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Occupational Exposures at Nuclear Power Plants

Fifteenth Annual Report of the ISOE Programme, 2005

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ISOE

INFORMATION SYSTEM ON OCCUPATIONAL EXPOSURE

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NEA No. 6317

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 since the early 1990s. An increased focus on plant operational procedures and work-management practices, improved water chemistry, technological advances, regulatory pressures, and exchange of information and experience 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 at nuclear power plants worldwide have found that occupational exposures are best managed through good job planning, implementation and review to ensure that exposures are "as low as reasonably achievable" (ALARA). A prerequisite for applying the principle of optimisation to occupational radiation protection is the timely exchange of dose reduction data, information and experience among stakeholders. To facilitate this global approach to work management and 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. As a joint programme of interested countries for technical information exchange, the objective of ISOE is to provide a forum for radiation protection experts from utilities and national regulatory authorities to discuss, promote and co-ordinate international co-operative undertakings for the radiological protection of workers at nuclear power plants.

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. In 1997, the NEA and the IAEA formed a Joint Secretariat in order to leverage the strengths of both organisations for the benefit of the ISOE Programme. Four ISOE Technical Centres (Europe, North America, Asia and the IAEA) manage the programme's day-to-day technical operations.

As a technical exchange initiative, the ISOE Programme includes a global occupational exposure data collection and analysis network, culminating in the world's largest occupational exposure database for nuclear power plants, and a vital information exchange programme for sharing dose reduction information and experience. Since its inception, ISOE participants have used this dual system of databases and communications networks to exchange occupational exposure data and information for dose trend analyses, technique comparisons, and cost-benefit and other analyses promoting the application of the ALARA principle in local radiation protection programmes, and the sharing of experience globally.

"... the exchange and analysis of information on individual and collective radiation doses to the personnel of nuclear installations and to the employees of contractors, as well as on dose-reduction techniques, is essential to implement effective dose-control programmes and to apply the ALARA principle..."

(ISOE Terms and Conditions)

Participants at the 1st ISOE Asian Regional ALARA Symposium, held in November 2005 in Hamaoka, Japan.

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EXECUTIVE SUMMARY

Since 1992, the ISOE programme has supported the optimisation of worker doses in nuclear power plants through an information and experience exchange network for radiation protection managers of nuclear power plants and national regulatory authorities world wide, and through the development and publication of relevant technical resources. This Fifteenth Annual Report of the ISOE Programme, 2005 represents the status of the ISOE Programme at the end of 2005.

At the end of 2005, the ISOE programme included 69 Participating Utilities in 29 countries (333 operating units; 40 shutdown units), as well as the regulatory authorities of 25 countries. The ISOE database itself included information on occupational exposure levels and trends at 480 reactor units (403 operating and 77 in cold-shutdown or some stage of decommissioning) in 29 countries. This database thus covers about 91% of the total number of power reactors (442) in commercial operation throughout the world. In 2005, five units from the Florida Light and Power Co. in the United States became official ISOE participants.

Based on the occupational exposure data supplied through the ISOE programme, the 2005 average annual collective dose for operating power reactors maintained a fairly low level with values of:

- 0.77 man·Sv for pressurised water reactors (PWR),
- 1.47 man·Sv for boiling water reactors (BWR), and
- 1.19 man·Sv for pressurised heavy water reactors (PHWR/CANDU),
- 0.93 man.Sv for all reactors, including gas cooled (GCR) and light water graphite reactors (LWGR).

In addition to information from operating reactors, the ISOE database contains dose data from 76 reactors which are shut down or in some stage of decommissioning. As the reactors represented in the database are of different type and size, and are generally at different phases of their decommissioning programmes, it is difficult to identify clear dose trends.

While ISOE is well known for its occupational exposure data and analyses, the strength of the system comes from its objective to share such information broadly amongst its participants. This important information exchange component facilitates the learning of lessons from experience, the growth and optimisation of expertise, and the increase in the value of ISOE participation.

In 2005, the web-based ISOE Network (www.isoe-network.net) was significantly upgraded with the objective of providing the ISOE membership with a “one-stop” web-based information and experience exchange portal on dose reduction and ALARA resources. This restricted-access portal will provide members with access to ISOE products, web forums for communications amongst participants, and on-line access to the ISOE occupational exposure database. Phase 1 development work for the migration of the database to website was completed in 2005. The ISOE programme also continued to produce the ISOE Newsletter throughout 2005 to keep its membership informed on topics of interest within the ISOE community.

The annual ISOE International ALARA Symposia on occupational exposure management at nuclear power plants, co-sponsored by the OECD/NEA and IAEA, continued to provide an important forum for radiation protection professionals from the nuclear industry and regulatory authorities to exchange practical information and experience on occupational exposure issues in nuclear power plants. The 2005 ISOE International ISOE ALARA Symposium was held in Ft. Lauderdale, Florida, organised by the ISOE North American Technical Centre. The technical centres also continued to host regional Symposia to meet regional needs. The period 2005-2006 marked the first Asian Regional Symposium, held in Hamaoka, Japan. These symposia continued the tradition of providing a global forum to promote the exchange of ideas and management approaches to maintaining occupational radiation exposures as low as reasonably achievable. The broad international participation in this workshop shows the continued interest in optimisation of radiation protection and occupational exposure issues.

Of increasing importance is the support that the technical centres supply in response to special requests for rapid technical feedback, and through the organisation of site benchmarking visits for dose reduction information exchange between ISOE regions. In 2005, three ISOE-organised technical centre site benchmarking visits were conducted. The combination of international and regional ISOE ALARA Symposium and technical visits provides a valuable forum for radiation protection professional to meet, discuss and share information, building linkages and synergies between the ISOE regions to develop a global approach to work management.

Finally, the ad-hoc Working Group on Strategic Planning continued its work to identify possible improvements to ISOE products, activities and organisation. With a view towards renewed ISOE Programme Terms and Conditions (2007), the intent of the WGSP is to develop a strategy that builds on ISOE strengths to make it a primary information source and communications network for the occupational radiation protection community.

Recent developments and principal events in ISOE participating countries are summarised in Section 4 of this report. Details of ISOE accomplishments, participation and programme of work for 2006 are provided in the Annexes.

SYNTHÈSE DU RAPPORT

Depuis 1992, le programme ISOE facilite la mise en œuvre de l'optimisation de la radioprotection des travailleurs dans les centrales nucléaires, par le biais d'un réseau d'échange d'information et d'expériences entre les responsables de la radioprotection des centrales nucléaires et les représentants des autorités réglementaires du monde entier ainsi que par le développement et la publication de produits techniques spécifiques. Ce quinzième rapport annuel du système ISOE fait le point sur le programme ISOE à la fin de l'année 2005.

À cette date, 69 exploitants de 29 pays participent au programme ISOE (333 réacteurs nucléaires en fonctionnement ; 40 réacteurs arrêtés) ainsi que les autorités réglementaires de 25 pays. La base de données ISOE contient des informations sur les expositions professionnelles et leurs tendances pour 480 réacteurs (403 en exploitation et 77 en arrêt à froid ou en cours de démantèlement) dans 29 pays. La base de données couvre ainsi près de 91 % de l'ensemble des réacteurs de puissance (441) en fonctionnement dans le monde. En 2005, cinq réacteurs de Florida Light and Power Co. aux États-Unis sont devenus des participants officiels d'ISOE.

Selon les données sur les expositions professionnelles fournies par le programme ISOE, la dose collective moyenne annuelle pour 2005 des réacteurs en fonctionnement s'est maintenue à un niveau assez bas avec des valeurs de :

- 0.77 Homme·Sv pour les réacteurs à eau pressurisée (PWR),
- 1.47 Homme·Sv pour les réacteurs à eau bouillante (BWR), et
- 1.19 Homme·Sv pour les réacteurs à eau lourde pressurisée (PHWR/CANDU).
- 0.93 Homme·Sv pour l'ensemble des réacteurs, y compris les réacteurs graphite-gaz (GCR) et les réacteurs graphite à eau ordinaire (LWGR).

Par ailleurs, la base de données ISOE contient également des données concernant les doses collectives de 76 réacteurs en arrêt à froid ou en phase de démantèlement. Étant donné que les réacteurs présents dans la base de données sont de type et de taille différents, et qu'ils sont généralement à des phases différentes de leurs programmes de démantèlement, il est difficile de mettre en évidence des tendances sur l'évolution des expositions.

Bien qu'ISOE soit connu pour ses données et ses analyses des expositions professionnelles, la force du système provient de son objectif de partager largement ces informations parmi ses participants. L'échange d'information, composante importante du système, facilite l'apprentissage par le retour d'expérience, la croissance et l'optimisation de l'expertise, ainsi que l'augmentation de la valeur associée à la participation à ISOE.

En 2005, le réseau Internet ISOE (www.isoe-network.net) a été sensiblement amélioré avec pour objectif de fournir aux participants d'ISOE un portail « unique » d'échange d'informations et d'expériences sur la réduction des doses et sur les documents ALARA. Ce portail à l'accès restreint, fournira aux membres ayant accès aux produits ISOE, un forum de discussions entre les participants, et un accès en ligne à la base de données sur les expositions professionnelles ISOE. La phase 1 des travaux de développement pour le transfert de la base de données sur le site Web a été terminée en 2005. Le programme ISOE a également continué de produire le bulletin ISOE News au cours de l'année 2005 afin de maintenir informé les membres du Système sur les sujets d'intérêt au sein de la communauté ISOE.

Les différents symposiums internationaux ISOE ALARA sur la gestion des expositions professionnelles dans les centrales nucléaires, co-sponsorisés par l'OCDE/AEN et l'AIEA, continuent de fournir aux professionnels de la radioprotection de l'industrie nucléaire et aux autorités réglementaires un important forum pour échanger des informations et des bonnes pratiques sur les expositions professionnelles dans les centrales nucléaires. Le symposium international ISOE ALARA de 2005 s'est tenu à Ft. Lauderdale, en Floride, organisé par le centre technique ISOE nord-américain. Les centres techniques continuent également à organiser des symposiums régionaux pour satisfaire les besoins au niveau régional. La période 2005-2006 a été marquée par le premier symposium régional asiatique, à Hamaoka, Japon. Ces symposiums perpétuent la tradition de fournir un large forum pour promouvoir les échanges d'idées et d'expériences de gestion en vue de maintenir les expositions professionnelles aussi basses que raisonnablement possibles. La large participation internationale à ces symposiums montre la continuité de l'intérêt envers l'optimisation de la radioprotection et les sujets liés aux expositions professionnelles.

L'appui offert par les centres techniques en réponse aux demandes spéciales de retour d'expérience technique, et pour l'organisation de visites de type benchmarking afin d'échanger des informations de réduction de dose entre les régions ISOE revêt une importance croissante. En 2005, trois visites benchmarking organisées par les centres techniques ISOE ont été effectuées. L'organisation conjointe du symposium ISOE ALARA international et régional avec des visites techniques fournit aux professionnels de la radioprotection un intéressant forum pour se rencontrer, discuter et partager des informations, construisant ainsi des liens et des synergies entre les régions ISOE pour développer une approche globale de l'organisation du travail..

Enfin, le groupe de travail ad-hoc sur la planification stratégique (WGSP) a continué son travail pour identifier des améliorations possibles des produits, des activités et de l'organisation d'ISOE. En gardant à l'esprit le renouvellement des modalités de fonctionnement d'ISOE (en 2007), l'objectif du WGSP est de développer une stratégie basée sur les forces du système ISOE, pour le faire devenir une source essentielle d'information et un réseau de communication pour la communauté des professionnels de la radioprotection.

Les développements récents et les principaux événements qui ont eu lieu dans les pays participants à ISOE sont résumés dans la section 4 de ce rapport. Les détails concernant les réalisations, la participation et le programme de travail d'ISOE pour 2006 sont fournis dans les Annexes.

ZUSAMMENFASSUNG

Seit 1992 ermöglicht das ISOE- Programm die Optimierung der beruflichen Strahlenexposition in Kernkraftwerken durch den weltweiten Informations- und Erfahrungsaustausch für Strahlenschutzmanager in KKW und für die nationalen Aufsichtsbehörden. Der vorliegende 15. Jahresbericht beschreibt den Stand des ISOE- Programms am Ende des Jahres 2005.

Zum Jahresende 2005 nahmen im ISOE- Programm 69 Betreiberorganisationen aus 29 Ländern (333 KKW im Betrieb, 40 stillgelegte KKW) und Aufsichtsbehörden aus 25 Ländern teil. Die ISOE-Datenbank enthält Daten zur Strahlenexposition und zu Dosistrends in 480 KKW- Blöcken (403 KKW in Betrieb und 77 KKW in verschiedenen Stadien der Stilllegung) aus 29 Ländern. Damit sind 91% der weltweit existierenden kommerziellen KKW (442) erfasst. In 2005 wurden 5 Blöcke der Florida Light and Power Co, USA, offiziell Mitglied im ISOE.

Die im ISOE vorhandenen Daten der in Betrieb befindlichen KKW ergeben für 2005 folgende mittlere Jahreskollektivdosen:

- 0,77 Personen Sv für DWR
- 1,47 Personen Sv für SWR
- 1,19 Personen Sv für Schwerwasseranlagen (CANDU)
- 0,93 Personen Sv für alle KKW inklusive gasgekühlte KKW und Leichtwasser-Graphit-KKW

In Ergänzung zu Informationen über in Betrieb befindliche KKW enthält die Datenbank Informationen über 76 Anlagen, die sich in verschiedenen Phasen der Stilllegung befinden. Da sich diese Anlagen nach Bauart, Größe und aktuellem Stilllegungszustand grundsätzlich unterscheiden sind Aussagen über Dosistrends schwierig.

ISOE bietet eine Basis für die Sammlung und Bewertung von Daten, die Stärke des Systems liegt im umfassenden Informationsaustausch unter den ISOE- Mitgliedern. Dies ermöglicht es, vom wachsenden Erfahrungsumfang zu profitieren und den Wert des Systems für die ISOE- Teilnehmer zu steigern.

In 2005 wurde das web-basierte ISOE- Netzwerk (www.isoe-network.net) erheblich weiterentwickelt. Es erlaubt den Teilnehmen einen einfachen Zugriff auf Informationen und stellt eine gute Plattform für den Erfahrungsaustausch über Dosismanagement im Sinne von ALARA dar. Der Zugriff auf Informationen im ISOE- Netzwerk ist durch unterschiedliche Zugriffsberechtigungen geregelt. Die Phase 1 für die Umsetzung der Datenbasis ins web- Format wurde in 2005 abgeschlossen. Die Information der Mitglieder über Schwerpunktthemen erfolgt weiterhin über Newsletters.

Die von ISOE organisierten und von OECD/NEA und IAEA unterstützten jährlichen internationalen ALARA Symposien stellen weiterhin ein wichtiges Forum für den Informationsaustausch zwischen Strahlenschutzexperten von Betreibern, Behörden und anderen Fachleuten aus der Nuklearindustrie dar. 2005 fand ein vom nordamerikanischen technischen ISOE-Zentrum organisiertes Symposium in Ft. Lauderdale, Florida, statt. Die technischen Zentren organisieren weiterhin auch Symposien zur Erfüllung regionaler Informationsbedürfnisse. Hierzu zählt für die Periode 2005-2006 erstmalig das Symposium für die asiatische Region in Hamaoka, Japan. Dieses Symposium setzt eine Tradition fort, die der Förderung des globalen Erfahrungsaustausches im Sinne eines stetigen ALARA- Prozesses dient. Das starke internationale Beteiligung an solchen Veranstaltungen verdeutlicht das stetige Interesse an Themen des Strahlenschutzmanagements.

Steigende Bedeutung gewinnt auch der Service der technischen ISOE- Zentren bei der Behandlung von Mitglieder-Anfragen zu speziellen Themen und bei der Organisation von Benchmarking Visits mit KKW aus unterschiedlichen Regionen. In 2005 wurden drei derartige Benchmarking Visits durchgeführt. Die Kombination von internationalen ALARA- Symposien und technischen Benchmarking Visits bietet ein wertvolles Forum für Strahlenschutzexperten im Sinne eines globalen Informationsaustausches zur Hebung von Synergien und zur Entwicklung eines globalen Verständnisses zum Strahlenschutzmanagement dar.

Eine ad-hoc Arbeitsgruppe „Strategische Planung“ befasste sich mit der Frage, ob weitere Möglichkeiten zur Verbesserung des ISOE – Programms bestehen. Im Hinblick auf eine Überarbeitung der vertraglichen Gestaltung des ISOE – ms in 2007 war es die Absicht der Arbeitsgruppe, eine Strategie zu entwickeln, die die Stärke von ISOE als primäre Informationsquelle und Kommunikationsnetzwerk für die verantwortlichen Strahlenschutzexperten nutzt.

Aktuelle Entwicklungen und Ereignisse von grundsätzlichem Interesse in den ISOE-Mitgliedsländern sind in Kapitel 4 dieses Berichtes zusammengefasst. Detailinformationen über erzielte Ergebnisse und das Arbeitsprogramm für 2006 sind in Anhängen dargestellt.

正文摘要

从 1992 年起，职业性照射信息系统计划就一直通过世界范围的核电厂和国家监管当局辐射防护管理人员信息和经验交流网络以及通过制订和发布相关技术资源，支持开展核电厂工作人员剂量优化工作。《职业性照射信息系统计划第 15 期年度报告》介绍了该计划截至 2005 年底的状况。

截至 2005 年底，职业性照射信息系统计划包括 29 个国家的 69 个参与电力公司（333 台机组在运行，40 台机组已关闭），以及 25 个国家的监管当局。职业性照射信息系统数据库本身包括 29 个国家的 480 台反应堆机组（403 台在运行，77 台处于冷停堆或某一退役阶段）的职业性照射水平和趋势的资料。因而，该数据库涵盖全世界正在商业运行的动力堆总数（442 座）的约 91％。2005 年，美国佛罗里达照明和电力公司的五台机组正式参加职业性照射信息系统。

根据通过职业性照射信息系统计划提供的职业性照射数据，2005 年在运行动力堆的年平均集体剂量维持在一个相当低的水平，各剂量值为：

- 压水堆 0.77 人・希
- 沸水堆 1.47 人・希
- 加压重水堆（加压重水堆/坎杜堆）1.19 人・希
- 包括气冷和轻水石墨反应堆在内的所有反应堆 0.93 人・希

除了来自在运行反应堆的资料外，职业性照射信息系统数据库还包括 76 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，难以确定清晰的剂量趋势。

虽然职业性照射信息系统以其职业性照射数据和分析著称，但该系统的强项还在于其促进各参加方广泛共享此类信息的目标。这一重要的信息交流部分有助于汲取经验教训、增加和优化专门知识以及提高参加职业性照射信息系统的价值。

2005 年，对基于网络的职业性照射信息系统网（www.isoe-network.net）进行了显著改进，目的是为职业性照射信息系统成员提供一个有关剂量减少情况和“合理可行尽量低”资源的“一站式”网基信息和经验交流门户。这个限制性访问门户将为成员访问职业性照射信息系统产品和参加方网络交流论坛提供准入，并提供对职业性照射信息系统职业照射数据库的在线访问。数据库向网络迁移的第一阶段开发工作已于 2005 年完成。在整个 2005 年期间，职业性照射信息系统计划仍继续编印《职业性照射

信息系统通讯》，就职业性照射信息系统界感兴趣的主题及时向其成员通报最新情况。

由经合组织/核能机构和原子能机构联合主办的核电厂职业性照射管理问题年度职业性照射信息系统“合理可行尽量低原则”国际专题讨论会，继续为来自核工业界和监管当局的辐射防护专业人员提供一个交流核电厂职业性照射问题实用信息和经验的重要论坛。2005 年度职业性照射信息系统“合理可行尽量低原则”国际专题讨论会由职业性照射信息系统北美技术中心组织，在佛罗里达州劳德代尔堡举行。该技术中心还继续主办地区性专题讨论会，以满足地区需求。2005－2006 年期间，首届亚洲地区专题讨论会在日本浜冈举行。这些专题讨论会继续坚持为促进思想和管理方案交流提供全球论坛的传统，以保持职业性辐射照射合理可行尽量低。国际上对这种讲习班的广泛参与表明，辐射防护的优化和职业性照射问题继续受到关注。

技术中心为响应对快速技术反馈的特别请求以及通过为职业性照射信息系统各地区之间进行减少剂量信息交流组织现场基准访问而提供的支助正变得越来越重要。2005 年，开展了三次由职业性照射信息系统组织的技术中心现场基准访问。职业性照射信息系统“合理可行尽量低原则”国际和地区专题讨论会与技术访问相结合，为辐射防护专业人员汇聚一堂讨论和共享信息，并建立职业性照射信息系统各地区之间的联系和协同作用以制订工作管理全球方案提供了一个有价值的论坛。

最后，战略规划特别工作组继续努力确定职业性照射信息系统产品、活动和组织工作的可改进之处。为了更新“职业性照射信息系统计划的条款和条件”（2007 年），战略规划特别工作组打算在职业性照射信息系统的优势基础上制订一项战略，使该系统成为职业性辐射防护界主要的信息源和交流网络。

本报告第四部分概述职业性照射信息系统参加国的近期发展和主要事件。附件提供有关职业性照射信息系统成就、参加情况和 2006 年工作计划的详细资料。

概 略

1992 年以来、ISOE プログラムは、原子力発電所の放射線防護マネージャーと規制当局による世界規模での情報と経験交換ネットワーク、及び関連した技術的な資源の開発と公表を通じて原子力発電所での作業員線量の最適化を支援している。 この ISOE プログラムの第 15 年次報告書 2005 は、2005 年末における ISOE プログラムの状況を示したものである。

2005 年末には、ISOE プログラムには 29 ヵ国の 69 加盟電気事業者（333 基は運転中； 40 基は操業停止）並びに 25 ヵ国の規制当局が含まれていた。ISOE データベース自体には 29 ヵ国の 480 基の原子炉（403 基は運転中、77 基は冷温停止または廃炉措置段階）における職業被ばくレベル及び傾向に関する情報が含まれていた。 その結果、このデータベースには全世界の商用運転中の動力炉の総数（442 基）のおよそ 91%が扱われている。 2005 年には米国のフロリダ・パワー・アンド・ライト社の 5 基が公式の ISOE 加盟原子炉になった。

ISOE プログラムを通して提供された職業被ばくデータによれば、運転中の動力炉における 2005 年の平均年間集団線量は以下のようにかなり低いレベルを維持した。

- 加圧水型原子炉（PWR）では 0.77 人・Sv
- 沸騰水型原子炉（BWR）では 1.47 人・Sv
- 加圧重水型原子炉（PHWR/CANDU）では 1.19 人・Sv
- ガス冷却炉（GCR）と軽水黒鉛炉 (LWGR）を含むすべての原子炉では 0.93 人・Sv

運転中の原子炉からの情報に加え、ISOE データベースには、操業停止または廃止措置段階にある 76 基の原子炉からの線量データが含まれている。 データベースに含まれる原子炉は型や規模が異なっており、また、通常それらの廃止措置計画の段階が異なっているので、明確な線量傾向を特定するのは難しい。

ISOE はその職業被ばくデータと分析においてよく知られているが、システムの強みは、加盟者の間でこのような情報を広く共有するという目的によるものである。この重要な情報交換という要素により、経験からの教訓の習得、専門的技術の進歩と最適化、及び ISOE への参加の価値の増加が促進されている。

2005 年に、ウェブベースの ISOE ネットワーク（www.isoe-network.net）は、線量低減と ALARA 資源に関する「ワンストップ」ウェブベースの情報と経験交換の入口を ISOE メンバーに提供する目的でかなり更新された。 この制限されたアクセスの入口によって ISOE 成果へのアクセス、加盟者間のコミュニケーションのためのウェブ・フォーラム、及び ISOE 職業被ばくデータベースへのオンラインアクセスがメンバーに提供される。データベースをウェブサイトへ移行するためのフェーズ 1 の開発は 2005 年に終了した。 また、ISOE プログラムは、ISOE 共同体の中で関心がある話題に関して会員に知らせるために 2005 年も ISOE 会報の作成を継続した。

OECD/NEA と IAEA が共同で毎年開催する、原子力発電所での職業被ばく管理に関する ISOE 国際 ALARA シンポジウムは、原子力発電所の職業被ばく問題に関する実用的な情報と経験を交換するために原子力産業と規制当局からの放射線防護専門家に重要なフォーラムを提供した。 2005 ISOE 国際 ALARA シンポジウムは ISOE 北米技術センターによって計画され、フロリダ州のフォート・ローダーデールで開催された。 また、技術センターは、地域のニーズに対応して地域シンポジウムを開催した。 2005～2006 年の期間に日本の浜岡で最初のアジア地域シンポジウムを記録した。 これらのシンポジウムは職業放射線被ばくを合理的に達成可能な限り低く維持する考え及び管理方法の交換を促進するために世界的規模のフォーラムを提供する伝統を続けた。 このワークショップへの広い国際的な参加により、放射線防護と職業被ばく問題の最適化に継続的に関心があることが分かる。

急速な技術的なフィードバックに対する特別な要求に答えて、そして ISOE 地域間の線量低減情報交換のためのサイト・ベンチマーキング訪問の機構を通じて、技術センターが供給する支援の重要性が増加しつつある。 2005 年には ISOE によって組織化された技術センターの 3 回のサイト・ベンチマーキング訪問が行われた。 国際的及び地域的な ISOE ALARA シンポジウムと技術的な訪問を組み合わせることによって、放射線防護専門家が集まり、議論し、情報を共有するための有益なフォーラムを提供し、作業管理のための世界的規模のアプローチを開発するために ISOE 地域間の連結と相乗効果を築いている。

最後に、戦略計画特別ワーキンググループ（WGSP）は、ISOE の成果、活動、及び組織の可能な改良を特定するために作業を続けた。 WGSP の意図は、ISOE プログラム条件の改訂（2007 年）に向けて、ISOE を職業放射線防護共同体のための主要な情報源及びコミュニケーション・ネットワークとして強化する戦略を開発することである。

本報告書の第 4 章で ISOE 加盟国の最近の進展と主な出来事について要約する。 ISOE の成果の詳細、参加者及び 2006 年の作業計画を附属書に提示する。

ОСНОВНЫЕ ИТОГИ

С 1992 года в рамках программы ИСПО оказывается содействие и поддержка деятельности по оптимизации получаемых работниками АЭС доз облучения путем использования сети по обмену информацией и опытом, предназначенной для руководителей служб радиационной защиты на АЭС и национальных компетентных органов во всем мире, а также путем разработки и публикации соответствующих технических ресурсов. Настоящий пятнадцатый Ежегодный доклад программы ИСПО за 2005 год отражает положение дел с осуществлением программы ИСПО на конец 2005 года.

В конце 2005 года программа ИСПО включала 69 участвующих энергопредприятий в 29 странах (333 эксплуатируемых энергоблока; 40 остановленных энергоблоков), а также регулирующие органы из 25 стран. База данных ИСПО, как таковая, включала информацию об уровнях и тенденциях профессионального облучения на 480 реакторных блоках в 29 странах (из которых 403 находятся в эксплуатации и 75 - в состоянии холодного останова или на определенной стадии снятия с эксплуатации). Таким образом, эта база данных охватывает около 91% общего числа энергетических реакторов (442), находящихся в промышленной эксплуатации во всем мире. В 2005 году пять энергоблоков компании "Florida Light and Power Co" в Соединенных Штатах стали официальными участниками ИСПО.

На основе данных о профессиональном облучении, полученных через программу ИСПО, в 2005 году средняя годовая коллективная доза в отношении находящихся в эксплуатации энергетических реакторов оставалась на довольно низком уровне со значениями:

- 0,77 чел.-Зв для реакторов с водой под давлением (PWR),
- 1,47 чел.-Зв для кипящих реакторов (BWR), и
- 1,19 чел.-Зв для реакторов с тяжелой водой под давлением (PHWR/CANDU),
- 0,93 чел.-Зв для всех реакторов, включая газоохлаждаемые (GCR) и легководные реакторы с графитовым замедлителем (LWGR).

В дополнение к информации по находящимся в эксплуатации реакторам база данных ИСПО содержит также данные о дозах по 76 реакторам, которые находятся в состоянии останова или на определенной стадии снятия с эксплуатации. Поскольку в базе данных представлены реакторы различных типов и мощностей, которые, как правило, находятся на различных стадиях снятия с эксплуатации, трудно определить четкие тенденции изменения дозы.

В то время как ИСПО хорошо известна в связи ее данными и анализами относительно профессионального облучения, сильная сторона этой системы состоит в ее цели - широко распространять такую информацию среди ее участников. Этот важный компонент программы - обмен информацией- содействует усвоению уроков, извлеченных из опыта, роста и оптимизации экспертных ресурсов, а также повышению значения участия в ИСПО.

В 2005 году работающая на базе Интернета сеть ИСПО (www.isoe-network.net) была значительно модернизирована с целью предоставления членам ИСПО "универсального" веб‑портала для обмена информацией и опытом по методам снижения дозы и ресурсам ALARA. Этот портал с ограниченным доступом предоставит членам доступ к продукции ИСПО, веб‑форумам для распространения сообщений среди участников, а также онлайновый доступ к базе данных ИСПО по профессиональному облучению. Технологические разработки первого этапа переноса этой базы данных на веб-сайт были завершены в 2005 году. В рамках программы ИСПО в течение 2005 года также продолжался выпуск информационного бюллетеня ИСПО, с тем чтобы информировать ее членов о представляющей интерес в сообществе ИСПО тематике.

Ежегодно проводимые ИСПО международные симпозиумы ALARA по управлению профессиональным облучением на АЭС, совместно организуемые ОЭСР/АЯЭ и МАГАТЭ, продолжали обеспечивать важный форум для специалистов по радиационной защите из ядерной отрасли и регулирующих органов, с тем чтобы они могли обменяться практической информацией и опытом по вопросам профессионального облучения на атомных электростанциях. В Форт Лодердейл, Флорида, был проведен Международный симпозиум ИСПО ALARA 2005, организованный Североамериканским техническим центром ИСПО. Технические центры также продолжали организовывать региональные симпозиумы в целях удовлетворения региональных потребностей. В отношении периода 2005-2006 годов следует особо отметить первый азиатский региональный симпозиум, проведенный в Хамаоке, Япония. Эти симпозиумы продолжали традицию обеспечения глобального форума для содействия обмену идеями и данными об управленческих подходах к поддержанию профессионального радиационного облучения “на разумно достижимом низком уровне". Широкое международное участие в этом семинаре-практикуме свидетельствует об интересе к вопросам оптимизации радиационной защиты и профессионального облучения.

Возрастает важность поддержки, которую технические центры предоставляют в ответ на специальные запросы для осуществления быстрой технической обратной связи, а также посредством организации контрольных посещений для обмена информацией между регионами ИСПО по вопросам снижения дозы. В 2005 году были проведены три организованные техническими центрами ИСПО контрольные посещения площадок Сочетание международного и регионального симпозиума ИСПО по ALARA и технических посещений обеспечивает ценный форум для специалистов по радиационной защите, с тем чтобы встретиться, обсудить информацию и обменяться ей с целью укрепления связей и синергизма между регионами ИСПО для разработки глобального подхода к управлению своей работой.

И наконец, специальная Рабочая группа стратегического планирования (РГСП) продолжила свою работу по определению возможных способов повышения качества продукции, деятельности и совершенствования организации ИСПО. С целью обновления положений и условий программы ИСПО (2007 год) намерение РГСП состоит в том, чтобы разработать стратегию, которая основывается на сильных сторонах ИСПО, с тем чтобы сделать ее первичным источником информации и коммуникационной системой для сообщества, занимающегося вопросами радиационной защиты персонала.

Последние и важнейшие события, произошедшие в участвующих в ИСПО странах, кратко излагаются в главе 4 настоящего доклада. Подробные сведения о достижениях в рамках ИСПО, об участии в ней и о программе работы на 2006 год содержатся в приложениях.

RESUMEN EJECUTIVO

Desde 1992 el programa ISOE ha facilitado y apoyado la optimización de las dosis ocupacionales en centrales nucleares a través del intercambio de información y experiencia entre los jefes de protección radiológica y los organismos reguladores de las distintas centrales nucleares de todo el mundo y a través del desarrollo y publicación de importantes recursos técnicos. Este décimo quinto informe anual del ISOE presenta el estado del programa ISOE a finales del año 2005.

A finales de dicho año, el programa ISOE ha contado con la participación de 69 centrales nucleares de 29 países (333 unidades en operación y 40 en parada). La base de datos del ISOE incluye información sobre los niveles de dosis ocupacionales y tendencias de 480 reactores nucleares (403 en operación actualmente y 77 en parada fría o en alguna fase de desmantelamiento) de 29 países. Esta base de datos cubre el 91% del número total de reactores nucleares comerciales en operación en todo el mundo (442). Además, también participan activamente en el ISOE los Organismos Reguladores de 25 países. En 2005, cinco unidades del Florida Light and Power Co. de Estados Unidos se convirtieron en participantes del ISOE.

De acuerdo a los datos de exposiciones ocupacionales proporcionado a través del programa ISOE, en 2005, la media anual de dosis colectiva para los reactores nucleares en operación alcanzó un nivel bastante bajo. La dosis colectiva media anual para los reactores de agua a presión (PWR) ha sido de 0,77 Sv·persona, para los reactores de agua en ebullición (BWR) ha sido de 1,47 Sv·persona y para los reactores de agua pesada a presión (PHWR/CANDU) ha sido de 1,19 Sv·persona. El valor medio de todos los tipos de reactor fue 0,93 Sv·persona (incluyendo los GCR y LWGR).

Además de información sobre reactores en operación, la base de datos del ISOE contiene datos sobre 76 reactores que están parados o en algún estado de desmantelamiento. Como estos reactores incluidos en la base de datos son de diferentes tipos y tamaños y están en diferentes fases de desmantelamiento, es muy difícil identifican tendencias de dosis y llegar a conclusiones definitivas.

Si bien ISOE es principalmente conocido por su base de datos y los análisis extraídos de la misma, la fuerza del sistema deriva de su objetivo de compartir ampliamente tal información entre sus participantes. Este importante componente de compartir información facilita el conocimiento de lecciones aprendidas de la experiencia al tiempo que incrementa el valor de la participación en el sistema ISOE.

En 2005, el sitio de Internet (www.isoe-network.net) se mejoró significativamente con el fin de proporcionar a los miembros de ISOE un portal de intercambio de experiencia y de información a través de la red acerca de la reducción de las dosis y los recursos ALARA. Este portal de acceso restringido proporcionará a los miembros un acceso a los productos ISOE, forums en la red para fomentar la comunicación entre los participantes y un acceso en línea a la base de datos de dosis ocupacionales. En 2005 se ha completado la fase 1 de migración de la base de datos al sitio de Internet. Asimismo, el programa ISOE ha continuado produciendo “ISOE Newsletters” a lo largo de 2005, manteniendo informados a sus miembros sobre temas de interés en el seno de la comunidad ISOE.

El simposio internacional anual ALARA de ISOE sobre gestión de las dosis ocupacionales en centrales nucleares, co-patrocidado por la AEN y la OIEA sigue constituyendo un importante foro de intercambio de información y experiencia sobre protección radiológica entre profesionales de la industria nuclear y reguladores. El 2005 International ISOE ALARA Symposium tuvo lugar en Ft. Lauderdale, Florida, organizado por el centro técnico de Norte América y patrocinado por la OECD/NEA y la IAEA. Los centros técnicos continuaron acogiendo simposios de alcance local para satisfacer necesidades regionales. Durante el periodo 2005-2006 se ha celebrado el primer simposio regional de Asia, en Hamaoka, Japón. Estos simposios han continuado con la tradición de proporcionar un foro global para la promoción del intercambio de ideas y líneas de gestión y actuación para conseguir mantener las dosis ocupacionales "tan bajas como sea razonablemente alcanzable" (ALARA). Su amplia participación internacional muestra el continuo interés en la optimización de la protección radiológica y las exposiciones ocupacionales.

De importancia creciente es el apoyo que los centros técnicos prestan en respuesta a peticiones especiales de apoyo técnico inmediato y a través de la organización de visitas de "benchmarking" entre emplazamientos. En 2005 tuvieron lugar 3 visitas de "benchmarking" organizadas por los centros técnicos del ISOE. La combinación de las visitas técnicas y los congresos regionales e internacionales proporciona un foro valioso para el encuentro de profesionales de la protección radiológica donde se discute y comparte información, y se construyen enlaces y sinergias entre las regiones ISOE que contribuyen a un enfoque global de la gestión de los trabajos.

Finalmente, el grupo ad-hoc sobre planificación estratégica continuó con su trabajo de identificación de posibles mejoras de los productos, actividades y organización ISOE. Con el objetivo de general nuevos términos y condiciones del programa ISOE para 2007, la intención del grupo de trabajo es desarrollar una estrategia apoyada en las fortalezas de ISOE que permita hacer del programa una fuente de información de referencia y una red de comunicaciones para la comunidad de la protección radiológica ocupacional.

Los progresos más recientes y los sucesos principales acaecidos en los países participantes en el ISOE se resumen en la sección 4 de este documento. Detalles del continuo crecimiento del programa ISOE, así como del programa de la participación y programa de trabajo para 2006 se detallan en los Anexos.

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

A prerequisite for applying the principle of optimisation to occupational radiation protection is the timely exchange of dose reduction data, information and experience among stakeholders. To facilitate this global approach to work management and 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. As a Joint Programme of interested countries for technical information exchange, the objective of ISOE is to provide a forum for radiation protection experts from utilities and national regulatory authorities to discuss, promote and coordinate international co-operative undertakings for the radiological protection of workers at nuclear power plants.

The Information System on Occupational Exposure (ISOE) Programme includes the world's largest occupational exposure database, and a network of utility and authority radiation protection experts for the exchange of information and experience. Since the inception of the ISOE Programme in 1992, ISOE participants have used this dual system of databases and communications networks to exchange occupational exposure data and information for dose trend analyses, technique comparisons, and cost-benefit and other analyses promoting the application of the ALARA principle in local radiation protection programmes.

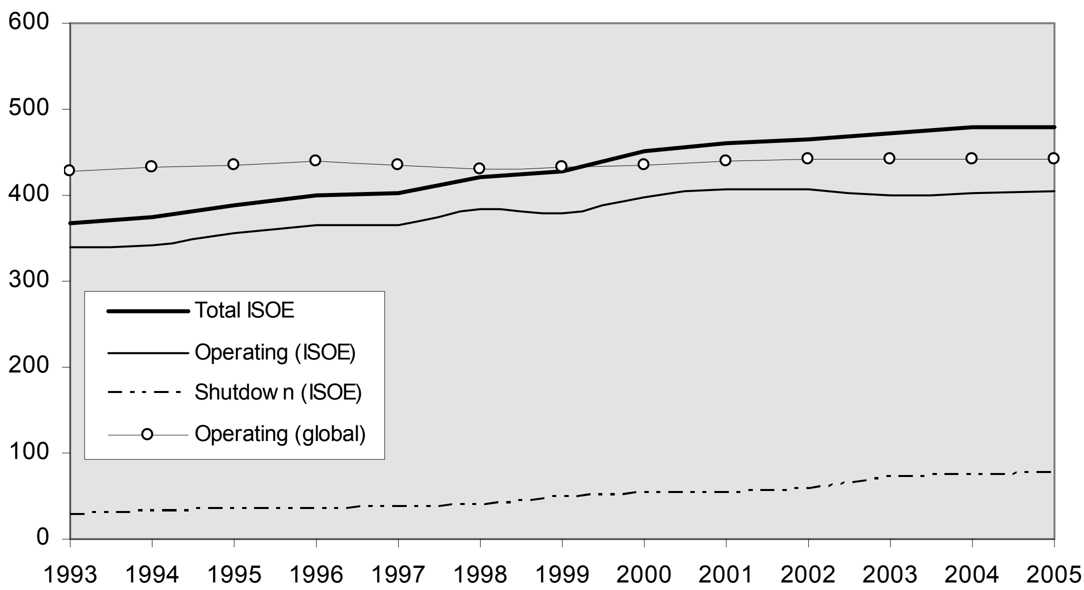
Participation in ISOE includes representatives from nuclear electricity utilities (public and private), from national regulatory authorities (or institutions representing them) and ISOE technical centres who have agreed to set up and participate in the operation of ISOE under its Terms and Conditions (2003). The objective of ISOE is to make available to the Participants:

- broad and regularly updated information on methods to improve the protection of workers and on occupational exposure in nuclear power plants;
- a mechanism for dissemination of information on these issues, including evaluation and analysis of the data assembled, as a contribution to the optimisation of radiation protection.

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. In 1997, NEA and IAEA formed a Joint Secretariat in order to leverage the strengths of both organisations for the benefit of the ISOE Programme. Four ISOE Technical Centres (Europe, North America, Asia and IAEA) manage the programme's day-to-day technical operations.

At the end of 2005, the ISOE programme included 69[1] Participating Utilities in 29 countries (333 operating units; 40 shutdown units), as well as the regulatory authorities of 25 countries. In addition to the detailed data provided directly by Participating Utilities for inclusion in the ISOE occupational exposure database, Participating Authorities also contribute official national data in cases where some of their licensees may not yet be ISOE members. The ISOE database thus includes information on occupational exposure levels and trends at 480 reactor units (403 operating; 77 in cold-shutdown or some stage of decommissioning) in 29 countries, covering about 91% of the world's operating commercial power reactors (442)[2]. Occupational exposure data collected annually from participants is made available to all ISOE members through the database.

Figure 1: Total number of reactors included in ISOE (1993-2005)



In 2005, five units from the Florida Light and Power Co in the United States became official ISOE participants. In addition, the Korean PWR Ulchin 6 (1 000 MWe) and Japanese BWRs Hamaoka 5 (1 380 MWe) and Higashidori 1 (1 100 MWe) started commercial operations, and the Swedish BWR Barsebäck 2 was shut down. In Canada, Bruce Power announced its intention to refurbish and bring on line Bruce Units 1 and 2.

Annex 3 provides a complete list of the units, utilities and authorities officially participating in the programme. Table 1 below summarises total participation by country, type of reactor and reactor status.

1 . This represents the number of lead utilities; in some cases, a plant may be owned/operated by multiple enterprises.

2 . The largest blocks of reactors not yet included in the database are in the Russian Federation and in India.

Table 1: Participation summary (as of December 2005)

Operating reactors participating in ISOE							
Country	**PWR**[3]	**BWR**	**PHWR**	**GCR**	**LWGR**	**FBR**	**Total**
Armenia	1	–	–	–	–	–	1
Belgium	7	–	–	–	–	–	7
Brazil	2	–	–	–	–	–	2
Bulgaria	4	–	–	–	–	–	4
Canada[4]	–	–	22	–	–	–	22
China	5	–	–	–	–	–	5
Czech Republic	6	–	–	–	–	–	6
Finland	2	2	–	–	–	–	4
France	58	–	–	–	–	–	58
Germany	11	6	–	–	–	–	17
Hungary	4	–	–	–	–	–	4
Japan	23	32	–	–	–	–	54
Korea, Republic of	16	–	4	–	–	–	20
Lithuania	–	–	–	–	2	–	2
Mexico	–	2	–	–	–	–	2
The Netherlands	1	–	–	–	–	–	1
Pakistan	1	–	1	–	–	–	2
Romania	–	–	1	–	–	–	1
Russian Federation	15	–	–	–	–	1	16
Slovak Republic	6	–	–	–	–	–	6
Slovenia	1	–	–	–	–	–	1
South Africa	2	–	–	–	–	–	2
Spain	7	2	–	–	–	–	9
Sweden	3	7	–	–	–	–	10
Switzerland	3	2	–	–	–	–	5
Ukraine	15	–	–	–	–	–	15
United Kingdom	1	–	–	–	–	–	1
United States	38	18	–	–	–	–	56
Total	**232**	**71**	**28**	**–**	**2**	**1**	**334**
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	31	17	–	–	–	–	48
Total	**31**	**17**	**–**	**22**	**–**	**–**	**70**
Total number of operating reactors included in the ISOE database							
	PWR	**BWR**	**PHWR**	**GCR**	**LWGR**	**FBR**	**Total**
Total	**263**	**88**	**28**	**22**	**2**	**1**	**404**

3. Includes VVER

4. In 2005, 18 CANDUs were in operation; Bruce A1, A2, and Pickering A2, A3 were in a laid-up state.

Definitively shutdown reactors participating in ISOE						
Country	**PWR**	**BWR**	**PHWR**	**GCR**	**LWGR**	**Total**
Bulgaria	2	–	–	–	–	2
Canada	–	–	2	–	–	2
France	1	–	–	6	–	7
Germany	3	1	–	1	–	5
Italy	1	2	–	1	–	4
Japan	–	–	–	1	–	1
The Netherlands	–	1	–	–	–	1
Russian Federation	2	–	–	–	2	4
Spain	–	–	–	1	–	1
Sweden	–	2	–	–	–	2
Ukraine	–	–	–	–	3	3
United States	4	3	–	1	–	8
Total	**13**	**9**	**2**	**11**	**5**	**40**
Definitively shutdown reactors not participating in ISOE but included in the ISOE database						
Country	**PWR**	**BWR**	**PHWR**	**GCR**	**LWGR**	**Total**
Germany	5	3	–	1	–	9
United Kingdom	–	–	–	18	–	18
United States	6	3	–	1	–	10
Total	**11**	**6**	–	**20**	–	**37**
Total number of definitively shutdown reactors included in the ISOE database						
	PWR	**BWR**	**PHWR**	**GCR**	**LWGR**	**Total**
Total	**24**	**15**	**2**	**31**	**5**	**77**

Total number of reactors included in the ISOE Database						
	PWR	**BWR**	**PHWR**	**GCR**	**LWGR**	**Total**
Total	**287**	**103**	**30**	**53**	**7**	**481** (incl 1 FBR)

Number of **utilities** officially participating[5]:	**69**
Number of **countries** officially participating:	**29**
Number of **authorities** officially participating:	**26**

5. This represents the number of lead utilities; in some cases, a plant may be owned/operated by multiple enterprises.

2. OCCUPATIONAL DOSE STUDIES, TRENDS AND FEEDBACK

A key aspect of the ISOE Programme is the tracking of annual occupational exposure trends from nuclear power facilities worldwide for benchmarking and comparative analysis, and experience exchange amongst ISOE members. Using the ISOE database, which contains annual occupational exposure data supplied by all participating utilities, ISOE members can perform various benchmarking and trend analyses by country, by reactor type, or by other criteria such as sister-unit grouping. The summary below provides highlights of the general trends and outcomes from the database supplemented as necessary by information from the country reports.

2.1 Occupational exposure trends: operating reactors

In general, the annual average collective dose per operating reactor unit has consistently decreased over the time period covered in the ISOE database, with the 2005 averages maintaining the fairly low level reached in last few years. In spite of some yearly variations, there is a clear downward dose trend in most reactors, although a continuing increase in the PHWR dose can be seen since the lows achieved in 1996-1998.

A summary of the exposure trends over the past three years for participating countries and by technical centre regional groupings, expressed as average annual and 3-year rolling average annual collective doses are shown in Tables 2 and 3 respectively, based primarily on data reported and recorded in the ISOE database as of September 2006, supplemented by the individual country reports (see Section 4) as required. Figures 2 to 5 show the 2005 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 1992-2005, with the average annual doses for 2005 maintaining a fairly low level:

- 0.77 man·Sv for pressurised water reactors (PWR),
- 1.47 man·Sv for boiling water reactors (BWR), and
- 1.19 man·Sv for pressurised heavy water reactors (PHWR/CANDU),
- 0.93 man.Sv for all reactors including gas cooled (GCR) and light water graphite reactors (LWGR).

In the European region, the 2005 average collective dose per reactor for PWRs was around 0.70 man·Sv per reactor, with most countries showing a stable or decreasing trend over the last three years. The average collective dose per reactor for European BWRs was around 1.18 man·Sv.

In the Asian region, the average collective dose for PWRs was 0.80 man·Sv, which was lower by about 20% compared to 2004. The BWR collective dose per reactor for 2005 has continued decreasing to 1.39 man·Sv, its lowest recorded value, due to a decrease in modification works under high radiation dose rates and a decrease in the number and duration of periodical inspections compared to 2004. The dosimetric trend for PHWRs in Korea started to decrease, showing an average 2005 collective dose of 0.75 man·Sv.

For the US, the average collective dose in 2005 for LWRs was 1.10 man·Sv per reactor. This average collective dose is 11% higher than in 2004, reflecting an increase in the number of units in refuelling outages in 2005 compared to 2004 as well as increased component replacement due to Alloy 600 issues, PWR reactor head replacements and water chemistry challenges. However, this value represents the 3rd lowest value recorded for U.S LWRs, and is almost half of the average LWR dose recorded ten years ago, reflecting industries' continuing commitment to the lowering of plant doses by implementing effective exposure reduction initiatives.

In 2005, the average collective dose for PWRs was 0.79 man·Sv. Although this average represents an 11% increase from the 2004 value of 0.71 man·Sv, it is the second lowest average dose recorded to date for US PWRs (after the dose recorded in 2004), and is the seventh year that the average annual PWR dose has been less than 1.00 man·Sv per reactor. The average collective dose for BWRs in 2005 was 1.71 man·Sv, which is the fourth lowest recorded average dose per unit for BWRs. Although the average collective doses increased slightly in 2005, one of the noted differences in comparison with 2004 were the number of plants having collective doses equal to or less than 1.00 man·Sv for the year.

In Mexico, the value of 1.68 man·Sv showed little change from 2004. In Canada, the average 2005 PHWR/CANDU dose of 1.30 man·Sv was significantly higher than the 2004 value of 0.82 man·Sv

In countries participating through the IAEA Technical Centre, the PWR average collective dose per reactor was about 0.91 man·Sv. The average dose for PHWRs was 1.08 man·Sv.

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 4 of this report.

Table 2: Evolution of average annual collective dose per unit, by country and reactor type, 2003-2005 (man·Sv)

	PWR			BWR			PHWR		
	2003	2004	2005	2003	2004	2005	2003	2004	2005
Armenia	0.86	1.16	0.84						
Belgium	0.38	0.41	0.41						
Brazil	1.11	n/a	0.62						
Bulgaria	0.73	1.04	0.78						
Canada[6]							1.04	0.82	1.30
China	0.83	0.57	0.60						
Czech Republic	0.20	0.16	0.18						
Finland	0.47	1.25	0.38	0.54	0.74	1.14			
France	0.89	0.79	0.78						
Germany[7]	1.04	0.90	1.32	0.93	1.06	1.01			
Hungary	0.76	0.38	0.47						
Japan[8]	1.07	1.25	0.97	2.38	1.58	1.39			
Korea, Rep. of	0.51	0.64	0.56				0.89	1.07	0.75
Mexico				1.91	3.54	1.68			
The Netherlands	0.26	0.79	0.20						
Pakistan	0.73	n/a	0.42				3.82	n/a	1.43
Romania							0.82	0.66	0.73
Russian Fed.	1.18	1.00	1.00						
Slovak Republic	0.31	0.29	0.40						
Slovenia	0.80	0.69	0.07						
South Africa	1.02	0.43	1.13						
Spain	0.43	0.31	0.42	2.22	0.46	2.32			
Sweden	0.54	0.58	0.63	1.23	0.63	1.06			
Switzerland	0.34	0.48	0.66	1.04	1.44	0.99			
Ukraine	1.47	1.18	1.07						
United Kingdom	0.35	0.03	0.36						
United States	0.93	0.72	0.78	1.61	1.57	1.70			
Average	**0.88**	**0.77**	**0.77**	**1.77**	**1.45**	**1.47**	**1.13**	**0.88**	**1.19**
By Region: Europe	0.74	0.66	0.70	1.15	0.84	1.18			
Asia	0.86	1.01	0.80	2.38	1.58	1.39	0.89	1.07	0.75
North America	0.93	0.72	0.79	1.62	1.68	1.71	1.04	0.82	1.30
IAEA	1.15	0.95	0.91				2.32	1.13	1.08

	GCR			LWGR		
LWGR: Lithuania				4.27	3.41	2.11
United Kingdom[9]	0.07	0.03	0.05			

6 . Dose is calculated for 17 reactors in 2003; 18 reactors in 2004, 2005.

7. Dose for 2003 is calculated including NPP Stade (KKS), which was shut down in November 2003.

8. Data for 2005 provided directly from country, and not derived from the ISOEDAT database.

9. Dose is calculated for 14 reactors in 2003-2005.

Table 3: Evolution of the 3-year rolling average annual collective dose per unit, by country and reactor type, 2001-2005 (man·Sv)

	PWR			BWR			PHWR		
	2001-2003	2002-2004	2003-2005	2001-2003	2002-2004	2003-2005	2001-2003	2002-2004	2003-2005
Armenia	0.82	0.99	0.96						
Belgium	0.44	0.40	0.40						
Brazil	0.79	0.76	0.74						
Bulgaria	0.76	0.77	0.85						
Canada[10]							0.90	0.92	1.05
China	0.69	0.69	0.67						
Czech Republic	0.23	0.18	0.18						
Finland	0.78	1.01	0.70	0.56	0.61	0.81			
France	0.96	0.88	0.82						
Germany[11]	1.05	1.06	1.08	0.92	0.92	1.00			
Hungary	0.73	0.65	0.54						
Japan	1.11	1.11	1.10	2.05	2.02	1.78			
Korea, Rep. of	0.56	0.56	0.57				0.72	0.86	0.91
Mexico				2.36	2.45	2.37			
The Netherlands	0.37	0.47	0.42						
Pakistan	n/a	0.29	0.34				3.18	2.64	2.28
Romania							0.65	0.68	0.74
Russian Fed.	n/a	1.14	1.06						
Slovak Republic	0.32	0.30	0.33						
Slovenia	0.84	0.69	0.52						
South Africa	1.00	0.76	0.86						
Spain	0.45	0.41	0.39	1.56	1.40	1.67			
Sweden	0.47	0.54	0.58	1.09	1.07	0.97			
Switzerland	0.44	0.44	0.49	0.92	1.07	1.16			
Ukraine	1.41	1.39	1.24						
United Kingdom	0.28	0.22	0.25						
United States	0.90	0.84	0.81	1.57	1.64	1.63			

	GCR			LWGR		
Lithuania				3.94	4.03	3.49
United Kingdom	0.11	0.07	0.05			

10 . Dose is calculated for 17 reactors in 2003, 13 in 2004.

11. Dose for 2003 is calculated including NPP Stade (KKS), which was shut down in November 2003.

Figure 2: 2005 PWR average collective dose per reactor by country

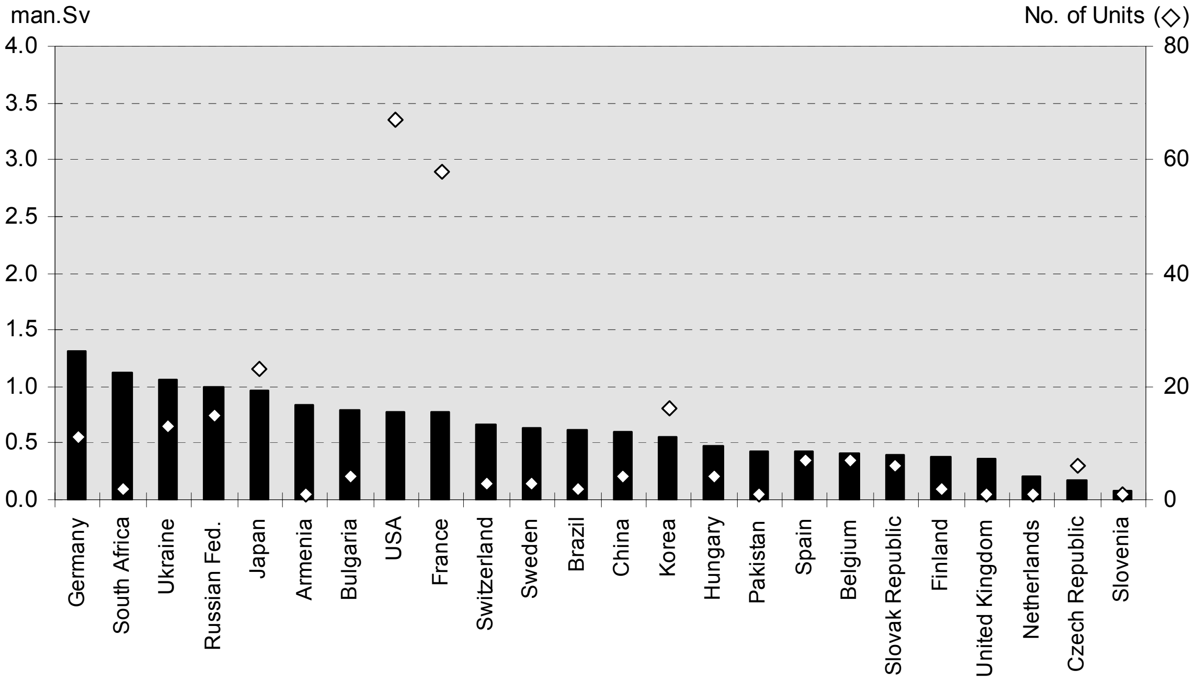


Figure 3: 2005 BWR average collective dose per reactor by country

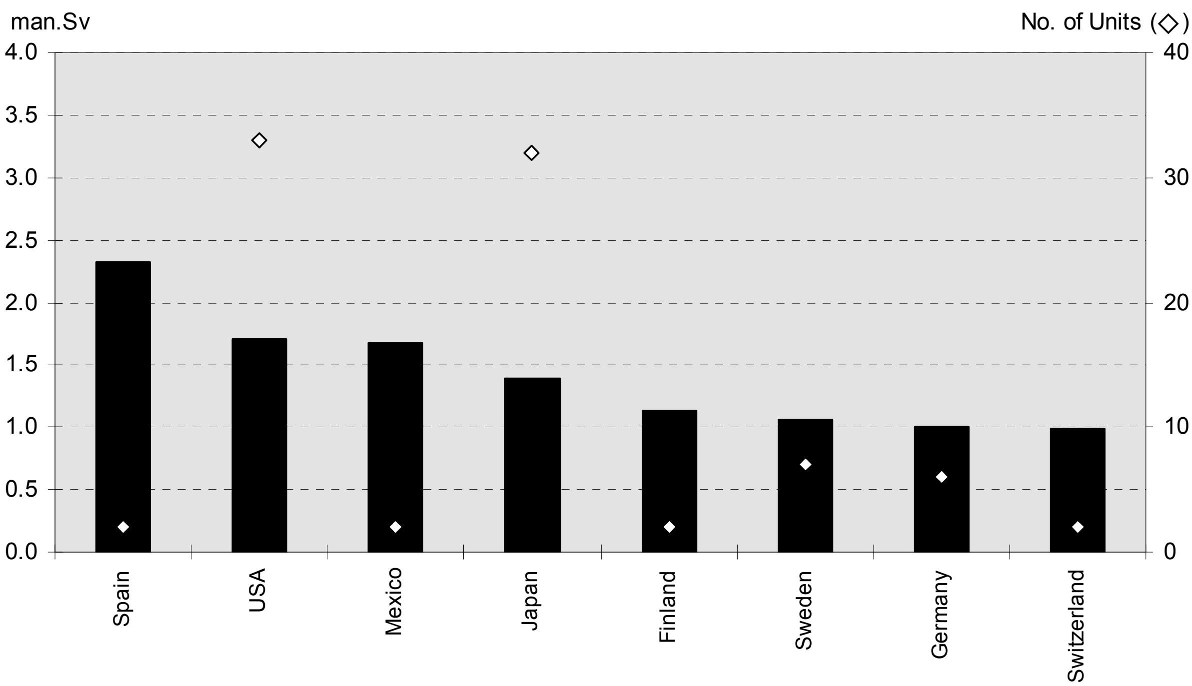


Figure 4: 2005 PHWR average collective dose per reactor by country

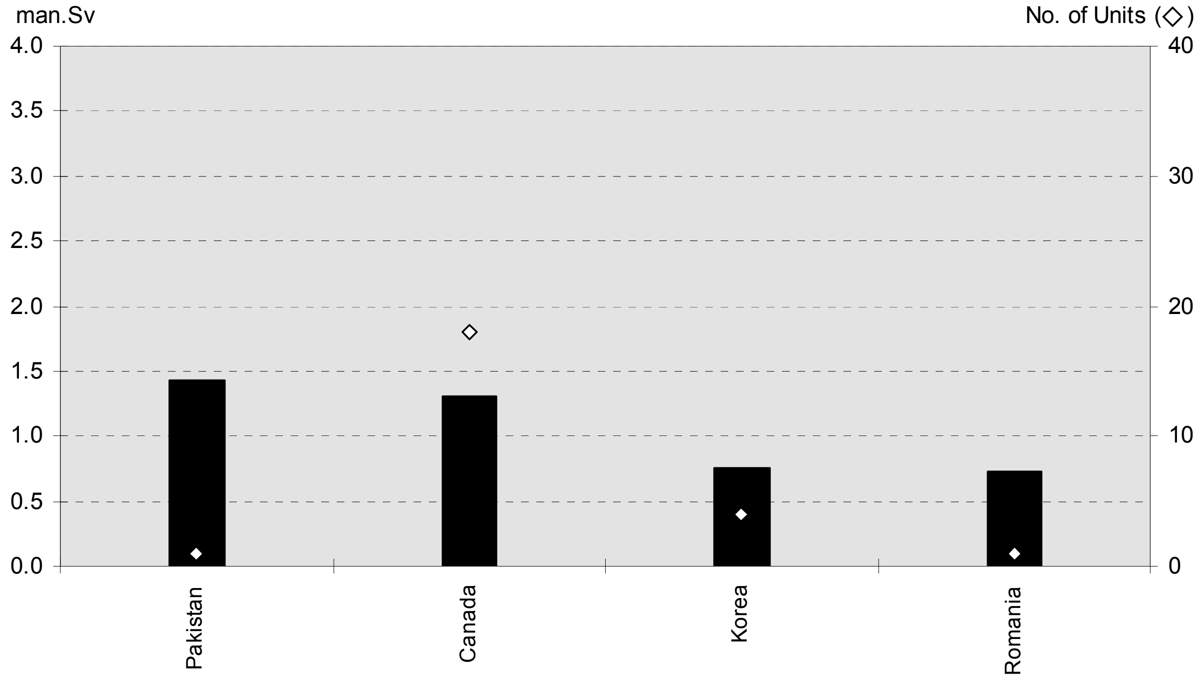


Figure 5: 2005 average collective dose per reactor type

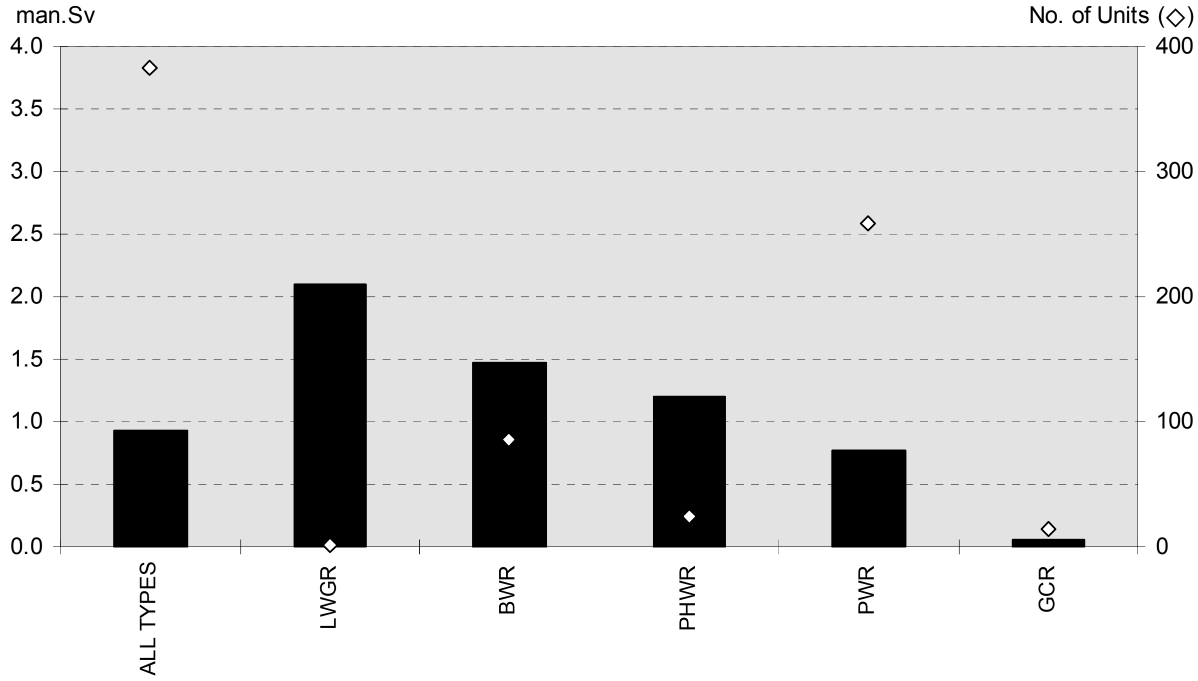
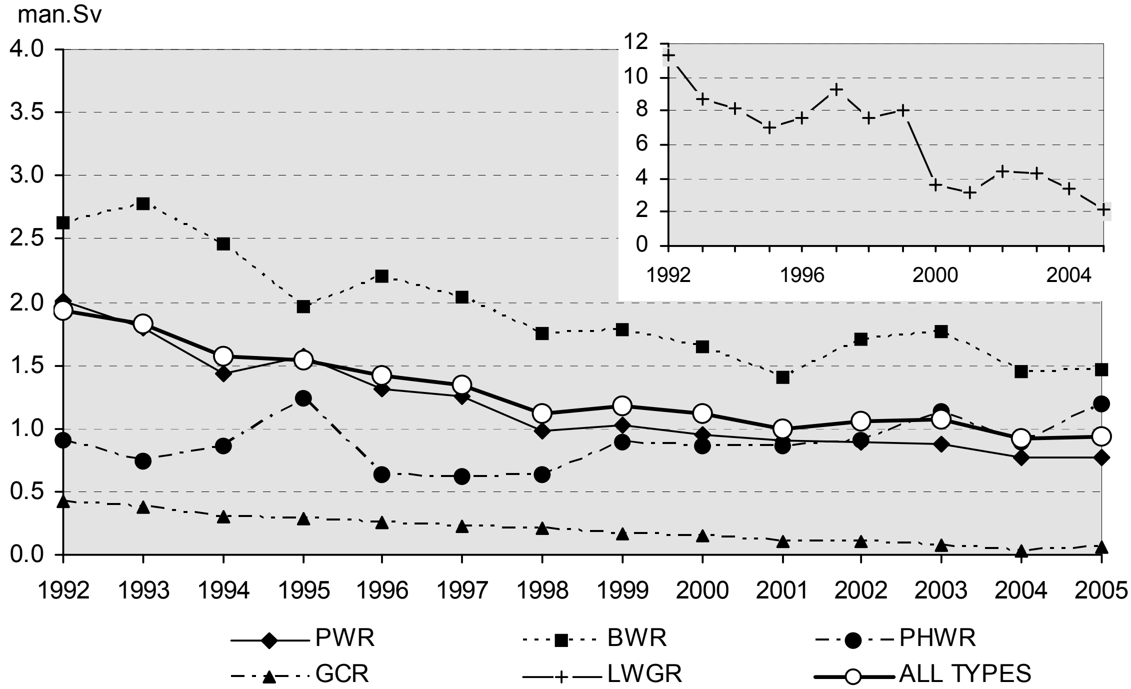


Figure 6: Average collective dose per reactor all operating reactors included in ISOE by reactor type (1992-2005)



Note: Inset chart shows average collective dose for LWGRs.

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

The ISOE database contains dose data from 76 reactors which are shut down or in some stage of decommissioning. The average collective dose per reactor for these reactors saw a reduction over the years 1992 to 2003, with a slight increase in 2004. 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 4 shows the average annual collective dose per unit by country and type of reactor for the years 2003 to 2005 for reporting reactors, based primarily on data reported and recorded in the ISOE database as of September 2006, supplemented by the individual country reports (see Section 4) as required. Figures 7-10 summarise the average collective dose per reactor for shutdown reactors for the years 1993-2005 by type (PWR, BWR and GCR).

Table 4: Number of shutdown units and average annual dose (man·mSv) per unit by country and reactor type for the years 2003-2005 for reporting reactors

	2003		2004		2005	
	No.	Dose	No.	Dose	No.	Dose
PWR						
France	1	4.6	1	4.6	1	5.6
Germany	1	38	2	213	3	175
Italy	1	0.2	1	90	1	31
United States	6	430	6	244	8	124
VVER						
Bulgaria	2	73	2	35	2	27
Germany[12]	5	47	5	36	5	37
Russian Fed.	2	340	2	178	2	232
BWR						
Germany	1	273	1	325	1	
Italy	2	43	2	27	2	5.0
The Netherlands	1	92	1	97		
Sweden	1	57	1	64	2	63
United States	4	335	4	175	5	160
GCR						
France	6	5.6	6	4.5	6	8.8
Germany	2	21	2	19	2	19
Italy	1	47	1	54	1	0
Japan	1	20	1	50	1	100
Spain	1	47	1	0		
LWGR						
Lithuania					1	364
Ukraine	3	3 525				

12 . Data for 2005 provided directly from country, and not derived from the ISOEDAT database.

Figure 7: Average collective dose per shutdown reactor: PWRs

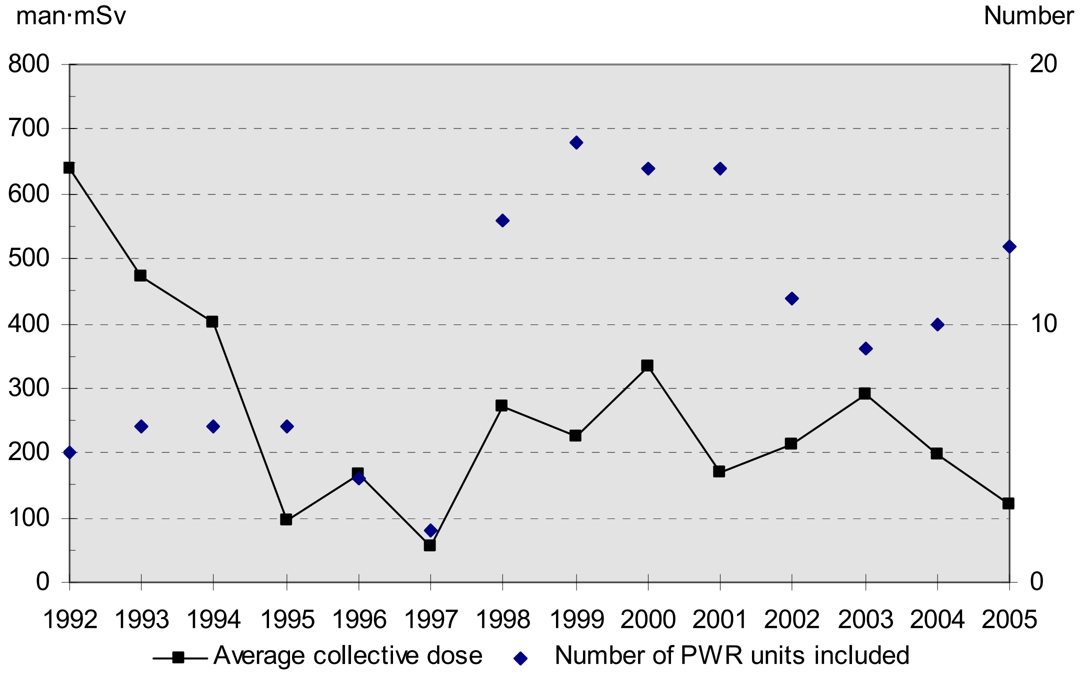


Figure 8: Average collective dose per shutdown reactor: BWRs

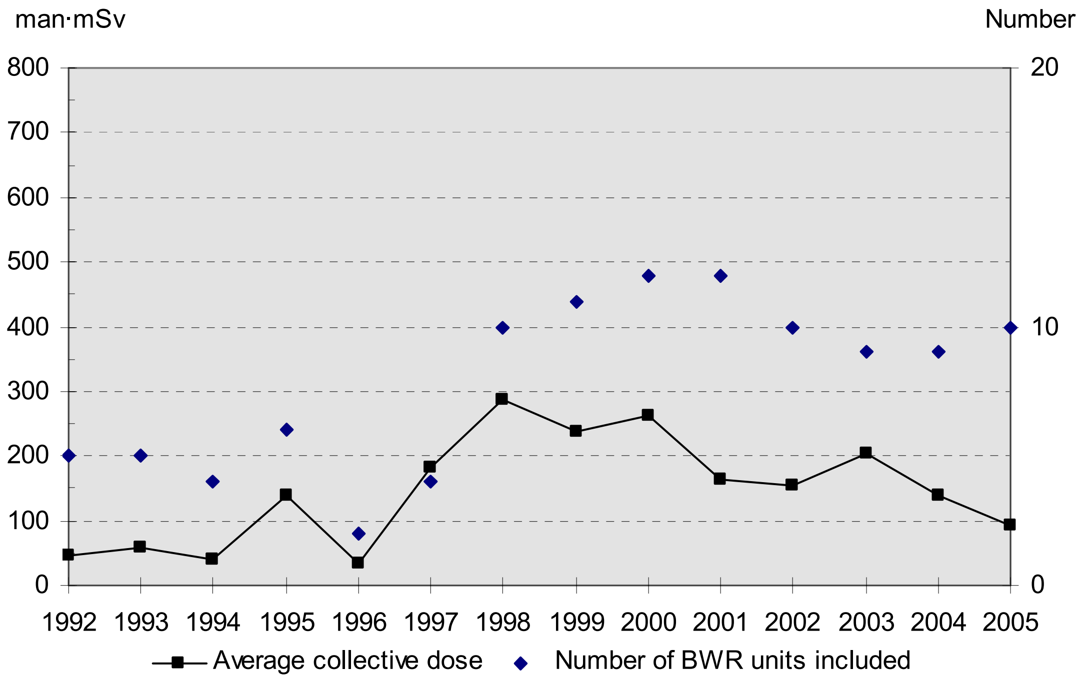


Figure 9: Average collective dose per shutdown reactor: GCRs

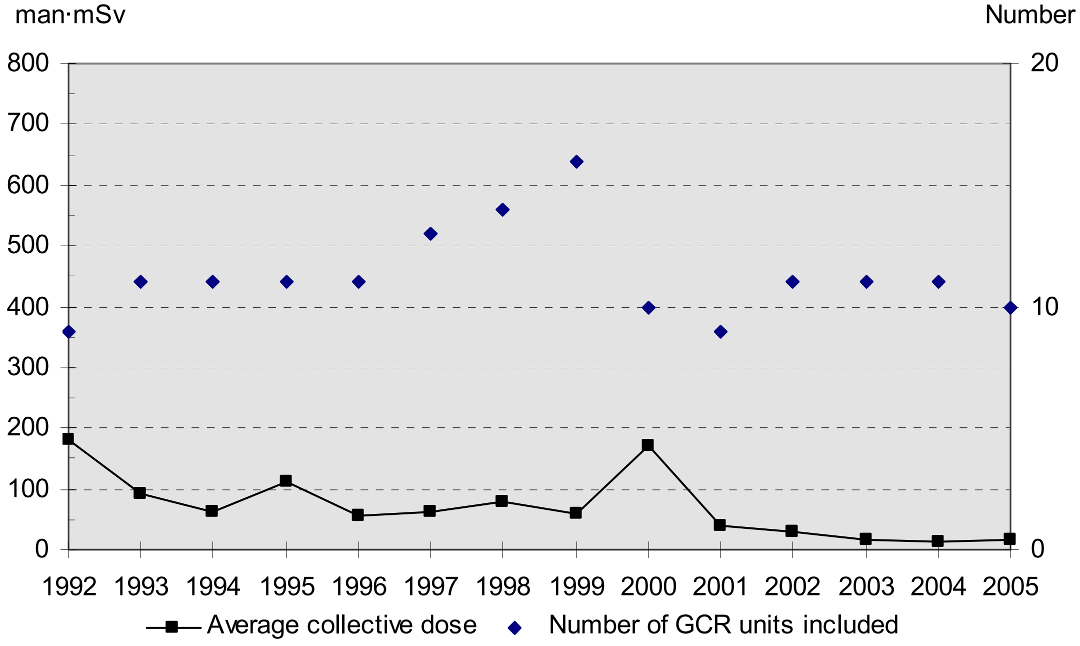
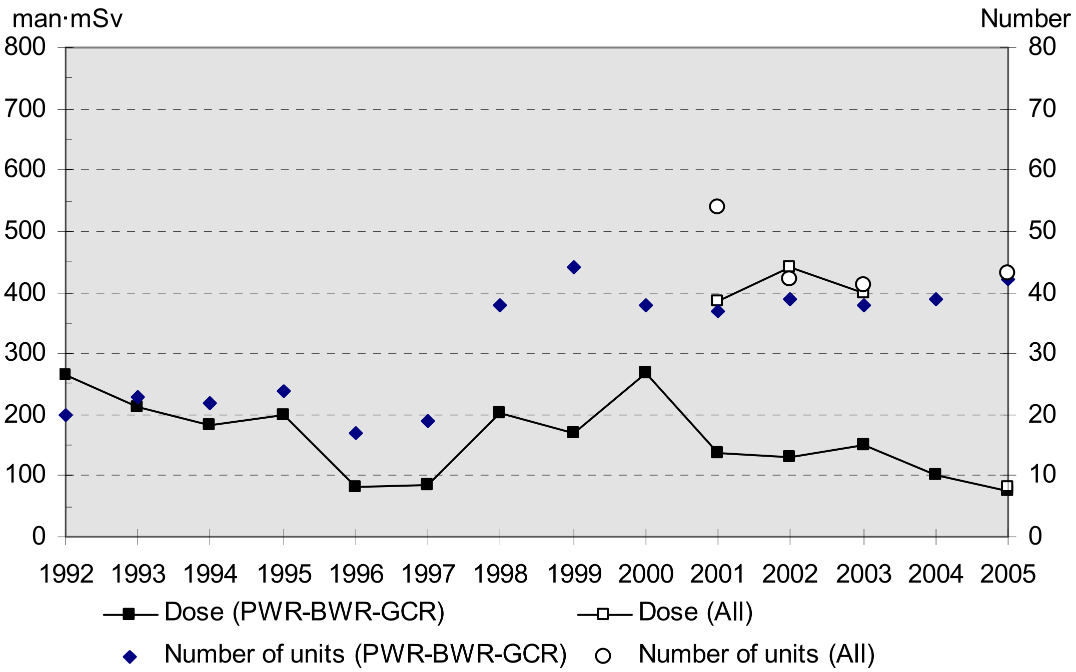


Figure 10: Average collective dose per shutdown reactor: PWR, BWR, GCR and all types



3. ISOE INFORMATION EXCHANGE AND OPERATIONS

While the ISOE programme is well known for its collection of occupational exposure management experience, information, data and analyses, the strength of the system comes from its objective to share such information broadly amongst its participants. This important information exchange component facilitates the learning of lessons from experience, the growth and optimisation of expertise, and the increase in the value of participation. The ISOE information exchange network comprises several components, both technical and social, aimed at ensuring the broad and effective exchange of information within and between ISOE regions.

3.1 ISOE network and ISOE database migration

ISOE includes a system for rapid communication of radiation protection-related information through the web-based ISOE Information Network and emailing system. The revised and upgraded ISOE Network (www.isoe-network.net) was formally launched in 2005 with the objective to provide the ISOE membership with a "one-stop" web-based ISOE/ALARA information and experience exchange portal on dose reduction and ALARA resources. This portal, containing both open and restricted-access resources, was set up to provide members with access to ISOE products, reports and publications, web forums for real-time communications amongst participants, members address books, and on-line access to the ISOE occupational exposure database.

During 2005, the MADRAS database analysis and interface module was successfully migrated to a web-enabled application, with resources and lead development by NEA and assistance from the European Technical Centre. The implementation of the web-enabled MADRAS analysis application as part of the upgraded ISOE Network was an important step forward in improving accessibility to the ISOE database for use by ISOE members in benchmarking studies and data analysis. While the CD-ROM version of the ISODAT database will continue to be produced annually, the web-enabled MADRAS analysis application will serve as the main data analyse application during 2006, during which the data input modules of the database will be developed.

3.2 2005-2006 ISOE ALARA symposium

Direct interaction remains an important component of information exchange within the ISOE communication network, as demonstrated by the annual ISOE International ALARA Symposia on occupational exposure management at nuclear power plants. Organised by the technical centres, the objective of these open symposia is to provide a forum for radiation protection professionals from the nuclear industry and regulatory authorities to exchange practical information and experience on occupational exposure issues in nuclear power plants. The technical centres also host regional Symposia to meet the needs of the local ISOE membership. The combination of international and regional ISOE ALARA Symposium provides a valuable forum for radiation protection professional to meet, discuss and share information, building linkages and synergies between the ISOE regions to develop a global approach to work management.

The ISOE Symposia have become an expected “rendez-vous” for representatives of both NPPs and regulatory bodies, helping to build a sense of a professional community facing common issues. Such networking appears to be a growing force in the optimisation of worker radiological protection, recognised by international organisations, and reinforcing the role and importance of ISOE. This continues to highlight the importance of experience exchange at local, regional and international levels.

International symposia

The NATC conducted the 2005 International ISOE ALARA Symposium on industry occupational experience in Fort Lauderdale, Florida (USA) in January 2005, with attendance of over 180 individuals from 11 countries. The Symposium was sponsored by IAEA, OECD/NEA and NATC. Electric Power Research Institute (EPRI) collaborated with NATC in hosting the meeting. The Symposium objective was to achieve international exchange on major dose activities at operating nuclear power plants, with a focus on industry operational experiences such as source term reduction, remote monitoring programmes, ultrasonic fuel cleaning, high level waste closures, and reactor coolant system equipment replacements. In order to continue the important exchange of information and experience, three distinguished technical presentations were selected and invited to the 2006 ISOE International ALARA Symposium in Essen, Germany.

Regional symposia

The first ISOE Asian ALARA Workshop took place in Hamaoka, Japan in November 2005 in conjunction with the 15th meeting of the ISOE Steering Group. This workshop, organised by the ATC, saw the involvement of about 55 participants from 14 countries. With the aim of encouraging methods for regional connection and communication, the workshop consisted of six presentations from Japanese utility representatives on the topic of current challenges and good practices in Japan, as well as 3 international presentations. One distinguished technical presentation was invited to the 2006 ISOE International ALARA Symposium in Essen, Germany.

3.3 Technical centre support activities

ISOE organised site benchmarking visits

In 2005, the ISOE programme expanded into organising site benchmarking visits for dose reduction information exchange among the 4 technical centres. ATC and NATC organised a series of US BWR site visits for the Japanese utilities and regulatory agencies, including a 5-day site visit to Fermi 1 (US BWR, Michigan) in February 2005. Topics discussed included station ALARA programme, management involvement in ALARA, hydrogen water chemistry, and refuelling outage dose management. Future US BWR visits include ISOE site benchmarking visits to Limerick, Susquehanna and Dresden NPPs.

In 2005, ETC organised for EDF one benchmarking visit to Sizewell B (UK) and one in St. Lucie (USA). These two visits comprised four people (2 EDF, 2 ETC) and lasted 4 and 3 days, respectively. The objectives were to point out practices that could explain good dosimetric results and that may be proposed as practical experience for radiological protection improvements.

Information requests

The year 2005 has shown a significant improvement in the use of the request system by the European utilities. Regularly requests from radiological protection managers sent to ETC were forwarded to all other radiological protection managers. Within two weeks, 5 to 20 answers were provided from all over the world. Some requests corresponded to very simple questions asking for quick descriptive answers, while others corresponded to more complex questions (often relying on a questionnaire asking for more information). Following these requests several utilities expressed their satisfaction and appreciation for this support.

3.4 ISOE documents and reports

The ISOE programme continued to disseminate data and information through a variety of publications throughout 2005. The Fourteenth ISOE Annual Report (2004) was prepared in 2005, and published in early 2006. The ISOE programme also contributed to the draft 2007 UNSCEAR Report on Occupational Exposure, providing information on occupational exposures of workers at nuclear power plants for the period 1995-2004. The ISOE Technical Centres continued to issue several new information sheets throughout 2005 (Annex 2). Finally, five issues of the ISOE Newsletter were issued during 2005, with the aim of keeping the ISOE membership informed on topics of interest within the ISOE community (Annex 2).

3.5 ISOE organisation

While the day-to-day technical operations of the ISOE programme are managed by each of the four ISOE Technical Centres, the overall management of the ISOE programme is carried out by the ISOE Steering Group, Bureau and technical working groups. These groups continued to meet throughout 2005 in order to ensure effective management of the programme in accordance with the ISOE Terms and Conditions.

3.6 Future directions

As the ISOE programme approaches its 15th year of experience in operational radiation protection, it has embarked on a strategic review of its operations in order to promote its use and optimise its value to participants. The strength of ISOE is based on its combination of technical information, communications, and utility and regulatory involvement. In order to build on these strengths, and work towards the renewal of its Terms and Conditions, the Working Group on Strategic Planning (WGSP), launched following the direction of the Steering Group, first met in 2005. The WGSP was tasked to provide suggestions to the ISOE Steering Group about strategic options, and make recommendations on possible revisions to the ISOE Terms and Conditions, due for renewal in 2007. Outcomes will address possible improvements to ISOE products, activities and organisation, to better meet user needs identified through a strategic programme analysis and direct feedback from its users. With a view towards renewed Terms and Conditions, a main goal of the WGSP is to develop a strategy that builds on ISOE strengths to make it a primary information source and communications network for the occupational radiation protection community.

4. PRINCIPAL EVENTS OF 2005 IN ISOE PARTICIPATING COUNTRIES

As with any summary data, the information presented in Section 2 above provides only a broad overview and graphical presentation of average numerical results from the year 2005. Such information serves to identify broad trends and helps to highlight specific areas where further study might reveal interesting detailed experiences or lessons. However, to help to enhance this numerical data, the following section provides a short list of important events which took place in participating countries during 2005 and which may have influenced the occupational exposure trends. These are presented as reported by the individual countries.[13]

ARMENIA

Principal events

Summary of national dosimetric trends

For the year 2005 the dosimetric trends at the Armenian NPP have decreased for collective dose, which is conditioned by modernisation of main radiation control system of ANPP, in particular:

- the automatic monitoring system
- aerosol radiation monitoring
- the blow-down water radiation monitoring system
- the personal dose monitoring
- a vehicle monitoring system

As a result of the modernisation the collective dose and the individual effective dose at the ANPP have been decreased. The contractors collective dose is 0.03 man·Sv.

Annual collective doses after restart of Armenian NPP in1995 (man·Sv)

Years	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Collective dose	4.18	3.46	3.41	1.51	1.57	0.96	0.66	0.95	0.86	1.08	0.82

13. Due to the various approaches in national reporting, no attempt has been made to standardise the dose units used by each country.

Events influencing dosimetric trends

In-service inspections, decontamination works and some works related to medium activity radioactive waste management.

Number and duration of outages

One outage (approx. 45days). 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 0.87 man·Sv. The real collective dose during the outage were 0.56 man·Sv. For this stage the maximum individual dose equivalent was 8.6 mSv.

Regulatory plans

To review the authorisation of radiation control system activity due to modernisation of the system.

BELGIUM

Dose information

Operating reactors

2005		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type (man·Sv)**
PWR	7	0.40

Principal events

Summary of national dosimetric trends

Collective doses for the year 2005 (man·mSv)

Tihange NPP	**Tihange 1**	**Tihange 2**	**Tihange 3**	**Total**
Plant personnel	124.8	112.9	20.4	258.1
Contractor's personnel	691.5	476.0	45.6	1 213.1
Total	**816.3**	**588.9**	**66.0**	**1 471.2**
Doel NPP	**Doel 1 + 2**	**Doel 3**	**Doel 4**	**Total**
Plant personnel	98.5	78.3	40.0	236.7
Contractor's personnel	559.1	339.7	220.2	1 141.7
Total	**657.6**	**418.0**	**260.2**	**1 378.4**

Collective doses in Tihange are stable compared to 2004. There were 2 outages in 2005 (Tihange 1 and 2) as in 2004 (Tihange 1 and 3). The grand total for Doel is more than the sum of the doses of the reactor units, due to the collective dose of the waste treatment building.

Events influencing dosimetric trends

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

Number and duration of outages

For Doel, there is one outage every year per unit. The total duration of the outages was 112 days.

Unit	Outage information	Number of workers	Collective dose (man·mSv)
Tihange 1	Outage duration:55 days, No exceptional work	1 301	719.3
Tihange 2	Outage duration:35 days, No exceptional work	1 093	514.8
Tihange 3	No outage	–	–
Doel 1	Outage duration 35days	1 053	389.2
Doel 2	Outage duration 13 days	805	209.1
Doel 3	Outage duration 22days	918	372.7
Doel 4	Outage duration: 42 days	719	235.4

Technical plans for major work in 2006

- Tihange 1: No outage.
- Tihange 2: Normal outage.
- Tihange 3: Normal outage.

BULGARIA

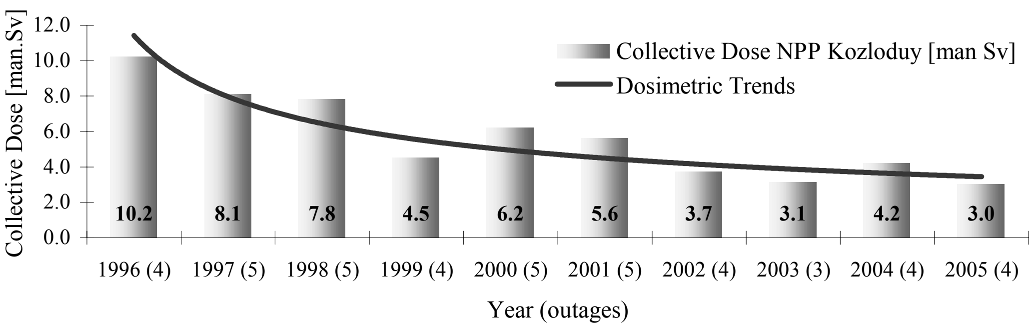
Dose information

2005		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type (man·Sv)**
1. Operating reactors		
VVER-440	2	0.516 man·Sv/unit – VVER-440
VVER-1000	2	0.958 man·Sv/unit – VVER-1000
2. Reactors in cold shutdown		
VVER-440	2	0.027 man·Sv/unit – VVER-440

Summary of national dosimetric trends

The total collective dose (CD) at NPP Kozloduy in 2005 was 3.001man·Sv (for utility employees 1.235 man·Sv, and for contractors' employees — 1.766 man·Sv). The average individual effective dose was 0.63 mSv, and the maximum individual effective dose (for a person from external organisation) was 13.42 mSv.

Collective Dose (CD) at NPP Kozloduy, 1996-2005



Number and duration of outages

	Outage information	**CD (man.Sv)**
Unit 3	29 days, standard maintenance outage with refuelling	0.225
Unit 4	28 days, standard maintenance outage with refuelling	0.328
Unit 5	86 days, standard maintenance outage with refuelling and modernisation	0.926
Unit 6	80 days, standard maintenance outage with refuelling and modernisation	0.982

Component or system replacements

Exchange and modernisation of some pipelines from the primary circuits of unit 6 and 5 have been performed during the prolonged outages contributing 0.633 [man·Sv] and 0.495 [man·Sv] respectively to the outage collective dose. The total collective dose only from modernisations tasks are as follows:

- unit 5 = 0.563 man·Sv;
- unit 6 = 0.650 man·Sv;

Organisational evolutions

The staff working at units 1 and 2 is separated from the rest of units 3 and 4.

For 2006

Some modernisation works are foreseen for units 5 and 6.

CANADA

Bruce Power

Bruce A 1-4, Bruce B 5-8

		Dose (mSv)		
Dose year	**Facility**	**EXT WB**	**INT WB**	**Grand total**
2005	BP TOTAL	7 963.73	733.71	8 697.44
	Bruce A*	1 969.04	372.69	2 341.73
	Bruce B*	5 994.69	346.47	6 341.16

Gentilly-2

Gentilly-2 Station 2005 annual dose summary is as follows:

Dose (mSv)						
Dose year	**Site**	**Outage**	**Online**	**External**	**Internal**	**Grand total**
2005	G-2		**X**	200.68	105.37	306.05
2005	G-2	**X**		1 027.20	165.32	1 192.52

In 2005, Gentilly-2 had a planned outage that lasted 58 days. This outage was partly used for the replacement of the D05 feeder in front of the reactor. During that year, the station introduced a new electronic radiological work permits system. Until November 2005, Radiation Work Permits were done by hand. Also, in 2005, Gentilly-2 introduced a daily dose follow-up at the production meeting. This dose follow-up includes analyses of the following events: electronic dosimeter alarms, tritium intake of 10 mrem (0.1 mSv) and more and gamma dose on electronic dosimeter of 10 mrem (0.1 mSv) and more. A new electronic dosimeters system (MGP DMC 2000 S) was implemented in 2005.

Ontario Power Generation

	Collective dose (mSv)		
	Whole body	**External**	**Internal**
Darlington	2 856	2 514	342
Pickering 1-4	4 880	3 260	1 620
Pickering 4-8	6 440	5 264	1 176
Total	14 176	11 038	3 138

Darlington: The Single Fuel Channel Replacement encountered significant problems during work execution. Challenges included position assembly removal, cutting and separation of the pressure tube, and welding rework during bellows installation. Dose from moderator level work was 15.3 Rem higher due to higher than expected dose rates in the vicinity of the Liquid Injection Shutdown System lines requiring significant dose expenditure in shielding installation. The forced shutdown of Unit 4 added 10 Rem unexpected dose.

Pickering A (1-4): Unit 1 returned to service after being shut down for seven (7) years. Intensive feeder inspection, replacements and feeder chaffing shields maintenance for both Units 1 and 4 added 153 Rem.

Pickering B: Significant improvement in internal dose results compared to previous years due to improved dryer performance and reliability, reduction in the number of heavy water leaks from active systems and the reduction in the tritium content in both the Moderator and Heat Transport systems. This improved CRE performance has been offset by the discovery work associated with: divider plate maintenance and boiler locking tab replacement (66.6 rem in P551, 64.8 rem in P561), and 18.2 rem for chafing shield and other feeder related repairs for P561.

New Brunswick Power

Point Lepreau Station 2005 annual dose summary is as follows:

- Total Site Dose: 1 576.9 mSv
- Internal Dose: 134.1 mSv
- Maintance Outage Dose: 1 443.4 mSv

In 2005, the initial outage dose target was exceeded significantly. Outage work was planned for 6 feeder replacements and 1 extra if inspections indicated another replacement was needed. There were 7 extra replacements based on inspection results. Most turned out to be false positive indications, but there was no way to disposition them until they were removed and tested. There were significant problems with dose expenditure for ice plugs due to new methods of applying them.

CHINA

Dose information

The dose information for Daya Bay and Lingao NPP is as follows:

Operating reactors

2005		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type (man·Sv)**
PWR	4	0.599

Principal events

Summary of national dosimetric trends

For Daya Bay NPP, the annual collective dose for the year 2005 is 1 306.5 man·mSv. For Lingao NPP, the annual collective dose for the year 2005 is 1 088.4 man·mSv.

Events influencing dosimetric trends

For Daya Bay NPP, there has a long refuelling outage during 2005. For Lingao NPP, there has been three refuelling outages during 2005.

Number and duration of outages

Unit	Duration	Collective dose (man·mSv)	Remark
Daya Bay unit 2	11th refuelling outage, from Sep.26, 2005 to Dec.05, 2005. Total 71 days.	1 187.7	
Daya Bay unit 2	2nd refuelling outage, from Dec.10, 2004 to Jan.12, 2005. Total 34 days.	503.9	Collective dose in 2005 is 59.4 man·mSv
Lingao unit 1	3rd refuelling outage, from Feb.1, 2005 to Mar.27, 2005. Total 55 days.	668.7	
Lingao unit 2	3rd refuelling outage, from Dec.17, 2005 to Jan.21, 2006. Total 36 days.	500.6	Collective dose in 2005 is 299.8 man·mSv

CZECH REPUBLIC

Dukovany NPP

Summary of dosimetric trends

The total collective effective dose (CED) at Dukovany NPP in 2005 was 0.619 man·Sv. CED for utility employees was 0.057 man·Sv, for contractors' employees 0.562 man·mSv. The total number of exposed radiation workers was 1933 (579 utility employees and 1 354 contractors). Four units of VVER-440, model 213 were in operation at Dukovany NPP. The average annual collective dose per unit in the year 2005 was 0.155 man·Sv. The maximal individual effective dose 7.32 mSv was reached by one of the contractor workers during performing the SG internal equipment fittings and inspections during 2005 unit 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	31 days, standard maintenance outage with refuelling	0.122
Unit 2	30 days, standard maintenance outage with refuelling	0.082
Unit 3	70 days, standard maintenance outage with refuelling	0.244
Unit 4	31 days, standard maintenance outage with refuelling	0.150

The actual collective dose at all outages in 2005 was the second lowest during last ten years. This value was reached due to optimised primary water chemistry, very good radiation protection ensuring and due to the lower number of the works related with high radiation risk.

During the outage of unit 3 the unplanned works on the steam generation number 4 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 40 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 22.2 mSv, the highest individual dose 0.74 mSv, total number of personnel 76. The lower actual collective dose was due to effective decontamination of SG, using water and lead shielding and good skill of workers.

Temelín NPP

Summary of dosimetric trends

Two units WWER 1000 MWe type V320 are in commercial operation since 11 October 2004. The total collective effective dose (CED) at Temelín NPP during the year 2005 was 0.416 man·Sv. CED for utility employees was 0.030 man·Sv, CED for contractors' employees was 0.386 man·Sv. All values of CED are from film dosimeters. The total number of exposed radiation workers was 1 696 (502 utility employees and 1194 contractors).

Events influencing dosimetric trends

The main contributions to the total collective effective dose at Temelín NPP were 2 planned refuelling outages. The most radiation risk activities were related to removal and reassembly of reactor upper parts especially the block of protective tubes (reactor plenum) and removal and disposal of in core neutron flux detectors.

Number and duration of outages

- Unit 1 – standard refuelling and maintenance outage, duration ~ 72 days,
  total CED ~ 146.6 mSv (16.8 mSv NPP employees + 129.8 mSv contractors employees).
- Unit 2 – major refuelling and maintenance outage, duration ~ 101 days,
  total CED ~ 264.4 mSv (23.7 mSv NPP employees + 240.7 mSv contractors employees).

A low value of total collective effective doses represents results from very low content of activation corrosion products in the primary coolant and a good quality of the fuel cladding. ALARA principles are strictly implemented during all working activities related to the works with potential high radiation risk.

Major evolutions

The possibility of reactor internals transports by "dry" way (transport above the water level within refuelling pools) was successfully verified last year taking into account all necessary ALARA principle implementation. Outer teledosimetry system (remote on-line radiation dose rate monitoring system) in the vicinity of the NPP was put in operation.

Issues of concern in 2006

Implementation of electronical personal neutron dosimetry for the radiation workers performing operational activities in the containment during the standard reactor operation.

FINLAND

Dose information

Operating reactors

2005		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type (man·Sv)**
BWR Olkiluoto	2	1.143
VVER Loviisa	2	0.406

Summary of National Dosimetric Trends

Dose trends at Finnish NPPs (man·Sv)

	2005	**2004**	**2003**	**2002**
Olkiluoto 1 (BWR)	0.456	1.062	0.274	0.809
Olkiluoto 2 (BWR)	1.830	0.452	0.758	0.312
Average	*1.143*	*0.757*	*0.516*	*0.560*
Loviisa 1 (VVER-440)	0.468	2.003	0.609	1.041
Loviisa 2 (VVER-440)	0.343	0.489	0.332	1.573
Average	*0.406*	*1.246*	*0.471*	*1.307*

Events Influencing Dosimetric Trends 2005

Olkiluoto

At unit 2 the annual outage was an extensive service outage and at unit 1 a short refuelling outage with durations of 21 days and 7 days respectively. The collective dose of OL1 outage was 0.361 man·Sv and OL2 1.742 man·Sv. The outage at unit 2 was the largest in plant history resulting in all time highest collective dose accumulation.

The most significant task in perspective of dose accumulation was turbine island modernisation at unit 2, this project included:

- replacement of high pressure turbine;
- replacement of moisture separator reheaters;
- renewal of switchgears in 6.6 kV grid;
- renewal of operational I&C system of turbine;
- replacement of steam dryers.

Loviisa

On both units the outages were short refuelling outages. The durations were 17 days (LO1) and 16 days (LO2). A distinctive feature of short refuelling outages is that no significant maintenance work is usually performed. Therefore the outage doses were among the lowest of plant history. LO1 ended up with a collective dose 0.4 man·Sv and LO2 0.3 man·Sv. In view of individual doses renewal of insulation of two steam generators was the most significant task. The highest individual dose was 13.5 mSv.

Technical plans for major work in 2006

Olkiluoto

Turbine island modernisation will be done at unit 1 in 2006. Moisture separator reheaters and high pressure turbine will be changed. Leak detection and repair of wet-well will also take place.

Loviisa

In 2006 at unit 2 some major maintenance work will be performed on reactor components. On RPV head two control rod drive mechanism nozzles will be repaired. Concerning the reactor internals, defective locking bolts of the baffle plate will be changed. Solidification plant of liquid radioactive waste will be taken into use as well as the final repository for solidified waste. Renewal of plant I&C systems will continue as planned and a new information management system will be taken into use.

Regulatory plans for major work in 2006.

The inspections concerning the construction phase of the OL3 unit will continue as well as the review work of the system specific descriptions. STUK has implemented its Construction Inspection Programme. One of the inspections will focus on radiation safety requirements in the design. The regulatory work linked with the modernisation of the installed RP instrument will be actual at Olkiluoto 1 and 2. The renewal process of the licensing of the dosimetric services at both NPPs will also be carried out during 2006.

FRANCE

Dose information

Collective doses

The average collective dose was 0.78 man·Sv per reactor in 2005 for a target of 0.79 man·Sv. The average 2005 collective dose for the 3-loop reactors (34 reactors) was about 0.93 man·Sv; the average 2005 collective dose for the 4-loop reactors (24 reactors) was about 0.56 man·Sv.

In 2005, there were 24 short outages, 25 standard outages and 4 ten-yearly outages.

One Steam Generators Replacement was realised in 2005 (Dampierre 2).

The collective dose from the outage is 79% of the annual collective dose; the collective dose from the operating period is 21% of the annual collective dose. The collective neutron dose is about 0.31 man·Sv (0.25 man·Sv from the spent fuel transport).

Individual doses

At the end of 2005, only 12 workers from highly exposed specialities (insulation, scaffolding, welding, mechanics) recorded doses over 16 mSv on 12-rolling months. At the end of 2005, there were no workers with a 12-month dose over 18 mSv and 15 workers over 16 mSv.

Events influencing dosimetric trends, number of outages

EDF 3-loop reactors:

In 2005, the lowest collective dose for a standard outage was Gravelines 5 with 0.52 man·Sv; the lowest dose for a short outage was Cruas 3 with 0.18 man·Sv. The highest outage dose was Saint-Laurent 2 with 1.65 man·Sv for a ten-yearly outage.

In 2005, 1 reactor had no outage and 4 reactors had an unscheduled outage; the lowest annual dose was Bugey 5 with 0.14 man·Sv. The main contributors were 14 short outages, 16 standard outages, 3 ten-yearly outages and one steam generator replacement (Dampierre 2). In September 2004, we started zinc injection on Bugey Unit 2, planned for 3 fuel campaigns.

EDF 4-loop reactors

In 2005, the lowest collective dose for a standard outage was Chooz 2 with 0.29 man·Sv. The lowest collective dose for a short outage was Cattenom 2 with 0.22 man·Sv. The highest dose for an outage was Paluel 2 with 2.06 man·Sv for a ten-yearly outage.

In 2005, 5 reactors had no outage and 1 reactor had an unscheduled outage; the lowest annual dose was Golfech 2 with 0.06 man·Sv. In 2005, the main dose contributors were 10 short outages, 9 standard outages and 1 ten-yearly outages.

RP incidents

At Flamanville 1 (13 April 2005), a contractor foreman was cleaning the bottom of the reactor cavity and handling wastes full of hot particles. He received a daily dose of 3.12 mSv. His total dose on 12-rolling months was 19.33 mSv. This incident was declared at the level 1 in the INES scale because of lack of individual dose survey.

At Gravelines 5 (7 May 2005), 2 irradiation capsules that were to be put into the reactor vessel could not be found. The NPP declared this event at the level 1 of the INES scale. The 2 sources were found later in another controlled area on the NPP.

Future activities in 2006-2007

High Radiation Area: four units should be modified with a key mechanism to lock the room under the vessel when the tube guide has been extracted.

Spectrometer: some RP staff had soon used the new portable spectrometer allowing quick determination of the radiation nature.

RP best practice: a carriage with all the alarm lamps and indications to each radiographer.

A new RP Information System: directly connected with the maintenance system, with an optimisation module, and a survey module giving RP data (contractors could access by the web).

New targets: the new targets in the field of collective doses are 0.77 in 2006 and 0.70 in 2010. In the field of individual doses, the target is to keep the good result of "no worker over 18 mSv".

GERMANY

Dose information

Operating reactors

2005		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type (man·Sv)**
PWR	11	1.34
BWR	6	1.00

Principal events

On 18 September 2005, a new parliament was elected. As a result, the conservatives and the social democrats will form a big coalition and are presently negotiating the essentials of the future governmental programme. The so called consensus agreement of the former red-green government on phasing out the peaceful use of nuclear energy in Germany within about 15 years is also under discussion. Up to now, no new agreement can be seen.

On 11 May 2005 NPP Obrigheim was finally shut down. In NPP Biblis the collective dose is still relatively high because comprehensive back-fitting work has to be performed which was blocked during the former red-green local government of the federal state Hessen.

Special subjects to mentioned are:

- The introduction of EPDs for the official dose monitoring is still dependent on the results of a field study performed by the BfS (Bundesamt für Strahlenschutz – Federal Office for Radiation Protection) in cooperation with GRS and some official monitoring offices under the supervision of BMU (Federal Ministry for Environmental Protection). VGB tries to ensure that practical RP aspects and the know-how already existent from projects in NPPs are sufficiently taken into account. A comprehensive status report will be given in the ISOE Workshop 2006 in Essen.
- Neutron dosimetry has become an increased matter of interest in connection with monitoring of interim storage facilities for spent fuel in CASTOR flasks at NPP sites.
- In NPP Obrigheim the injection of Zn for a time span of about 5 years resulted in a dose rate reduction by a factor of two. Similar results can be seen in NPP Biblis.
- The BMU revised the Guideline for Radiation Protection during Inspection, Maintenance, Repair and Dismantling of NPPs. This guideline represents the essential basis for ALARA management. In order to ensure that aspects of practical radiation protection in NPPs are sufficiently taken into account, the VGB Working Panel "Practical Radiation Protection" has elaborated a paper for the interpretation of this guideline. The VGB paper was officially sent to and accepted by BMU as a tool for mutual understanding.
- BfS has started a discussion about new German guidelines for radiation protection. The content is at present partially conflicting with the present national RP practice and the upcoming new ICRP philosophy.

For 2006

The national discussion in connection with the ICRP development has to be observed carefully. The introduction of new electronic dosemeters for legal dosimetry will be promoted further on. The political discussion about the nuclear option will be continued.

HUNGARY

Dose information

Operating reactors

2005		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type (man·Sv)**
VVER	4	0.688 (with electronic dosimeters) 0.547 (with film badges)

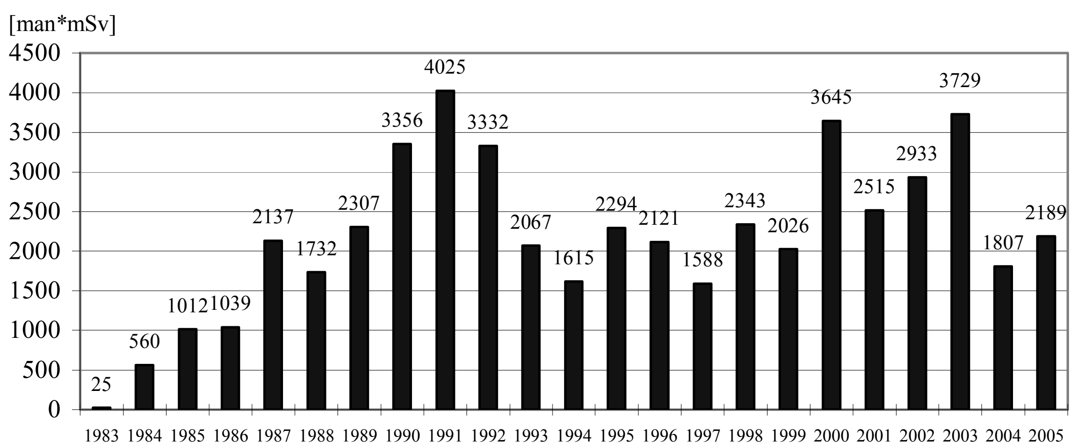
Principal events

Summary of national dosimetric trends

Upon the result of operational dosimetry the collective radiation exposure was 2752 man•mSv for 2005 at Paks NPP (1 878 man•mSv with dosimetry work permit + 874 man•mSv without dosimetry work permit). The highest individual radiation exposure was 16.6 mSv, which was well below the dose limit of 50 mSv/year, and our dose constrain of 20 mSv/year.

The collective dose increased in comparison to the previous year. The higher collective exposures were mainly ascribed to the two "so-called" long outages at Unit 2 and Unit 3. It can be stated upon considering the additional work that the collective dose received in 2005 was justified.

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)/

Events influencing dosimetric trends

There were two general overhaul (long maintenance outage) in 2005. The collective dose of outages were 598 man•mSv on Unit 2 and 759 man•mSv on Unit 3.

Number and duration of outages

The duration of outages were 28 days on Unit 1, 100 days on Unit 2, 69 days on Unit 3 and 30 days on Unit 4.

Major evolutions

The four units of the Paks NPP were put into operation between 1983 and 1987. Taking into account the designed lifetime (30 years), they should be shut down between 2013 and 2017. In possession of our present technical knowledge it can be considered as a real long-term goal to extend the designed lifetime of the units with at least ten years.

Component or system replacements

We finished the replacement of the installed release and environmental monitoring system in 2005.

Safety-related issues

We finished the replacement of the installed release and environmental monitoring system in 2005.

Technical plans for major work in 2006

There was a serious incident occurred at Unit 2 on 10 April 2003. The cleaning of 30 irradiated fuel assemblies from magnetite deposit was being performed by FANP personnel in Pit 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. We would like to start the recovery in the Pit 1 before the end of this year.

JAPAN

Dose information

Operating reactors

2005		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type (man·Sv)**
PWR	23	0.97
BWR	32	1.39

Reactors in cold shutdown or in decommissioning

2005		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type (man·Sv)**
GCR	1	0.10

Principal events

Summary of national dosimetric trends

Total collective dose in the fiscal year 2005 was 66.91 man•Sv that was decrease of 10.95 man•Sv from the previous year for all units. The average annual collective doses per unit for all units, BWRs, and PWRs were 1.19 man•Sv, 1.39 man•Sv, 0.97 man•Sv respectively. The BWR collective dose per unit for 2005 has decreased continuously last year, and recorded the lowest value in the past. The PWR collective dose per unit for 2005 has changed from the increase to the decrease, and has become the second lowest dose.

Events influencing dosimetric trends

The reasons for the collective dose reduction are the decrease of modification works under high radiation dose rate and the decrease of number and duration of periodical inspections compared to 2004.

Number and duration of outages

Periodical inspections were completed at 16 BWRs and 16 PWRs. The average duration for periodical inspection was 197 days for BWRs and 77 days for PWRs.

New plants on line/plants shut down

During fiscal year 2005, Shika 2 of Hokuriku Electric Power Company started commercial operation. This reactor is an ABWR, advanced BWR, of 1 358 MWe.

Major evolutions

The regulatory body initiated to study maintenance optimisation including condition-directive maintenance and maintenance rules. It is expected that the maintenance optimisation will promote to decrease the exposure in Japanese plants.

Regulatory plans for major work in 2006.

The study of the maintenance optimisation will be continued, and the study report will be published.

KOREA, REPUBLIC OF

Summary of national dosimetric trends

For the year of 2005, 20 NPPs were in operation; 16 PWR units and 4 CANDU units. A new PWR, Ulchin Unit 6 (1 000 MWe) completed the test operation and started the commercial operation in 2005. The average collective dose per unit for the year 2005 was 0.60 man·Sv lower than 0.69 man·Sv in 2004. As in previous years, the outages of units in 2005 contribute the major part to the collective dose, 78.2% 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 2005 are shown in the following tables:

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

Year	2001	2002	2003	2004	2005
PWR (number of reactors)	0.67 (12)	0.52 (13)	0.51 (14)	0.65(15)	0.56(16)
CANDU (number of reactors)	0.67 (4)	0.63 (4)	0.79 (4)	0.83(4)	0.75(4)

Average collective doses per reactor and individual dose for the year of 2005

NPP	Type	Planned outage duration (days)	Collective doses (man·Sv)	Average individual doses (mSv)
Kori 1	PWR	64	1.28	1.37
Kori 2	PWR	21	0.69	
Kori 3	PWR	37	1.49	1.13
Kori 4	PWR	–	0.28	
Yonggwang 1	PWR	–	0.23	0.79
Yonggwang 2	PWR	36	0.81	
Yonggwang 3	PWR		0.03	0.53
Yonggwang 4	PWR	36	0.67	
Yonggwang 5	PWR	37	0.38	0.55
Yonggwang 6	PWR	33	0.34	
Ulchin 1	PWR	–	0.12	0.97
Ulchin 2	PWR	52	1.13	
Ulchin 3	PWR	33	0.47	0.62
Ulchin 4	PWR	29	0.47	
Ulchin 5	PWR	49	0.33	0.26
Ulchin 6	PWR	–	0.04	
Wolsong 1	CANDU	51	1.52	1.35
Wolsong 2	CANDU	22	0.58	
Wolsong 3	CANDU	–	0.21	0.76
Wolsong 4	CANDU	22	0.71	

There were total 9 810 people involved in radiation works in 20 operating units and the total collective dose was 11 930 man·mSv. The outage duration was 521 days in 2005 and 717 days in 2004. As the outage duration is shorter than the one in 2004 the total collective dose is also lower as well.

There was no person who received radiation dose exceeding the annual dose of 20 mSv during the period between 1999 and 2005.

Number of Reactors and outage duration for recent 5 years

Year	Number of reactors	Collective doses (man·Sv)		Planned outage duration	
		Total	Average doses per unit	Number of outage reactors	Total 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
2004	19	13.03	0.69	17	715
2005	20	11.93	0.60	14	522

Year	Number of reactors	Collective doses (man·Sv)		Planned outage duration	
		Total	Average doses per unit	Number of outage reactors	Total 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
2004	19	13.03	0.69	17	715
2005	20	11.93	0.60	14	522

LITHUANIA

Dose information

Operating reactors

2005		
Reactor type	Number of reactors	Average annual collective dose per unit and reactor type (man·Sv)
LWGR	1	2.1055

Reactors in cold shutdown or in decommissioning

2005		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type [man·Sv]**
LWGR	1	0.3641

Principal events

Summary of national dosimetric trends

In 2005, the occupational doses at the Ignalina NPP have kept reducing trends: 4.40 man·Sv in 2002, 4.27 man·Sv in 2003, 3.41 man·Sv in 2004 (all doses are averaged per unit) and for 2005 collective dose was 2.47 man·Sv (2.1055 man·Sv for operating Unit 2 and 0.3641 man·Sv for shutdown Unit 1). In 2005, 2794 INPP workers and 1403 outside workers were working under the influence of ionising radiation in the controlled area of the INPP.

Planned annual collective dose for INPP personnel was 4.088 man·Sv, for outside workers – 1.180 man·Sv. But in fact there was no need to perform all planned repair works and therefore the collective dose for INPP personnel was 1.912 man·Sv (46.8% of planned), and for outside workers – 0.558 man·Sv (47.3% of planned). Overall collective dose for INPP personnel and outside workers was 2.47 man·Sv (46.8% of planned dose).

The average effective individual dose for INPP staff was 0.68 mSv, for INPP staff and outside workers – 0.59 mSv. The highest individual effective dose for INPP staff was 13.55 mSv, and for outside workers – 13.16 mSv.

Events caused the dosimetric trends

The main part of the overall collective dose consists of the collective dose, received during the outage period of Unit 2. Due to the shorter outage period of Unit 2 and not all the works carried out as planned, the collective dose was 1.150 man•Sv, which means 46.5% of the INPP annual occupational collective effective dose.

The main works that contributed to the collective dose during 2005 at the INPP are presented in the table below:

Main works	Collective dose (man·mSv)
Repairing of the Main Circulation Circuit	407.8
Thermo – insulation works	158.7
Maintenance, Repairs, Replacement of the Reactor Fuel Channels; Installation of the System of the Additional Emergency Reactor Protection	126.0
Repairing of Main Circulation Circuit pipeline valves	89.27
Decontamination of premises	32.5
Radiological monitoring of workplaces	20.1
Other works	226.0

Number and duration of outages

One planned outage at Unit 2 was in 2005 (Unit 1 of INPP was shut down on 31 December 2004). The duration of outage at Unit 2 was 36 days. The collective dose was distributed as following: normal operation – 53.5% of annual collective dose, outage of Unit 2 – 46.5% of annual collective dose.

New plants on line/plants shut down

In 2005, the new Cement Solidification Facility (CSF) for treatment of liquid radioactive waste and Temporary Storage Building (TSB) were constructed at the INPP site and prepared for operation in 2005.

After Government decision, the Unit 1 of INPP was shut down on 31 December 2004.

Major evolutions

Modernisation of the automatised system AKRB-06 for control of assurance of radiation protection of workers and environment of the INPP launched in 2003 and finished in 2005. All modifications were agreed with the Radiation Protection Centre.

In 2005, the measures foreseen in the Plan of Implementation of the Decommissioning Programme for the Unit 1 at the INPP were further implemented.

Goals for 2006:

- continuing the safe decommissioning of Unit 1;
- safe operation of Unit 2 for production of electricity and thermal energy;
- evaluation and upgrading the level of safety culture;
- extension and support to the effectiveness of the quality improvement system;
- highest individual dose shall be below 20 mSv;
- continuous implementation of ALARA principle.

According to the dose plan for 2006:

- the collective dose shall not to exceed 5.41 man·Sv;
- the collective dose during planned outage of Unit 2 shall not to exceed 3.55 man·Sv;
- the collective dose during normal operation of Unit 2 shall not to exceed 1.15 man·Sv;
- the collective dose during technical service of shutdown Unit 1 shall not to exceed 1.15 man·Sv.

Component or system replacements

Eight CONSTOR type containers, charged with spent fuel, were delivered to the spent nuclear fuel dry interim storage facility. Installation of means and equipment for transportation of partly burned fuel from Unit 1 to Unit 2 started in 2005.

Unexpected events

On 17 May 2005, the Unit 2 was shut down with the aim of decreasing power when turbogenerator No. 3 was turned out. ON 4 August 2005 the Unit 2 was shut down for the reason of turned out turbogenerators No. 3 and No. 4, after short-circuit took place in outside circuit.

Organisational evolutions

During preparation for decommissioning of INPP, the changes in INPP structural departments continue. The growing part of works conducted at INPP will fall to the outside workers and also to the Decommissioning Project Management Unit of the INPP.

Regulatory work in 2005 and plans in the coming year

Exercising the radiation protection state supervision and control at Ignalina NPP (INPP), in 2005 five inspections were carried out at Ignalina NPP and also two inspections were carried out at spent nuclear fuel interim dry storage facility. Also 9 outside organisations (contractors) have been supervised and controlled.

In 2005, the Radiation Protection Centre (RSC) reviewed the INPP related decommissioning documents: decommissioning project U1DP0 (defuelling of Unit 1), Safety Assessment Report of decommissioning project U1DP0, Environmental Impact Assessment Report for the Near Surface Repository, Environmental Impact Assessment Programme for planned temporary storage of RBMK spent nuclear assemblies for INPP Units 1 and 2, documents for the design of a new temporary storage facility for storage of spent nuclear fuel, documents related to licensing of INPP Cement Solidification Facility and Temporary Storage Facility for solidified liquid radioactive waste.

Exercising the radiation protection state supervision and control at Ignalina NPP in 2006, RPC plans to carry out 6 inspections, it will also continue review of the documents related to INPP decommissioning.

MEXICO

Dose information

Operating reactors

2005		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type (man·Sv)**
BWR	2	1.68

Principal events

Summary of national dosimetric trends

2005 has been the best historical year for LVNPS regarding collective dose. The downwards collective dose trend continues since 1996.

Events influencing dosimetric trends

- U1 Reactor Water Cleanup System (RWCU) seals repairs: 81.5 man•mSv.
- U1 & U2 steam leakages inspection and repairs: 100 man•mSv.
- U1 non refuelling outages (two): 66 man•mSv.
- U2 non refuelling outage (one): 60 man•mSv.

Number and duration of outages

- U1 non refuelling outage, 17-24 February.
- U1 non refuelling outage, 28-31 August.
- U1 11th refuelling outage, 8 September- 11 October.
- U2 non refuelling outage, 26-30 August.

Major evolutions

A project for 120% power rate increase for Laguna Verde is approved. This project will be developed through year 2010.

Unexpected events

Leakage of a reactor feedwater valve (RFW-AV-9070) leads to multiple attempts to repair it, making necessary at the end an outage for that purpose.

Technical plans for major work in 2006

- Hydrogen/noble metals chemistry will start up for Unit 2.
- Replacement of recirculation pumps during the 8th U2 refuelling outage.
- Contract bid for the plant approved 120% power increase.

THE NETHERLANDS

Dose information

Operating reactors

2005		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type (man·Sv)**
PWR	1	0.212

Reactors in cold shutdown or in decommissioning

2005		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type (man·Sv)**
BWR	1	0.003

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. The modification works for transferring the plant into a "safe enclosure" (for 40 years) have been completed in July 2005. In the past years a number of buildings have been demolished and several decommissioning activities have been carried out. New systems were built for ventilation, water treatment and monitoring of emissions. The collective annual dose in 2005 was 0.003 man·Sv. For the next years every year some surveillance and maintenance activities will continue to be carried out. The annual collective dose is expected to be kept below 0.5 man·mSv.

The Borssele plant (450 MWe), operated by NV EPZ, is a baseload unit. Up to this year it has enjoyed 32 years of commercial operation. Major back-fittings were completed in the plant in 1997. The unit capability factor in 2004 was 94.7%. The annual outage in October lasted 12 days. It was a short reshuffle outage. The collective dose in the outage was 0.120 man·Sv. The annual collective dose amounted 0.212 man·Sv In 2005 the average individual dose 0.36 mSv for plant and 0.41 mSv for contractor personnel. The highest annual individual dose was 4.25 mSv for plant and 3.14 mSv for contractor personnel. In 2006 a 6 week outage is foreseen in which major activities are inspection of the steam generators, a turbine-upgrade and several modifications related to the latest 10 yearly evaluation.

ROMANIA

Dose information

Operating reactors

2005		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type (man·Sv)**
CANDU	1	0.732

Principal events

Summary of national dosimetric trends

Occupational exposure at Cernavoda NPP

February 1996-December 2005			
	Internal effective dose (man·mSv)	**External effective dose (man·mSv)**	**Total effective dose (man·mSv)**
1996	0.6	31.7	32.3
1997	3.81	244.48	248.28
1998	54.37	203.25	257.62
1999	85.42	371.11	469.89
2000	110.81	355.39	466.2
2001	141.42	433.44	574.86
2002	206.43	344.04	550.48
2003	298.02	520.27	818.28
2004	398.26	258.45	656.71
2005	389.3	342.29	731.59

Events influencing dosimetric trends

In 2005 the planned outage had a 35% contribution to the collective dose, less than previous years. The contribution of internal dose due to tritium intake was 50% for the planned outage period and 53% for the entire year 2005.

Number and duration of outages

During 2005 there were:

- one 3 days unplanned outage between 19-21 January;
- one 8 days unplanned outage between 28 January 28-4 February;
- one 3 days unplanned outage between 19-21 July;
- one 27 days planned outage, between 19 August and 14 September.

Major evolutions

During 2005 CNCAN continued to issue new regulations:

- Ord. 156/2005 “Regulations for classification of radioactive waste”.
- Ord. 221/2005 “Regulations for limiting releases of radioactive effluents into environment”.
- Ord. 275/2005 “Regulations for monitoring of radioactivity in the environment in the vicinity of a nuclear or radiological installations”.
- Ord. 274/2005 “Regulations for monitoring of international radioactive waste shipments involving Romanian teritory”.
- Ord. 276/2005 “Regulations for monitoring radioactive emissions from nuclear and radiological installations”.
- Ord. 357/2005 “Regulations for transport of radioactive materials”.
- Ord. 356/2005 “Regulations for orphan sources and control of high activity sealed sources”.
- Ord. 364/2005 “Regulations for envelope system of CANDU nuclear power plants”.

- Ord. 365/2005 “Regulations for shut down systems of CANDU nuclear power plants”.
- Ord. 372/2005 “Regulations to forbid usage of fluoroscopic radiological medical installations without image intensifier”.
- Ord. 400/2005 “Regulations for near surface storage of radioactive waste”.
- Ord. 407/2005 “Regulations for authorising execution of nuclear construction”.

Component or system replacements

- 11 vertical neutron flux detectors.

Safety-related issues

- proper removal of an activated small object in a pipe from Liquid Injection Shutdown System, generating high gamma dose rates in one accessible area of the reactor building;
- successful replacement of 11 vertical neutron flux detectors: individual and collective doses were kept very low;
- Area Alarming Gamma Monitors System with 34 loops was replaced.

Issues of concern in 2006

Due to the increase of tritium dose rate in the Reactor Building (boiler room and accessible areas) for two consecutive years (2004 and 2005), individual and collective internal doses became a major concern. Corrective and preventive actions and recommendations aimed both work planning and technical aspects:

- ALARA planning of routine and maintenance activities in Reactor Building/Boilers Room (respiratory protection, limiting the time spent in Reactor Building, postponing some activities, optimise the routine activities performed by the operators and radiation protection technicians in the Boilers Room);
- Acquisition of a semi-portable tritium monitor Overhoff 421 NPPM, with gamma and noble gases compensation;
- Design change, so dryers serving Reactor Vaults (R107, R108) and Boilers Room (R501) to “suck the air” direct from these rooms.
- Analyse the opportunity and necessity of installing a drying unit on the entrance of the ventilation tubes serving reactor building in order to decrease the influence of the humidity of air on tritium fields.
- Re-routing moderator cover gas purge line, for both units.
- Modernise the Tritium in Air Monitoring system.

Technical plans for major work in 2006

The major activities planned for 2006 outage having a potential impact on the collective dose are activities included in preventive/corrective maintenance programme and replacement of 11 Vertical Flux Detectors assemblies.

Regulatory plans for major work in 2006.

CNE-PROD ALARA Programme was issued during 2005 and ALARA committee will be established during 2006.

RUSSIAN FEDERATION

Dose information

Operating reactors

2005		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type (man·Sv)**
PWR (VVER)	15	0.998

Reactors in cold shutdown or in decommissioning

2005		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type (man·Sv)**
PWR (VVER)	2	0.116

Summary of national dosimetric trends

Collective doses

Personnel, contractors and total collective doses for of all operating VVERs are shown below.

Nuclear power plant		**Personnel (man·Sv)**	**Contractors (man·Sv)**	**Total (man·Sv)**
Balakovo	Unit 1, VVER-1000	0.276	0.220	0.496
	Unit 2, VVER-1000	0.258	0.195	0.453
	Unit 3, VVER-1000	0.425	0.414	0.839
	Unit 4, VVER-1000	0.307	0.301	0.608
	Total for Balakovo NPP	1.266	1.130	2.396
Kalinin	Unit 1, VVER-1000	0.807	0.320	1.127
	Unit 2, VVER-1000	0.776	0.248	1.024
	Unit 3, VVER-1000	0.154	0.035	0.189
	Total for Kalinin NPP	1.737	0.603	2.340
Kola	Unit 1, VVER-440	0.427	0.245	0.672
	Unit 2, VVER-440	0.791	0.276	1.067
	Unit 3, VVER-440	0.371	0.204	0.575
	Unit 4, VVER-440	0.205	0.122	0.327
	Total for Kola NPP	1.794	0.847	2.641
Novovoronezh	Unit 3, VVER-440	2.516	0.332	2.848
	Unit 4, VVER-440	2.090	0.337	2.427
	Unit 5, VVER-1000	1.614	0.576	2.190
	Total for Novovoronzh NPP	6.220	1.245	7.465
Volgodonsk	Unit 1, VVER-1000	0.035	0.098	0.133

In 2005, the total effective annual collective dose of all Russian operational VVER type reactors was 14.975 man·Sv that was practically at the level (14.054 man·Sv) of 2004.

Main aspects of collective dose forming in the year 2005 were determined by the next factors:

- Collective dose accounting for Kalinin 3 which started commercial operation on 16 December 2004.
- The considerable increase of annual collective dose in Novovoronezh 3 (a 55% increase over 2004) and Novovoronezh 4 (a 46% increase over 2004). These data were mainly resulted from the maintenance and repairing work during major outage in Novovoronezh 3 and standard outage in Novovoronezh 4, as well as the high number of staff at these Units.
- Stable collective doses with some tendency to decrease at Balakovo, Kalinin, Kola and Volgodonsk NPPs. In 2005, there was a small increase in Kalinin 2, related to major repairing work at the reactor pressure vessel head.

Individual doses

In 2005, the annual effective individual doses received by 4 workers of Novovoronezh NPP exceeded control level of 20 mSv (in 2004, 6 workers from Novovoronezh NPP received individual doses more than 20 mSv). This control level was fixed by concern Rosenergoatom – operating organisation of all Russian NPPs – as operational dose constraint. The main occupational dose limit, used for all NPPs in Russia and defined as 100 mSv per 5 years, but not more than 50 mSv in any single year, was unconditionally valid. These individual doses (23.5 mSv, 23.3 mSv, 23.2 mSv, 22.0 mSv) were gradually received by persons from the plant maintenance department during reactor pressure vessel repairing with the penetration tubes replacement procedure at Novovoronezh 5.

There were no events of exceeding 20 mSv of annual individual dose at other plants with VVER type reactors in 2005. The maximum annual effective individual doses were:

- Balakovo – 15.8 mSv.
- Kalinin – 19.6 mSv.
- Kola – 18.2 mSv.
- Volgodonsk – 3.2 mSv.

Indicated maximum individual doses were gradually received by workers from the plants maintenance departments as a result of inspections and repairs of reactor vessels, reactor vessel heads, main coolant pumps, steam generator headers and valves.

Moreover, there was an unplanned repairing outage at Novovoronezh 5 from 7 to 11 September 2005. The outage collective dose (personnel and contractors) for this period was 0.013 man·Sv.

Main dose-reduction activities in 2005

- Personal dosimetry instrumentation improvement was performed in some NPPs. "Harshaw 6600" TLD System was put into operation at Kola, "Dosacus" automatic TLD readers were introduced at Novovoronezh.
- Radiation exposure goals (annual collective dose per unit) were evaluated and enacted for all NPPs of concern Rosenergoatom.
- New recording and reporting practice was implemented for occupational exposures.

- Special Workshop on the experience of ISOE software and database application was held in Moscow from 14 to 15 December 2005. Participants from all Russian NPPs took part in the Workshop. As a result, the guide "Basic principles of ISOE 1 data standardisation for operational VVER type reactors" was issued.
- Continuation of the centralised delivery and implementation of electronic personnel dosimeters at NPPs.

Planned outages duration and collective doses

Name of reactor	Duration (days)	Collective dose (man·Sv)	Part of total annual collective dose (%)
Balakovo 1	47	0.395	80
Balakovo 2	45	0.389	86
Balakovo 3	70	0.759	90
Balakovo 4	42	0.487	80
Kalinin 1	51	1.076	95
Kalinin 2	60	0.973	95
Kalinin 3	61	0.165	87
Kola 1	37	0.475	71
Kola 2	54	0.952	89
Kola 3	40	0.533	93
Kola 4	35	0.288	88
Novovoronezh 3	64	2.475	87
Novovoronezh 4	49	2.058	85
Novovoronezh 5	242	2.095	96
Volgodonsk 1	45	0.124	93

Issues of concern for 2006

- Development and implementation of the portable system for automated gamma mapping of NPP equipment and area.
- Comparative analysis of tungsten, lead and depleted uranium protective shields application in high radiation areas.
- Arrangement and realisation of "Best health physicist of NPPs" competition.
- Continuation of the centralised delivery of electronic personnel dosimeters at NPPs.

SLOVAK REPUBLIC

Dose information

Operating reactors

2005		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type (man·Sv)**
VVER	6	0.386

Principal events

Summary of national dosimetric trends

Bohunice NPP (4 units)

The total annual effective dose in Bohunice NPP in 2005 calculated from legal film dosimeters was 1 557.053 man·mSv (employees 186.613 man·mSv, outside workers 1 370.44 man·mSv). The maximum individual dose was 14.44 mSv (contractor).

Mochovce NPP (2 units)

The total annual effective dose in Mochovce NPP in 2005 calculated from legal film dosimeters was 759.434 man mSv (employees 283.817 man·mSv, outside workers 475.617 man·mSv). The maximum individual dose was 9.738mSv (contractor).

Events influencing dosimetric trends

Bohunice NPP

The higher collective exposure in 2005 at the unit 1 was caused by the unplanned works combined with the removing of the resins that penetrated to the primary circuit at the end of the outage. All 6 primary loops had to be open again, internal part of the reactor had to be removed and all items including the reactor vessel and many tanks had to be cleaned. The event prolonged the outage for 30 days more and it created the unplanned exposure 235.72 man·mSv.

The differences between the collective exposures in 2004 and 2005 at unit 3 and 4 were expected and they were caused by the different types of the outages – standard and major ones.

Mochovce NPP

The higher collective dose in 2005, in comparison to the year 2004, was caused by two factors. Firstly in the 2005 there were performed one major outage on unit 1 and one standard outage on the unit 2. Second factor contributing to the higher value of collective dose was the exchanging of ECCS flap valves in Unit 1.

Number and duration of outages

Bohunice NPP

- Unit 1 – 101 days major maintenance outage prolonged due to the removing of the resins that penetrated to the primary circuit at the end of outage. The total collective exposure was 810.99 man·mSv.
- Unit 2 – 32 days standard maintenance outage. The total collective exposure was 277.51 man·mSv.
- Unit 3 – 72 days major maintenance outage combined with the modernisation works. The total collective exposure was 435.08 man·mSv.
- Unit 4 – 45 days standard maintenance outage combined with the modernisation works. The total collective exposure was 239.18 man·mSv.

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

Mochovce NPP

- Unit 1 – 0 days major maintenance outage with the exchange of ECCS system valve flaps. The total collective exposure was 560.279 man·mSv.
- Unit 2 – 35 days standard maintenance outage. The total collective exposure was 151.157 man·mSv.

Unexpected events

Bohunice NPP

- Unit 1 – the unplanned works combined with the removing of the resins that penetrated to the primary circuit at the end of the outage. See the text above.

New/experimental dose-reduction programmes

Bohunice NPP

Improving of the working conditions and cleaning of gas discharges during the outage at Bohunice V1 NPP – full description is provided in the proceedings of the 5th ISOE Workshop. The dose reduction measures consist of the following items:

- Generation of the under pressure in the reactor after its first opening.
- Improving of the air exhausting above the water level during the reactor vessel filling.
- Modification of the exhausting ventilation systems from the reactor hall – purification of the air before the discharge to the environment.

Mochovce NPP

An action was started in order to characterise CRUD in the primary circuit of the 1 unit. Within the action some measures were proposed how to remove the CRUD and to decrease dose rate values of the primary circuit systems.

Organisational evolutions

Bohunice NPP

Preparation for the privatisation of the Slovak Electricity Company: At the end of the year the four units plant – Bohunice NPP was divided into the two plants – Bohunice V1 (Unit 1+2) and Bohunice V2 (Unit 3+4).

Issues of concern in 2006

The privatisation process of the Slovak Electricity Company will be finished. Bohunice V1 will be involved into the new state running company and Bohunice V2 will continue its operation in the privatised company. Due to that both plants will have to establish the new organisations, obtain new licences.

On 31 December, Bohunice V1, Unit 1, will be shut down ahead of schedule due to the government decision. It was one of the conditions of the EU given to the Slovak republic during the accession process to the EU. The reconstruction of Bohunice V1 was finished in 2000, cost 250 million US dollars and after that the plant reached the internationally acceptable safety level.

Technical plans for major work in 2006

Bohunice NPP

- installation of accident gas discharge monitor in ventilation stack;
- installation of internal contamination monitors at the exits from the change rooms;
- establishing of the dosimetry service at V2 (legal and operational) as the whole dosimetry after the privatisation will be left in Bohunice V1.

Regulatory plans for major work in 2006

- Implementation of new regulations in radiation protection.
- Regulatory control of privatisation process of NPPs.
- Inspections of outages in all operated units.

SLOVENIA

Radiological performance indicators of Krško nuclear power plant (PWR) for the year 2005 were:

- Collective radiation exposure was 0.07 man-Sv (0.01 man·mSv per GWh electrical output).
- Maximum individual dose was 6.87 mSv, average dose per person was 0.14 mSv.

Planned outage

In this year the plant was for the first time in 18 months fuel cycle with no planned outage.

Major evolution

The plant activities were related to outage planning in 2006 with preparation of replacement of low pressure turbine rotors.

SPAIN

In the year 2005 the average dose per outage has been 0.428 person·Sv for PWR (5 units). The average dose per outage for BWR has been 2.016 person·Sv (2 units).

Per plant annual collective doses and the outage collective doses

NPP	Type	Outage coll. doses (person·Sv)	No. days	Annual doll. doses (person·Sv)	Comments
J. Cabrera	PWR	0.327	28	0.619	
Almaraz I	PWR	0.373	23	0.418	
Almaraz II	PWR	—	—	0.045	No outage
Ascó I	PWR	—	—	0.044	No outage
Ascó II	PWR	0.492	33	0.592	
Vandellos II	PWR	0.729	169	0.782	
Trillo	PWR	0.221	24	0.238	
S.M Garoña	BWR	1.106	31	1.310	
Cofrentes	BWR	2.926	81	3.329	

Relating the annual collective dose in PWRs, the PWR average for this year is 0.39 person·Sv and the three-year rolling average is 0.39 person·Sv. This last value indicates that the downward trend continues (decreasing from 0.43 to 0.39), with values in line with those of the previous years, as it can be seen in the next table.

Regarding the annual collective dose in BWRs, the total collective dose average for this year is 2.32 person·Sv and the three-year rolling average is 1.65 person·Sv, increasing from 1.39 to 1.65, principally due to the lack of outages during 2004 and the increase of the drywell dose rates in Cofrentes NPP in 2003 and CRDH piping repair during the 15th refuelling outage in 2005.

	PWR			BWR		
Year	**Outages**	**Collective doses (person·Sv)**	**3 year rolling average**	**Outages**	**Collective doses (person·Sv)**	**3 year rolling average**
2000	6	0.59	0.62	1	1.47	1.48
2001	5	0.43	0.58	1	0.94	1.62
2002	5	0.53	0.52	1	1.54	1.32
2003	6	0.47	0.48	2	2.16	1.55
2004	4	0.30	0.43	0	0.46	1.39
2005	5	0.39	0.39	2	2.32	1.65

Cofrentes NPP has performed three main ALARA activities during the 15th refuelling outage. The first one was the repair of a vertical fissure in the Steam dryer. It was the first "Authorised Special Operation" in Spain. It was necessary because the American specialist diver workers were close to the 5 years limit of 100 mSv. Finally, no worker exceeded the legal dose limits and the total collective dose was 5.13 person·mSv, below the estimation of 18 person·mSv. The second one was the chemical decontamination of the Recirculation System, Reactor Water Clean-up and partially of the Residual Heat Removal system inside the drywell. For this task Cofrentes applied several Dose Reduction Techniques due to the contamination detected during the 14th outage (2003). The last activity was the repair of the tubes of the 2nd quadrant of the CRDH System, which had to be replaced because 8 of them presented fissures due to intragranular corrosion. This was the reason of the long 15th outage (81 days).

Relating Vandellós II NPP, during the 14th outage the plant has carried out the chemical cleaning of the refuelling cavity, to eliminate the presence of iron oxide deposits and increase of the quantity of filters used in the purification of the cavity and primary circuit mainly due to the cavity was flooded during 6 months. On the other hand, this outage has been specially long (6 months: March-August 2005) because it was necessary to implement several improvement actions required by the Spanish Regulatory Body, after the pipe break in essential service water system occurred in 25 August 2004.

Since September 2004 and during 2005, both the Spanish Regulatory Body (CSN) and utilities have been working in close collaboration in the development of the different aspects of the new Integrated System for Supervision of NPP, the SISC Project, such as: the system of indicators, the definition of a risk informed baseline inspection programme and the inspections procedures; the methodology to assess the inspection findings and indicators; the threshold values to categorise findings and indicators, and the methodology, accessible to all the licensee organisation, to identify deficiencies, analyse and categorise them, and make the follow up of the corrective actions taken. The pilot phase of the SISC implementation starts in January 2006, and the official phase will start in January 2007.

The definitive shutdown and start of the pre-decommissioning activities of José Cabrera NPP will take place on the 30 April 2006. According to the Spanish regulation, prior to that data the Ministry of Industry, Commerce and tourism has to declare the definite shutdown of the plant and establish the conditions applicable to the activities to be developed in this period until the concession of the decommissioning authorisation planned in 2009.

SWEDEN

Dose information

Operating reactors

2005		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type, [man·Sv]**
PWR	3	0.634
BWR	7 (8*)	1.018 (0.906)

* Barsebäck 2 in operation to 2005-06-22, thereafter cold shutdown.

Reactors in cold shutdown or in decommissioning

2005		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type, [man·Sv]**
BWR	1 (2*)	0.022

* Barsebäck 2 in final cold shutdown 2005-06-23.

Principal events

Summary of national dosimetric trends

The total collective dose for the Swedish NPP 2004 was 9.15 man·Sv. The collective dose is higher than 2004, for the upcoming years we expect higher collective doses because of modernisation and upgrading at all the Swedish sites.

The average collective dose per PWR unit (3 units) was 0.63 man·Sv and the average collective dose per BWR unit (7 units) was 1.02 man·Sv. The average personnel dose was 2.2 mSv and the highest individual dose was 23.6 mSv.

Events influencing dosimetric trends

Forsmark: F1 operated with a minor fuel leak and to decrease the influence on personnel exposure the unit was shut down 1 month before planned outage for unloading leaking fuel. Recontamination on F3 Reactor system that was decontaminated in 2001 is approximately 30%.

Oskarshamn: Sourse terms/dose rates are in principle stable or slightly increasing at all three units, very much depending on Zn-injection after earlier system decontamination, the outcome of Zink injection at O1 and O2 is very positive from an ALARA point of view. However a 75% increase on the Reactor circulation loops at O1 is under investigation.

Ringhals: Dose rates decreased by 20-30% at the Reactor circulation loops at R1. Optimised hydrogen injection after MTL and Steam Dryers replacement 2003 has stabilised acceptable source terms equilibriums in both Reactor and Turbine systems. Stable and slightly decreased dos rates at R2/3 (pH control). Increased levels by 30–100 % on CL, SG and HL at R4.

Number and duration of outages

Plant	Type	Outage length (days)	Collective dose (man·Sv)	Comments
Forsmark 1	BWR	41	1.3	Incl. Exchange of Low Pressure Turbines
Forsmark 2	BWR	11	0.2	
Forsmark 3	BWR	10	0.13	
Oskarshamn 1	BWR	52	1.034	Extended 23 days due to HT replacement.
Oskarshamn 2	BWR	24	0.341	
Oskarshamn 3	BWR	32	0.632	
Ringhals 1	BWR	51	2.47	Planned outage was 30 days, dose plan before outage was 3.5 manSv. Difference in dose plan due to good planning and training before work in PS (Containment). Extended 21 days much due to HT replacement.
Ringhals 2	PWR	79	0.8	Planned outage was 25 days. The outage started in February after shutdown due to inspection/repair of Containment Liner (Toroid plates). Planned outage was 0.65 manSv, increased dose due to extra work on PRZ Relief Valves/system, increased inspections on RT Vessel Head.
Ringhals 3	PWR	28	0.43	
Ringhals 4	PWR	29	0.48	3 days delay because of problem with fuel transfer system.

New plants on line/plants shut down

Barsebäck 2 was shut down 2005-06-23 and all irradiated fuel will be removed by September 2006.

Major evolutions

Ringhals: Thanks to international exchange of experience it has been possible to bring down an increasing Steam Generator tube leakage rate 2006 to a safe level which otherwise could have resulted in unplanned shut down for R4.

Component or system replacements

Barsebäck: After B2 shutdown 2005-06-22 the Reactor Vessel was unloaded, all irradiated fuel will be removed from site in September 2006.

Forsmark: Replacement of the Low Pressure Turbines, NDT of Reactor Vessel nozzles, extended CRDM service and installation of diversified/redundant Residual Heat Removal and Cooling Water systems F1.

Oskarshamn: Replacement of the High Pressure Turbine at O1.

Ringhals: Dismantling of Asbestos Insulation and Test Channels to make NDT possible on the Reactor Vessel circumferential welds, replacement of High Pressure Turbines, replacement of RH/FW Thermal Blender at R1. Repair of Containment Toroid shaped liner, replacement of Pressurised Relief valves, inspection NDT of all pipe head penetrations on RVH at R2. Replacement of the Reactor Vessel Head including CRDM, SG maintenance, exchange of recirculation Strainers at R3/R4.

Safety-related issues

Oskarshamn: In order to improve in handling of leaking Fuel there will be forcible measures taken in a specific project ”Prevent and handling leaking Fuel situations”.

Unexpected events

There were 2 internal contaminations in Sweden resulting in an effective dose greater than 0.25 mSv.

Forsmark: F1 was in operation since autumn 2004 with a minor fuel leak.

Oskarshamn: Fuel leaks occurred at 3 times at O3, with a total of 6 damage Fuel Pins. For this reason there were 2 short stop for unloading leaking fuel after growth to secondary damages and fuel dissolution.

Ringhals: R2 operated with a Fuel leak (no tramp Uranium) until February when the plant was shut down due to repair of the Containment liner. An external leak at a tee-conduit on the Residual Heat system resulted in an unplanned stop for R1

New/experimental dose-reduction programmes

Forsmark: Decision has been made to NOT introduce Hydrogen water chemistry at any unit.

Organisational evolutions

Barsebäck: After the final shutdown of unit B2, (B1 is shut down since 1999) the organisation is in a downsising mode. By January 2006 app. 200 employees are still working in Barsebäck, mainly with decommissioning planning and preparation and normal maintenance. The number of radiation protection engineers has been reduced from six to three in the same period.

Issues of concern in 2006

Forsmark: Application for Power upgrade has been handed in, an approval for Power upgrade will lead to extensive actions concerning Reactor safety and system modifications.

The situation is pretty much the same at all Swedish nuclear sites, Power upgrades, system modifications and modernisation to allow Plant Life extension.

Technical plans for major work in 2006

Barsebäck: During 2006 the remaining fuel on site will be transported to the intermediate storage for spent nuclear fuel, CLAB.

Forsmark: Replacement of the Low Pressure Turbine, NDT of Reactor Vessel nozzles, extended CRDM service and installation of diversified/redundant Residual Heat Removal and Cooling Water systems at F2 in 2006.

Oskarshamn: Modernisation of O2, Plant Life Extension starts 2006 with exchange of Low Pressure Turbine.

Ringhals: Power upgrade at Unit 1 and 3. Modernisation of RPS (Reactor Protection system), installation of diversified/redundant Residual Heat Removal and Cooling Water systems at R1 and exchange of Low Pressure Turbine at R3.

Regulatory plans for major work in 2006

The legislation on clearance and Radiation Protection for personnel will be reviewed under 2006. SSI will perform an intensified inspection at one NPP concerning the Radiation Protection activities in field and from an administrative/organisational point of view. SSI makes the overall judgement that the Radiation Protection at the Swedish NPP has been of high quality but emphasise that it is of great importance that Radiation Protection factual matters continue to have a high priority to the plant management, in order to maintain a future positive development in the field of Radiation Protection.

Moreover SSI have focus on:

- Power upgrades and system modernisation as regards to radiation levels, indirectly personnel doses, radioactive waste and radioactive discharge.
- Resource and competence issues concerning staff retirement and plant use of external resources, SSI has the opinion that there is a potential for improving the cooperation between plant and external resources to maintain a high quality in the field of radiation protection.
- Radioactive discharge to the environment, SSI calls for continuing work to reduce the radioactive discharge by for example using best available technique.

SWITZERLAND

Dose information

Operating reactors

2005		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type (man·Sv)**
PWR	3	657 (705+1266/3)
BWR	2	991 (1411+570/2)

Principal events

Summary of national dosimetric trends

Facility	Number of monitored workers 2005	Years' collective dose (man mSv)		
		2005	2004	2003
NPP Beznau I + II (PWR)	900	705	617	454
NPP Gösgen (PWR)	1099	1266	823	555
NPP Mühleberg (BWR)	1086	1411	1048	1180
NPP Leibstadt (BWR)	1300	570	1746	862

Events influencing dosimetric trends

NPP Beznau I + II

Good practices reduced the collective dose of the short outage in unit I (expected 188 man mSv) resulting in 152 man mSv, especially thanks to a well done preparation of the RDB-vessel head isolation exchange. Normal in-service inspections and maintenance works in unit 2 resulted in 451 man mSv during standard outage. Dose rates are slightly dropping due to improved water chemistry.

NPP Gösgen

The outage 2005 was longer then the standard outages last years because of the replacement of spray pipes, spray nozzles and safety valves (PISA-project). Therefore the collective dose during the outage was 1146 man mSv, including 594 man mSv resulting from the PISA-project. The ALARA measures are described during the ISOE workshop in Essen March 2006.

NPP Leibstadt

A shortcut inside the stator of the generator on the 28 March 2005 resulted in a complex repair, leading to a prolonged shutdown until 30 August 2005. An extended outage work programme, including jobs planned for the coming years, was carried out during the shutdown. The collective dose of the outage was 398 man mSv.

NPP Mühleberg

The standard outage resulted in a higher collective dose (871 man•mSv) then the year before, due to more service inspections and maintenance works. No fuel rod cladding leakage was inspected. The collective dose during normal operation increased to 540 man•mSv as a result of the decommissioning of casks for spent fuel elements.

Number and duration of outages

- NPP Beznau I 1 outage, 11 days (last year 42 days).
- NPP Beznau II 1 outage, 42 days (last year 10 days).
- NPP Gösgen 1 outage, 41 days (last year 20 days).

- NPP Leibstadt 1 shutdown, 5 months (last year 45 days).
- NPP Mühleberg 1 outage, 27 days (last year 20 days).

Component or system replacements

- NPP Gösgen: replacement of spray pipes, spray nozzles and safety valves.
- NPP Leibstadt: replacement of stator.

Safety-related issues

At NPP Leibstadt the reactor core was loaded while two control rods were outside.

Unexpected events

No unexpected event resulting in impermissible exposure of persons has been reported in 2005.

New/experimental dose-reduction programmes

Optimisation in RP was done introducing improved tools, e.g. a special vacuum cleaner for the dry well sump pit at NPP Mühleberg.

UKRAINE

Principal events

Average collective doses for operational reactors in 2005

Reactor type	Number of units	Collective dose/unit (man·mSv)
VVER	15	983.2

Summary of national dosimetric trends.

In 2005 the collective occupational exposure dose of NNEGC "EnergoAtom" NPP personnel was 14.75 man·Sv, that is 1.09 man·Sv less in comparison with 2004.

Average collective doses per reactor in 2005

NPP	Total collective dose (man·Sv; man Sv/unit)	Individual annual dose: plant personnel (man·Sv)	Individual annual dose: outside personnel (man·Sv)	Outside personnel dose contribution to annual collective dose (%)
Zaporizhzhe NPP	6.02 (1.00)	1.22	1.24	13.4%
Rivno NPP	2.85 (0.71)	0.75	0.45	8.4%
South Ukraine NPP	3.70 (1.27)	1.27	1.63	28%
Khmelnitsky NPP	2.18 (1.09)	0.79	0.64	22.7%

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

For the year of annual report (2005), overwhelming majority (85.9%) of personnel obtained individual annual doses less than 2 mSv. Within 15-20 mSv only 56 workers were registered, that is 0.4% from the total number of personnel.

Events influencing dosimetric trends

At Rivne NPP, the collective dose was 2.85 man·mSv, being 0.5 man·mSv (or 18%) less in comparison with 2004. Average individual dose Rivne NPP staff was 0.75 man·mSv, being 0.19 man·mSv (or 20%) less in comparison with 2004.

Causes have an influence on collective dose reduction:

- lack of the units major repairs;
- removal by Rivne 3 repair to 2006;
- transfer of terms beginning of Rivne 4 repair to 2006;
- execution of technical and organisation evolutions are provided by ALARA Annual Programme;
- application of dose budgets into separate subdivisions for year and for outage;
- application of allowed individual dose levels system during outages and control for these performance;
- putting into operation software system of the work permission to the control zone and more strong checking on line operative exposure figures.

Number and duration of outages

Planned unit outages took place at all NPP units in 2005.

NPP	**Duration of the outage per unit (days)**	**Annual collective dose (mSv)**
Zaporizhzhe NPP	56	0.86
Rivno NPP	43	0.69
South Ukraine NPP	53	0.84
Khmelnitsky NPP	60	0.93

In 2005 average duration of outage was 53.1 days that is 4.9 days (10%) more that last year; but average collective dose per unit was 0.82 mSv, that is less by 0.06 mSv (7%) in comparison with 2004.

Major cause of the collective dose reduction is ALARA ideology implementation, especially for planning, developing and maintenance dose budget not only for NPP’s subdivisions but carrying out for separate tasks.

UNITED KINGDOM

Dose information

Operating reactors

2005		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type (man.Sv)**
PWR	1	0.35
GCR (AGR)	14	0.055
GCR (Magnox)	8	0.13

Reactors in cold shutdown or in decommissioning

2005		
Reactor type	**Number of reactors**	**Average annual collective dose per unit and reactor type (man.Sv)**
GCR (Magnox)	14	0.13

Principal events

Summary of national dosimetric trends

UK nuclear power plants continue to demonstrate low individual and collective radiation exposures. With the exception of Sizewell B all of UK's nuclear power plants are gas-cooled. Doses during 2005 were typical for UK reactor types.

Events influencing dosimetric trends

There were no major evolutions having a significant impact upon radiation doses.

Number and duration of outages

The gas-cooled reactors operate to a two-yearly outage frequency so each site typically has one reactor outage per annum. Refuelling of the gas-cooled reactors is carried out on-load. The highest outage doses on the gas-cooled reactors were received at Hinkley Point B and Hunterston B plants with outage doses of approximately 0.3 man·Sv. Sizewell B performed its ten-year major outage that required inspection of the Reactor Pressure Vessel together with a large number of welds around the primary circuit. The outage lasted 55 days are resulted in a collective dose of 0.31 man·Sv.

Major evolutions

Amongst the Magnox Reactor sites four operated throughout 2005. Four sites are completely defuelled and are at various stages of decommissioning. Defuelling continues at Bradwell NPP (shutdown in March 2002). Defuelling is yet to start at Chapelcross (shutdown in 2004). The rate of Magnox Reactor defuelling is in part influenced by the capacity of Sellafield's reprocessing plant to handle the spent fuel.

Organisational evolutions

The Nuclear Decommissioning Authority (NDA) officially came into existence on 1st April 2005. The NDA was established by the 2004 Energy Act to take strategic responsibility for UK's nuclear legacy. The NDA took over the ownership of twenty nuclear sites in UK including the Magnox Reactor sites and will be responsible for managing the safe decommissioning and clean-up of the UK's nuclear programme. The seven AGR NPPs and Sizewell B PWR remain in the private sector.

Issues of concern in 2006

During 2006 two more Magnox Reactor plants, Sizewell A and Dungeness A will be permanently shutdown. In the middle of 2006 the UK government is due to receive a report from the Committee on Radioactive Waste Management (CORWM) which will make recommendations on the long-term management of higher activity radioactive wastes.

Technical plans for major work in 2006

Sizewell B is due to perform its eighth refuelling outage in the Autumn of 2006. During this outage the Reactor Pressure Vessel Head and the SIGMA Refuelling Machine will be replaced.

Annex 1

PROPOSED PROGRAMME OF WORK FOR 2006

The Information System on Occupational Exposure programme of work for the year 2006 will include:

Information Exchange

- Develop and implement the revamped ISOE Network (www.isoe-network.net).
- Develop a unified ISOE contact database.
- Promote the revamped system.

Continue implementation of improvements from the in-depth evaluation of the ISOE System (2003)

- Reinforce the role of the National Co-ordinators;
  - Present the activities of the national co-ordinators at each Steering Group meeting;
  - Encourage utilities to introduce procedures at their NPPs encouraging the use of the ISOE system as a work-planning resource, and as an important information storage and exchange mechanism.
- General promotion of the ISOE System;
  - ISOE Chair will send a promotion letter to high level management in utilities and regulatory authorities in context of revamped ISOE Network. National co-ordinators will send the co-ordinates of appropriate addressees via the technical centres to the Secretariat;
  - ISOE Bureau and the Secretariat will prepare a short document explaining the benefits of the ISOE system. This document will be sent together with the above mentioned promotion letter.
- Recognise the top five ISOE 3 reports with a special presentation at the annual meetings of the ISOE utilities or user groups.
- Promote new products by the technical centres (for example the organisation of topical meetings for radiation protection managers).
- Develop additional easy-to-use predefined analyses of the ISOE data (see also Software Management).

ISOE Future Direction (under the auspices of the ISOE Working Group on Strategic Planning)

- Investigate in detail proposed focus areas for strategic issues and options, and address possible improvements to the ISOE activities and products, and its organisation.
- Prepare the new ISOE Terms and Conditions, due for renewal in 2007.

Data collection and management (performed through the ISOE Technical Centres)

- Collect ISOE 1 and ISOE 2 (dynamic) data for the year 2005.
- Collect ISOE 2 static data.
- Use the web-enabled ISOEDAT-MADRAS as the primary data viewing and analyses application (see Software Maintenance); issue updates of the ISOEDAT database on the ETC server and distribute on CD-ROM.
- Organise national training courses on the use of the ISOE system, especially with a view to using the revamped ISOE Network as an enhanced information and experience exchange mechanism.

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

- Review ISOE 2 data, discuss and propose useful analyses;
- Perform further analyses to clarify and enhance data from nuclear power plants which are in shutdown or some stage of decommissioning.
- Perform other technical analysis as directed by the Steering Group, based on end-user feedback and in support of the 15th Annual Report.

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

- ***15th ISOE Annual Report 2005:*** Objective to publish the report in September 2006.
- ***ISOE News:*** Continue to electronically issue news and current information through the ISOE News.

Technical centre information sheets planned for 2006

Yearly analyses	**Centre**
Preliminary European dosimetric results for 2005	ETC
Update of annual outage duration and doses in European reactors (1995-2005)	ETC
Japanese Dosimetric Results: FY 2005 Data and Trends	ATC
Japanese Occupational Exposure during Periodical Inspection at PWR & BWR ended in FY 2004, 2005	ATC
Special analyses	
Update of the Steam Generators Replacement in the World	ETC
Analysis of the impact of SGR on dosimetric trends: the case of France	ETC
Optimisation of Radiation Protection for Non-Destructive Testing in Naps	ETC
Survey of the Reactor Vessel Head Replacements in the World	ETC
Other information sheets or reports, as synthesis following answers to requests by participants	ETC

Software maintenance (under the auspices of the WGDA, and the ISOEDAT-Web Working Group)

- Implement the web-enabled version of ISOEDAT – MADRAS component, for easy data analysis and further enhance the usefulness of the ISOE system.
- Continue development of the web-enabled ISOEDAT by:
  - Developing a web data input module for ISOE 1 and 2 (NEA with ETC support).
  - Organising software training sessions to meet user needs (organised by the ETC on request).
- Refurbish the ISOE Network (www.isoe-network.net) subject to Steering Group direction in order to create an effective information and experience exchange network, including easy access to ISOEDAT, ISOE contact information, and an interactive RP discussion/experience exchange forum.

ISOE ALARA Symposia on occupational exposure in nuclear power plants

- ***International:*** The 2006 ISOE International ALARA Symposium (5th European ISOE workshop) will be held 15-17 March 2006 in Essen, Germany, as well as three specific stakeholders meetings for RPMs, regulatory bodies and research reactors on 14 March 2006. Several visits of facilities are planned on 17 March 2006. The workshop will comprise plenary and small group sessions.
- ***Regional:*** The 2006 ISOE North American ALARA Symposium will be held 16-18 January 2006 in Orlando, Florida USA with the theme: "ISOE Achievements in Occupational Dose Reduction at Nuclear Power Plants". The 2006 ISOE Asian ALARA Symposium is planned for September 2006 in Kashiwazaki, Japan, with the theme of exchange of dose reduction experiences in Asian countries.

Interaction with the International Organisations

- Establish closer links to other international organisations with occupational exposure programmes, such as the European Commission, and harmonise occupational exposure data collection programmes as deemed appropriate by the Steering Group.
- ***INPO:*** Intensify the co-operation between INPO and the ISOE System especially in the domain of ISOE 3 reporting system;
- ***EPRI:*** Explore areas where mutual co-operation between EPRI and ISOE could be beneficial.

Other topics of interest

- Review the new draft ICRP recommendations and prepare comments for submission to NEA/CRPPH.

Annex 2

LIST OF ISOE PUBLICATIONS

Reports

1. *Occupational Exposures at Nuclear Power Plants: Fourteenth Annual Report of the ISOE Programme, 2004*, OECD, 2006.
2. *Occupational Exposures at Nuclear Power Plants: Thirteenth Annual Report of the ISOE Programme, 2003*, OECD, 2005.
3. *Optimisation in Operational Radiation Protection,* OECD, 2005.
4. *Occupational Exposures at Nuclear Power Plants: Twelfth Annual Report of the ISOE Programme, 2002*, OECD, 2004.
5. *Occupational Exposure Management at Nuclear Power Plants: Third ISOE European Workshop, Portoroz, Slovenia, 17-19 April 2002,* OECD 2003.
6. *ISOE – Information Leaflet,* OECD 2003.
7. *Occupational Exposures at Nuclear Power Plants: Eleventh Annual Report of the ISOE Programme, 2001*, OECD, 2002.
8. *ISOE – Information System on Occupational Exposure, Ten Years of Experience, OECD, 2002.*
9. *Occupational Exposures at Nuclear Power Plants: Tenth Annual Report of the ISOE Programme, 2000*, OECD, 2001.
10. *Occupational Exposures at Nuclear Power Plants: Ninth Annual Report of the ISOE Programme, 1999,* OECD, 2000.
11. *Occupational Exposures at Nuclear Power Plants: Eighth Annual Report of the ISOE Programme, 1998*, OECD, 1999.
12. *Occupational Exposures at Nuclear Power Plants: Seventh Annual Report of the ISOE Programme, 1997*, OECD, 1999.
13. *Work Management in the Nuclear Power Industry*, OECD, 1997 (also available in Chinese, German, Russian and Spanish).
14. *ISOE – Sixth Annual Report: Occupational Exposures at Nuclear Power Plants: 1969-1996*, OECD, 1998.
15. *ISOE – Fifth Annual Report: Occupational Exposures at Nuclear Power Plants: 1969-1995*, OECD, 1997.
16. *ISOE – Fourth Annual Report: Occupational Exposures at Nuclear Power Plants: 1969-1994*, OECD, 1996.
17. ISOE – *Third Annual Report: Occupational Exposures at Nuclear Power Plants: 1969-1993*, OECD, 1995.
18. *ISOE – Nuclear Power Plant Occupational Exposures in OECD Countries: 1969-1992*, OECD, 1994.
19. *ISOE – Nuclear Power Plant Occupational Exposures in OECD Countries: 1969-1991, OECD, 1993.*

ISOE news

No. 8, December 2005	No. 4, December 2004
No. 7, October 2005	No. 3, July 2004
No. 6, June 2005	No. 2, March 2004
No. 5, April 2005	No. 1, December 2003

ISOE information sheets

Asian Technical Centre	
No. 28, November 2005	Japanese Dosimetric Results : FY 2004 Data and Trends
No. 27, November 2004	Achievements and Issues in Radiation Protection in the Republic of Korea
No. 26, November 2004	Japanese occupational exposure during periodic inspection at PWRs and BWRs ended in FY 2003
No. 25, November 2004	Japanese dosimetric results: FY2003 data and trends
No. 24, October 2003	Japanese Occupational Exposure of Shroud Replacements
No. 23, October 2003	Japanese Occupational Exposure of Steam Generator Replacements
No. 22, October 2003	Korea, Republic of; Summary of national dosimetric trends
No. 21, October 2003	Japanese occupational exposure during periodic inspection at PWRs and BWRs ended in FY 2002
No. 20, October 2003	Japanese dosimetric results: FY2002 data and trends
No. 19, October 2002	Korea, Republic of; Summary of national dosimetric trends
No. 18, October 2002	Japanese occupational exposure during periodic inspection at PWRs and BWRs ended in FY 2001
No. 17, October 2002	Japanese dosimetric results: FY2001 data and trends
No. 16, October 2001	Japanese occupational exposure during periodical inspection at PWRs and BWRs ended in FY 2000
No. 15, October 2001	Japanese Dosimetric results: FY 2000 data and trends
No. 14, September 2000	Japanese Occupational Exposure During Periodical Inspection at LWRs Ended in FY 1999
No. 13, September 2000	Japanese Dosimetric Results: FY 1999 Data and Trends
No. 12, October 1999	Japanese Occupational Exposure During Periodical Inspection at LWRs Ended in FY 1998
No. 11, October 1999	Japanese Dosimetric Results: FY 1998 Data and Trends
No. 10, November 1999	Experience of 1st Annual Inspection Outage in an ABWR
No. 9, October 1999	Replacement of Reactor Internals and Full System Decontamination at a Japanese BWR
No. 8, October 1998	Japanese Occupational Exposure During Periodical Inspection at LWRs Ended in FY 1997

Asian Technical Centre	
No. 7, October 1998	Japanese Dosimetric Results: FY 1997 data
No. 6, September 1997	Japanese Occupational Exposure during Periodical Inspection at LWRs ended in FY 1996
No. 5, September 1997	Japanese Dosimetric Results: FY 1996 data
No. 4, July 1996	Japanese Occupational Exposure during Periodical Inspection at LWRs ended in FY 1995
No. 3, July 1996	Japanese Dosimetric Results: FY 1995 data
No. 2, October 1995	Japanese Occupational Exposure during Periodical Inspection at LWRs ended in FY 1994
No. 1, October 1995	Japanese Dosimetric Results: FY 1994 data
European Technical Centre	
No. 42, November 2005	Self-employed Workers in Europe
No. 41, 2005	Update of the annual outage duration and doses in European reactors (1994-2004)
No. 40, 2005	Workers internal contamination practices survey
No. 39, 2005	Preliminary European dosimetric results for 2004
No. 38, November 2004	Update of the annual outage duration and doses in European reactors (1993-2003)
No. 37, July 2004	Conclusions and recommendations from the 4th European ISOE workshop on occupational exposure management at NPPs
No. 36, October 2003	Update of the annual outage duration and doses in European reactors (1993-2002)
No. 35, July 2003	Preliminary European dosimetric results for 2002
No. 34, July 2003	Man-Sievert monetary value survey (2002 update)
No. 33, March 2003	Update of the annual outage duration and doses in European reactors (1993-2001)
No. 32, November 2002	Conclusions and Recommendations from the 3rd European ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants
No. 31, July 2002	Preliminary European Dosimetric Results for the year 2001
No. 30, April 2002	Occupational exposure and steam generator replacements - update
No. 29, April 2002	Implementation of Basic Safety Standards in the regulations of European countries
No. 28, December 2001	Trends in collective doses per job from 1995 to 2000
No. 27, October 2001	Annual outage duration and doses in European reactors
No. 26, July 2001	Preliminary European Dosimetric Results for the year 2000
No. 25, June 2000	Conclusions and recommendations from the 2nd EC/ISOE workshop on occupational exposure management at nuclear power plants
No. 24, June 2000	List of BWR and CANDU sister unit groups
No. 23, June 2000	Preliminary European Dosimetric Results 1999

European Technical Centre	
No. 22, May 2000	Analysis of the evolution of collective dose related to insulation jobs in some European PWRs
No. 21, May 2000	Investigation on access and dosimetric follow-up rules in NPPs for foreign workers
No. 20, April 1999	Preliminary European Dosimetric Results 1998
No. 19, October 1998	ISOE 3 data base – New ISOE 3 Questionnaires received (since September 1998) (restricted distribution)
No. 18, September 1998	The Use of the man-Sievert monetary value in 1997 (general distribution)
No. 17, December 1998	Occupational Exposure and Steam Generator Replacements, update (general distribution)
No. 16, July 1998	Preliminary European Dosimetric Results for 1997 (general distribution)
No. 15, September 1998	PWR collective dose per job 1994-1995-1996 data (general distribution)
No. 14, July 1998	PWR collective dose per job 1994-1995-1996 data (restricted distribution)
No. 12, September 1997	Occupational exposure and reactor vessel annealing
No. 11, September 1997	Annual individual doses distributions: data available and statistical biases
No. 10, June 1997	Preliminary European Dosimetric Results for 1996
No. 9, December 1996	Reactor Vessel Closure Head Replacement
No. 7, June 1996	Preliminary European Dosimetric Results for 1995
No. 6, April 1996	Overview of the first three Full System Decontamination
No. 4, June 1995	Preliminary European Dosimetric Results for 1994
No. 3, June 1994	First European Dosimetric Results: 1993 data
No. 2, May 1994	The influence of reactor age and installed power on collective dose: 1992 data
No. 1, April 1994	Occupational Exposure and Steam Generator Replacement
IAEA Technical Centre	
No. 9, August 2003	Preliminary dosimetric results for 2002
No.8, November 2002	Conclusions and Recommendations from the 3rd European ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants
No. 7, October 2002	Information on exposure data collected for the year 2001
No. 6, June 2001	Preliminary dosimetric results for 2000
No. 5, September 2000	Preliminary dosimetric results for 1999
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. 3, April 1999	IAEA technical co-operation projects on improving occupational radiation protection in nuclear power plants

IAEA Technical Centre	
No. 2, April 1999	IAEA Publications on occupational radiation protection
No. 1, October 1995	ISOE Expert meeting
North American Technical Centre	
NATC-No. 05-6	3-year rolling average annual dose comparisons Canadian CANDU (2002-2004)
NATC-No. 05-5	3-year rolling average annual dose comparisons US BWR (2002-2004)
NATC-No. 05-2	US BWR refuelling outage duration and dose trends for 2004
NATC-No. 05-1	US PWR refuelling outage duration and dose trends for 2004
NATC-No. 04-4	3-year rolling average annual dose comparisons US PWR (2002-2004)
No. 02-6, 2002	Monetary value of person-rem avoided
No. 02-5, July 2002	US BWR 2001 Occupational Dose Benchmarking Chart
No. 02-4, July 2002	US PWR 2001 Occupational Dose Benchmarking Chart
No. 02-2, July 2002	3-year rolling average annual dose comparisons US BWR, 1999-2001
No. 02-1, Nov 2002	3-year rolling average annual dose comparisons US PWR, 1999-2001
No. 8, 2001	Monetary Value of person-REM Avoided: 2000
No. 7, 2001	U.S. BWR 2000 Occupational Dose Benchmarking Charts
No. 6, 2001	U.S. PWR 2000 Occupational Dose Benchmarking Charts
No. 5, 2001	3-year rolling average annual dose comparisons CANDU, 1998-2000
No. 4, 2001	3-year rolling average annual dose comparisons US BWR, 1998-2000
No. 3, 2001	3-year rolling average annual dose comparisons US PWR, 1998-2000
No. 2, 1998	Monetary Value of person-REM Avoided 1997
No. 1, July 1996	Swedish Approaches to Radiation Protection at Nuclear Power Plants: NATC site visit report by Peter Knapp

ISOE topical session reports

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

ISOE international workshop proceedings

Asian Technical Centre	
November 2005, Hamaoka, Japan	First Asian ALARA Symposium
European Technical Centre	
March 2004, Lyon, France	Fourth ISOE European 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
April 2000, Tarragona, Spain	Second EC/ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants
September 1998, Malmö, Sweden	First EC/ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants
North American Technical Centre	
January 2005, Ft. Lauderdale, FL, USA	2005 International ALARA Symposium
January 2004, Ft. Lauderdale, FL, USA	2004 North American ALARA Symposium
January 2003, Orlando, FL, USA	2003 International ALARA Symposium
February 2002, Orlando, FL, USA	North-American National ALARA Symposium
February 2001, Anaheim, CA, USA	2001 International ALARA Symposium
January 2000, Orlando, FL, USA	North-American National ALARA Symposium
January 1999, Orlando, FL, USA	Second International ALARA Symposium
March 1997, Orlando, FL, USA	First International ALARA Symposium

Annex 3

ISOE PARTICIPATION AS OF DECEMBER 2005

Officially participating utilities: detailed information on 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 *(* laid-up)*
China	Guangdong Nuclear Power Joint Venture Co., Ltd Qin Shan Nuclear Power Co. Lingao Nuclear Power Co. Ltd	Guangdong 1, 2 Qin Shan 1 Lingao 1, 2
Czech Republic	CEZ	Dukovany 1, 2, 3, 4 Temelin 1, 2
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

France		Paluel 1, 2, 3, 4 Penly 1, 2 Saint-Alban 1, 2 Saint Laurent B1, B2 Tricastin 1, 2, 3, 4
Germany	E.ON Kernkraft GmbH	Grafenrheinfeld Isar 1, 2 Brokdorf Grohnde Unterweser
	EnBW Kernfraft AG	Philippsburg 1, 2 Gemeinschaftskraftwerk Neckar 1, 2
	RWE Power AG	Biblis A, B Gundremmingen B, C Emsland
	Vattenfall Europe Nuclear Energy GmbH *(Note: Where multiple owners and/or operators are involved, only Leading Undertakings are listed above)*	Brunsbüttel Krümmel
Hungary	Magyar Vilamos Muvek Rt	Paks 1, 2, 3, 4
Japan	Hokkaido Electric Power Co.	Tomari 1, 2
	Tohoku Electric Power Co.	Onagawa 1, 2, 3 Higashidori 1
	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, 5
	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
Korea	Korean Hydro and Nuclear Power	Wolsong 1, 2, 3, 4 Kori 1, 2, 3, 4 Ulchin 1, 2, 3, 4, 5, 6 Yonggwang 1, 2, 3, 4, 5
Lithuania	Ignalina Nuclear Power Plant	Ignalina 1, 2

Mexico	Comisiòn Federal de Electricidad	Laguna Verde 1, 2
The 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, 3 Kola 1, 2, 3, 4 Novovoronezh 3, 4, 5 Volgodonsk 1
Slovak Republic	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	Forsmarks Kraftgrupp AB OKG AB Ringhals AB	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, 2 Rovno 1, 2, 3, 4 South Ukraine 1, 2, 3 Zaporozhe 1, 2, 3, 4, 5, 6
United Kingdom	Nuclear Electric	Sizewell B
United States	Amergen Energy Company American Electric Power Arizona Public Service Co. Calvert Cliffs Nuclear Power Plant Inc. Carolina Power and Light Co. Entergy Nuclear NE	Clinton 1 Oyster Creek 1 TMI 1 D.C. Cook 1, 2 South Texas 1, 2 Palo Verde 1, 2, 3 Calvert Cliffs 1, 2 H. B. Robinson 2 Indian Point 2, 3 Pilgrim 1

United States	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
	Florida Power and Light	Seabrook St. Lucie 1, 2 Turkey Point 3, 4
	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

Officially participating utilities: Detailed information on 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 Kernfraft GmbH	Würgassen Stade
	EnBW Kernkraft AG	Obrigheim
	Energiewerke Nord GmbH	AVR Jülich
	RWE Power AG *(Note: Where multiple owners and/or operators are involved, only Leading Undertakings are listed above)*	Mülheim-Kärlich

Italy	SOGIN	Caorso Garigliano
Italy		Latina (GCR) Trino
Japan	Japan Atomic Power Co.	Tokai 1
The Netherlands	NCGKN	Dodewaard
Russian Federation	Rosenergoatom	Beloyarsky 1, 2 Novovoronezh 1, 2
Spain	UNESA	Vandellos 1
Sweden	Barsebäck Kraft AB	Barsebäck 1, 2
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 3 San Onofre 1

Participating regulatory authorities

Country	Authority
Armenia	Armenian Nuclear Regulatory Authority (ANRA)
Belgium	Federal Agency for Nuclear Control
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 l'Institut de Radioprotctin et de Sûreté Nucléaire (IRSN)
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
The Netherlands	Ministerie van Sociale Zaken en Werkgelegenheld
Pakistan	Pakistan Atomic Energy Commission

Romania	National Commission for Nuclear Activities Control
Slovak Republic	State Health Institute of the Slovak Republic
Slovenia	Slovenian Nuclear Safety Administration (SNSA) Slovenian Radiation Protection Administration (SRPA)
South Africa	Council for Nuclear Safety
Spain	Consejo de Seguridad Nuclear
Sweden	Statens strålskyddsinstitut (SSI)
Switzerland	Office Fédéral de l'Énergie, Division principale de la Sécurité des Installations Nucléaires, DSN
United Kingdom	Nuclear Installations Inspectorate
United States	U.S. Nuclear Regulatory Commission (US NRC)

Country – Technical Centre affiliations

Country	Technical Centre*	Country	Technical Centre
Armenia	IAEATC	Mexico	NATC
Belgium	ETC	The Netherlands	ETC
Brazil	IAEATC	Pakistan	IAEATC
Bulgaria	IAEATC	Romania	IAEATC
Canada	NATC	Russian Federation	IAEATC
China	IAEATC	Slovak Republic	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, Republic of	ATC	United States	NATC
Lithuania	IAEATC		

* Note: ETC: European Technical Centre ; ATC: Asian Technical Centre ; IAEATC: IAEA Technical Centre; NATC: North American Technical Centre

ISOE Technical Centre Information

ISOE network web portal	
ISOE Network	www.isoe-network.net
ISOE Technical Centres	
European Region (ETC)	Centre d'étude sur l'évaluation de la protection dans le domaine nucléaire (CEPN), Fontenay-aux-Roses, France
	isoe.cepn.asso.fr
Asian Region (ATC)	Japan Nuclear Energy Safety Organisation(JNES), Tokyo, Japan
	www.jnes.go.jp/isoe/

IAEA Region (IAEATC)	International Atomic Energy Agency (IAEA), Vienna, Austria Agence internationale de l'énergie atomique (AIEA), Vienne, Autriche	
	www-ns.iaea.org/tech-areas/rw-ppss/isoe-iaea-tech-centre.htm	
North American Region (NATC)	University of Illinois, Urbana-Champaign, Illinois, U.S.A.	
	www.natcisoe.org	

Joint Secretariat	
NEA (Paris)	www.nea.fr/html/jointproj/isoe.html
IAEA (Vienna)	www-ns.iaea.org/tech-areas/rw-ppss/isoe.htm

International cooperation

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

Annex 4

ISOE BUREAU, SECRETARIAT AND TECHNICAL CENTRES

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Annex 5

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Annex 6

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UNITED STATES	MILLER, David .W.	D.C. Cook Plant

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Occupational Exposures at Nuclear Power Plants – 2005

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. ISOE 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 480 commercial nuclear power plants participating in the programme (representing some 90% of the world's total operating commercial reactors).

The Fifteenth Annual Report of the ISOE Programme summarises achievements made during 2005 and compares annual occupational exposure data. Principal developments in ISOE participating countries are also described.

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