. This work was performed by the European Technical Centre under the auspices of the WGDA.

Web pages

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

ATC	http://www.jnes.go.jp/isoe/
ETC	http://isoe.cepn.asso.fr
IAEATC	http://www-ns.iaea.org/tech-areas/rw-ppss/isoe-iaea-tech-centre.htm
NATC	http://www.natcisoe.org
NEA	http://www.nea.fr/html/jointproj/isoe.html

3.2 Proposed programme of work for 2004

The Information System on Occupational Exposure Programme for the year 2004 includes:

Follow-up from the in-depth evaluation of the ISOE System

- Reinforce the role of the National Co-ordinators:
  - Preparation of a more descriptive understanding of the role and responsibilities of the national co-ordinators.
  - Presentation of the activities of the national co-ordinators at the next Steering Group meeting.
  - Encourage utilities to introduce procedures in nuclear power plants, which request the exchange of information with the ISOE system.

- General promotion of the ISOE System:
  - ISOE Chair will send a promotion letter to high level management in utilities and regulatory authorities. National co-ordinators will send the co-ordinates of appropriate addressees via the Technical Centres to the Secretariat.
  - Preparation of a short document explaining the benefits of the ISOE system. This document will be sent together with the above mentioned promotion letter.
- Promotion of the ISOE 3 reporting system:
  - Commitment of National co-ordinators to organise the preparation and inclusion of at least a few ISOE 3 reports into the system.
  - Promotion of ISOE 3 reports by the Technical Centres.
  - Preparation of a process for the recognition of the top five ISOE 3 reports, to be presented at the annual meeting of the ISOE utilities.
- Review of the meeting structure for the ISOE Steering Group.
- Promotion of new products by the Technical Centres (for example the organisation of topical meetings for radiation protection managers).
- Development and installation of an ISOE web page (see also Software Maintenance);
- Further development of easy to use predefined analyses of the ISOE Software (see also Software Management).

Data collection and management

- Collection of ISOE 1 and ISOE 2 (dynamic) data for the year 2003.
- Collection of ISOE 2 static data.
- Organisation of national training courses on the use of the ISOE system, especially with a view to use the ISOE 3 reporting system (Commitment from national co-ordinators).
- Issuance of several updates of the ISOEDAT database on the ETC server and distribution of a CD-ROM in December 2004.

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

- Review of ISOE 2 data, discussion and proposal for useful analysis of the ISOE 2 data.
- Further analysis to clarify and enhance data from nuclear power plants which are in shutdown or in any other stage of decommissioning.

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

- ***ISOE Annual Report*** 2003 – Objective to publish the report in September 2004.
- Pilot project to prepare a regularly issued information newsletter on ISOE called ***ISOE News***.
- **Information Sheets** planned for 2004.

Yearly analyses		Technical centre
1.	Japanese dosimetric results: FY2003 data and trends	ATC
2.	Korea, Republic of; Summary of national dosimetric trends	ATC
3.	Japanese occupational exposure during periodical inspection at PWRs and BWRs ended in FY 2003	ATC
4.	Korea occupational exposure during periodical inspection at PWRs ended in 2003	ATC
5.	Preliminary European Dosimetric Results for the year 2003	ETC
6.	Annual outage duration and doses in European reactors (update)	ETC
7.	Information on exposure data collected for the year 2003	IAEATC
8.	3-year rolling average annual dose comparisons US PWR, 2001-2003	NATC
9.	3-year rolling average annual dose comparisons US BWR, 2001-2003	NATC
10.	3-year rolling average annual dose comparisons Canadian CANDU, 2001-2003	NATC
11.	US PWR refuelling outage duration and dose trends	NATC
12.	US BWR refuelling outage duration and dose trends	NATC
13.	Dollars per person Sv saved	NATC
Special analyses		
	Special analyses from ATC, ETC, IAEATC and NATC to be announced	

International ISOE Workshop on occupational exposure in nuclear power plants

- Organisation and follow-up of the 4th ISOE European Workshop on Occupational Exposure Management in NPPs, 24-26 March 2004, Lyon, France.

- Preparation of the 2005 International ALARA Symposium in the USA.

Interaction with the international organisations

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

- Publication of the occupational radiation protection specialists' views on the development of new ICRP recommendations. Presentation of the results at the IRPA-11 Congress, May 2004 in Madrid, Spain.

European Commission

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

INPO

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

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

- To further enhance the usefulness of the ISOE system, it was decided to offer an ISOE web page for easy data analysis and ISOE 3 reports retrieval. In 2004, the Working Group on Data Analysis will prepare an action plan for the development of an ISOE web page.

- Establishment of a discussion forum on the web by ETC.

- To further improve the usefulness of the ISOEDAT software package, the following maintenance will be performed:

  – Inclusion of additional predefined easy to use analysis through the MADRAS module.

  – Publication of a hard copy of the User's Manual for the management of ISOE 1 data, ISOE 2 data and ISOE 3 reports using the ISOE Software.

  – Translation of the ISOE software and the ISOE User's Manual in various languages.

  – The ETC offers to organise training sessions on request in order to meet the user's needs.

Web pages and e-mail re-mailing system

ATC	http://www.jnes.go.jp/isoe/
ETC	http://isoe.cepn.asso.fr
IAEATC	http://www-ns.iaea.org/tech-areas/rw-ppss/isoe-iaea-tech-centre.htm
NATC	http://www.natcisoe.org
NEA	http://www.nea.fr/html/jointproj/isoe.html

Further promotion of the e-mail re-mailing system installed at the NEA.

Further topics of interest

Topic
Dosimetry: • Electronic vs TLD; Active vs Passive. • Lessons learned by those who use electronic dosimetry as official dosimetry. • Neutron dosimetry (important for fuel transport). • Technical abilities. • Calibration. • Possible use in emergency situations with high dose rates.
Optimisation and training in Radiation Protection (How to train the next generation?)
Ageing workforce
External companies responsibilities in optimisation
Criteria for the calculation of collective dose (reporting level)
Multidisciplinary workers in nuclear installations: Radiation protection and welding

Annex 1

LIST OF ISOE PUBLICATIONS

Reports

1. *Occupational Exposures at Nuclear Power Plants: Twelfth Annual Report of the ISOE Programme, 2002*, OECD, 2004

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

ISOE Information Sheets

Asian technical centre	
No. 1, October 1995	Japanese Dosimetric Results: FY 1994 data
No. 2, October 1995	Japanese Occupational Exposure during Periodical Inspection at LWRs ended in FY 1994
No. 3, July 1996	Japanese Dosimetric Results: FY 1995 data
No. 4, July 1996	Japanese Occupational Exposure during Periodical Inspection at LWRs ended in FY 1995
No. 5, September 1997	Japanese Dosimetric Results: FY 1996 data
No. 6, September 1997	Japanese Occupational Exposure during Periodical Inspection at LWRs ended in FY 1996
No. 7, October 1998	Japanese Dosimetric Results: FY 1997 data
No. 8, October 1998	Japanese Occupational Exposure During Periodical Inspection at LWRs Ended in FY 1997
No. 9, October 1999	Replacement of Reactor Internals and Full System Decontamination at a Japanese BWR
No. 10, November 1999	Experience of 1st Annual Inspection Outage in an ABWR
No. 11, October 1999	Japanese Dosimetric Results: FY 1998 Data and Trends
No. 12, October 1999	Japanese Occupational Exposure During Periodical Inspection at LWRs Ended in FY 1998
No. 13, September 2000	Japanese Dosimetric Results: FY 1999 Data and Trends
No. 14, September 2000	Japanese Occupational Exposure During Periodical Inspection at LWRs Ended in FY 1999
No. 15, October 2001	Japanese Dosimetric results: FY 2000 data and trends
No. 16, October 2001	Japanese occupational exposure during periodical inspection at PWRs and BWRs ended in FY 2000
No. 17, October 2002	Japanese dosimetric results: FY2001 data and trends
No. 18, October 2002	Japanese occupational exposure during periodic inspection at PWRs and BWRs ended in FY 2001
No. 19, October 2002	Korea, Republic of; Summary of national dosimetric trends
No. 20, October 2003	Japanese dosimetric results: FY2002 data and trends
No. 21, October 2003	Japanese occupational exposure during periodic inspection at PWRs and BWRs ended in FY 2002
No. 22, October 2003	Korea, Republic of; Summary of national dosimetric trends
No. 23, October 2003	Japanese Occupational Exposure of Steam Generator Replacements
No. 24, October 2003	Japanese Occupational Exposure of Shroud Replacements
No. 25, 2004	Japanese dosimetric results: FY2003 data and trends
No. 26, 2004	Japanese occupational exposure during periodic inspection at PWRs and BWRs ended in FY 2003
No. 27, 2004	Achievements and Issues in Radiation Protection in the Republic of Korea
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

European technical centre (cont'd)	
No. 7, June 1996	Preliminary European Dosimetric Results for 1995
No. 9, December 1996	Reactor Vessel Closure Head Replacement
No. 10, June 1997	Preliminary European Dosimetric Results for 1996
No. 11, September 1997	Annual individual doses distributions: data available and statistical biases
No. 12, September 1997	Occupational exposure and reactor vessel annealing
No. 14, July 1998	PWR collective dose per job 1994-1995-1996 data (restricted distribution)
No. 15, September 1998	PWR collective dose per job 1994-1995-1996 data (general distribution)
No. 16, July 1998	Preliminary European Dosimetric Results for 1997 (general distribution)
No. 17, December 1998	Occupational Exposure and Steam Generator Replacements, update (general distribution)
No. 18, September 1998	The Use of the man-Sievert monetary value in 1997 (general distribution)
No. 19, October 1998	ISOE 3 data base – New ISOE 3 Questionnaires received (since September 1998) (restricted distribution)
No. 20, April 1999	Preliminary European Dosimetric Results 1998
No. 21, May 2000	Investigation on access and dosimetric follow-up rules in NPPs for foreign workers
No. 22, May 2000	Analysis of the evolution of collective dose related to insulation jobs in some European PWRs
No. 23, June 2000	Preliminary European Dosimetric Results 1999
No. 24, June 2000	List of BWR and CANDU sister unit groups
No. 25, June 2000	Conclusions and recommendations from the 2nd EC/ISOE workshop on occupational exposure management at nuclear power plants
No. 26, July 2001	Preliminary European Dosimetric Results for the year 2000
No. 27, October 2001	Annual outage duration and doses in European reactors
No. 28, December 2001	Trends in collective doses per job from 1995 to 2000
No. 29, April 2002	Implementation of Basic Safety Standards in the regulations of European countries
No. 30, April 2002	Occupational exposure and steam generator replacements – update
No. 31, July 2002	Preliminary European Dosimetric Results for the year 2001
No. 32, November 2002	Conclusions and Recommendations from the 3rd European ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants
No. 33, March 2003	Update of the annual outage duration and doses in European reactors (1993-2001)
No. 34, July 2003	Man-Sievert monetary value survey (2002 update)
No. 35, July 2003	Preliminary European dosimetric results for 2002
No. 36, October 2003	Update of the annual outage duration and doses in European reactors (1993-2002)
No. 37, July 2004	Conclusions and recommendations from the 4th European ISOE workshop on occupational exposure management at NPPs
No. 38, November 2004	Update of the annual outage duration and doses in European reactors (1993-2003)

IAEA technical centre	
No. 1, October 1995	ISOE Expert meeting
No. 2, April 1999	IAEA Publications on occupational radiation protection
No. 3, April 1999	IAEA technical co-operation projects on improving occupational radiation protection in nuclear power plants
No. 4, April 1999	IAEA Workshop on implementation and management of the ALARA principle in nuclear power plant operations, Vienna 22-23 April 1998
No. 5, September 2000	Preliminary dosimetric results for 1999
No. 6, June 2001	Preliminary dosimetric results for 2000
No. 7, October 2002	Information on exposure data collected for the year 2001
No. 8, November 2002	Conclusions and Recommendations from the 3rd European ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants
No. 9, August 2003	Preliminary dosimetric results for 2002
North American technical centre	
No. 1, July 1996	Swedish Approaches to Radiation Protection at Nuclear Power Plants: NATC site visit report by Peter Knapp
No. 2, 1998	Monetary Value of person-REM Avoided 1997
No. 3, 2001	3-year rolling average annual dose comparisons US PWR, 1998-2000
No. 4, 2001	3-year rolling average annual dose comparisons US BWR, 1998-2000
No. 5, 2001	3-year rolling average annual dose comparisons CANDU, 1998-2000
No. 6, 2001	U.S. PWR 2000 Occupational Dose Benchmarking Charts
No. 7, 2001	U.S. BWR 2000 Occupational Dose Benchmarking Charts
No. 8, 2001	Monetary Value of person-REM Avoided: 2000
No. 02-1, November 2002	3-year rolling average annual dose comparisons US PWR, 1999-2001
No. 02-2, July 2002	3-year rolling average annual dose comparisons US BWR, 1999-2001
No. 02-4, July 2002	US PWR 2001 Occupational Dose Benchmarking Chart
No. 02-5, July 2002	US BWR 2001 Occupational Dose Benchmarking Chart
No. 02-6, 2002	Monetary value of person-rem avoided

ISOE topical session reports

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

ISOE international workshop proceedings

North American technical centre	
March 1997, Orlando, Florida, USA	First International ALARA Symposium
January 1999, Orlando, Florida, USA	Second International ALARA Symposium
January 2000, Orlando, Florida, USA	North-American National ALARA Symposium
February 2001, Anaheim, California, USA	2001 International ALARA Symposium
February 2002, Orlando, Florida, USA	North-American National ALARA Symposium
January 2003, Orlando, Florida, USA	2003 International ALARA Symposium
European technical centre	
September 1998, Malmö, Sweden	First EC/ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants
April 2000, Tarragona, Spain	Second EC/ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants
April 2002, Portoroz, Slovenia	Third ISOE European Workshop on Occupational Exposure Management at Nuclear Power Plants

Annex 2

ISOE PARTICIPATION AS OF DECEMBER 2003

Operating reactors

Country	Utility	Plant name
Armenia	Armenian (Medzamor) NPP	Armenia 2
Belgium	Electrabel	Doel 1, 2, 3, 4 Tihange 1, 2, 3
Brazil	Electronuclear A/S	Angra 1, 2
Bulgaria	Nuclear Power Plant Kozloduy	Kozloduy 3, 4, 5, 6
Canada	Bruce Power Ontario Power Generation Hydro Quebec New Brunswick Power	Bruce A1, A2, A3, A4 Bruce B5, B6, B7, B8 Pickering A1, A2, A3, A4 Pickering B5, B6, B7, B8 Darlington 1, 2, 3, 4 Gentilly 2 Point Lepreau
China	Guangdong Nuclear Power Joint Venture Co., Ltd Qinshan Nuclear Power Co. Lingao Nuclear Power Co., Ltd.	Guangdong 1, 2 Qinshan 1 Lingao 1, 2
Czech Rep.	CEZ	Dukovany 1, 2, 3, 4 Temelin 1, 2 pre-operational
Finland	Fortum Power and Heat Oy Teollisuuden Voima Oy	Loviisa 1, 2 Olkiluoto 1, 2
France	Électricité de France	Belleville 1, 2 Blayais 1, 2, 3, 4 Bugey 2, 3, 4, 5 Cattenom 1, 2, 3, 4 Chinon B1, B2, B3, B4 Chooz B1, B2 Civaux 1, 2 Cruas 1, 2, 3, 4 Dampierre 1, 2, 3, 4 Fessenheim 1, 2 Flamanville 1, 2

		Golfech 1, 2 Gravelines 1, 2, 3, 4, 5, 6 Nogent 1, 2 Paluel 1, 2, 3, 4 Penly 1, 2 Saint-Alban 1, 2 Saint Laurent B1, B2 Tricastin 1, 2, 3, 4
Germany	Energie-Versorgung BadenWürttemberg (EnBW)	Obrigheim Philippsburg 1, 2
	E.ON	Grafenrheinfeld Isar 1, 2 Brokdorf Grohnde Stade Unterweser
	Neckarwerke AG, TWS Stuttgart	Gemeinschafts – Kernkraftwerk Neckar, Neckarwestheim (GKN) 1, 2
	Vattenfall Europe/Hamburgische Elektrizitäts- Werke AG (HEW)	Brunsbüttel
	Vattenfall Europe/HEW and E.ON	Krümmel
	RWE Power	Biblis A, B Gundremmingen B, C Emsland
Hungary	Magyar Vilamos Muvek Rt	Paks 1, 2, 3, 4
Japan	Hokkaido Electric Power Co.	Tomari 1, 2
	Touhoku Electric Power Co.	Onagawa 1, 2, 3
	Tokyo Electric Power Co.	Fukushima Daiichi 1,2,3,4,5,6 Fukushima Daini 1,2,3,4 Kashiwazaki Kariwa 1,2,3,4,5,6,7
	Chubu Electric Power Co.	Hamaoka 1, 2, 3, 4
	Hokuriku Electric Power Co.	Shika
	Kansai Electric Power Co.	Mihama 1, 2, 3 Takahama 1, 2, 3, 4 Ohi 1, 2, 3, 4
	Chugoku Electric Power Co.	Shimane 1, 2
	Shikoku Electric Power Co.	Ikata 1, 2, 3
	Kyushu Electric Power Co.	Genkai 1, 2, 3, 4 Sendai 1, 2
	Japan Atomic Power Co.	Tokai 2 Tsuruga 1, 2
	Japan Nuclear Cycle Development Institute (JNC)	Fugen ATR

Korea	Korean Hydro and Nuclear Power	Wolsong 1, 2, 3, 4 Kori 1, 2, 3, 4 Ulchin 1, 2, 3, 4, 5 Yonggwang 1, 2, 3, 4, 5
Lithuania	Ignalina Nuclear Power Plant	Ignalina 1, 2
Mexico	Comisiòn Federal de Electricidad	Laguna Verde 1, 2
Netherlands	N.V. EPZ	Borssele
Pakistan	Pakistan Atomic Energy Commission	Chasnupp 1 Kanupp
Romania	Societatea Nationala Nuclearelectrica	Cernavoda 1
Russian Federation	Rosenergoatom	Balakovo 1, 2, 3, 4 Beloyarsky 3 Kalinin 1, 2 Kola 1, 2, 3, 4 Novovoronezh 3, 4, 5 Volgodonsk 1
Slovakia	Slovenske Electrarne	Bohunice 1, 2, 3, 4 Mochovce 1, 2
Slovenia	Krsko Nuclear Power Plant	Krsko 1
South Africa	ESKOM	Koeberg 1, 2
Spain	UNESA	Almaraz 1, 2 Asco 1, 2 Cofrentes Santa Maria de Garona Trillo Vandellos 2 Jose Cabrera
Sweden	Barsebäck Kraft AB Forsmarks Kraftgrupp AB OKG AB Ringhals AB	Barsebäck 2 Forsmark 1, 2, 3 Oskarshamn 1, 2, 3 Ringhals 1, 2, 3, 4
Switzerland	Kernkraftwerk Leibstadt AG (KKL) Forces Motrices Bernoises (FMB) Nordostschweizerische Kraftwerke AG (NOK) Kernkraftwerk Gosgen-Daniken (KGD)	Leibstadt Mühleberg Beznau 1, 2 Gosgen

Ukraine	Ministry of Fuel and Energy of Ukraine	Khmelnitski 1 Rovno1,2,3 South Ukraine 1,2,3 Zaporozhe 1,2,3,4,5,6
United Kingdom	Nuclear Electric	Sizewell B
United States	Amergen Energy Company	Clinton 1 Oyster Creek 1 TMI 1
	American Electric Power	D.C. Cook 1, 2 South Texas 1, 2
	Arizona Public Service Co.	Palo Verde 1, 2, 3
	Calvert Cliffs Nuclear Power Plant Inc.	Calvert Cliffs 1, 2
	Carolina Power and Light Co.	H. B. Robinson 2
	Entergy Nuclear NE	Indian Point 2, 3 Pilgrim 1
	Exelon	Braidwood 1, 2 Byron 1, 2 Dresden 2, 3 LaSalle County 1, 2 Limerick 1, 2 Peach Bottom 2, 3 Quad Cities 1, 2
	First Energy Corporation	Beaver Valley 1,2 Davis Besse 1 Perry 1
	Nuclear Management Company	Duane Arnold 1 Kewaunee 1 Monticello 1 Palisades 1 Point Beach 1, 2 Prairie Island 1,2
	Pacific Gas and Electric Company	Diablo Canyon 1, 2
	PPPL Susquehanna LLC	Susquehanna 1, 2
	South Carolina Electric Co.	Virgil C. Summer 1
	Southern California Edison Co.	San Onofre 2, 3
	TXU Electric	Comanche Peak 1, 2

Definitively shutdown reactors

Country	Utility	Plant name
Bulgaria	Nuclear Power Plant Kozloduy	Kozloduy 1, 2
Canada	Ontario Power Generation Hydro Quebec	NPD Gentilly 1
France	Électricité de France	Bugey 1 Chinon A1, A2, A3 Chooz A St. Laurent A1, A2
Germany	E.ON Arbeitsgemeinschaft Versuchsreaktor AVR RWE Power	Würgassen Jülich Mülheim-Kärlich
Italy	SOGIN	Caorso Garigliano Latina (GCR) Trino
Japan	Japan Atomic Power Co.	Tokai 1
Netherlands	NCGKN	Dodewaard
Russian Federation	Rosenergoatom	Beloyarsky 1, 2 Novovoronezh 1, 2
Spain	UNESA	Vandellos 1
Sweden	Barsebäck Kraft AB	Barsebäck 1
Ukraine	Ministry of Energy of Ukraine	Chernobyl 1, 2, 3
United States	Amergen Energy Company Nuclear Management Company Exelon Pacific Gas and Electric Company Southern California Edison Co.	TMI 2 Big Rock Point 1 Dresden 1 Peach Bottom 1 Zion 1, 2 Humboldt Bay 1 San Onofre 1

Participating regulatory authorities

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

ISOE technical centres

European Region (ETC)	Centre d'étude sur l'évaluation de la protection dans le domaine nucléaire (CEPN), Fontenay-aux-Roses, France	
	http://isoe.cepn.asso.fr	
Asian Region (ATC)	Nuclear Power Engineering Corporation (NUPEC), Tokyo, Japan (until September 2003) Japan Nuclear Energy Safety Organisation(JNES),Tokyo, Japan (since October 2003)	
	http://www.jnes.go.jp/isoe/	
IAEA Region (IAEATC)	International Atomic Energy Agency (IAEA), Vienna, Austria Agence Internationale de l'Énergie Atomique (AIEA), Vienne, Autriche	
	http://www-ns.iaea.org/tech-areas/rw-ppss/isoe-iaea-tech-centre.htm	
North American Region (NATC)	University of Illinois, Champagne-Urbana, Illinois, USA	
	http://www.natcisoe.org	

International cooperation

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

Definitively shutdown reactors country – technical centre

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

Annex 3

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Occupational Exposures at Nuclear Power Plants – 2003

The Information System on Occupational Exposure (ISOE) was created by the OECD Nuclear Energy Agency in 1992 to promote and co-ordinate international co-operative undertakings in the area of worker protection at nuclear power plants. The ISOE Programme provides experts in occupational radiation protection with a forum for communication and exchange of experience. The ISOE databases enable the analysis of occupational exposure data from the 465 commercial nuclear power plants participating in the Programme (representing some 90% of the world's total operating commercial reactors).

The Thirteenth Annual Report of the ISOE Programme summarises achievements made during 2003 and compares annual occupational exposure data. Principal developments in ISOE participating countries are also described.

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