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Occupational Exposures at Nuclear Power Plants

Sixteenth Annual Report of the ISOE Programme, 2006

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NUCLEAR ENERGY AGENCY
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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, work-management practices, technological advances, regulatory pressures and exchange of information and experience has 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 continues to present challenges. 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.

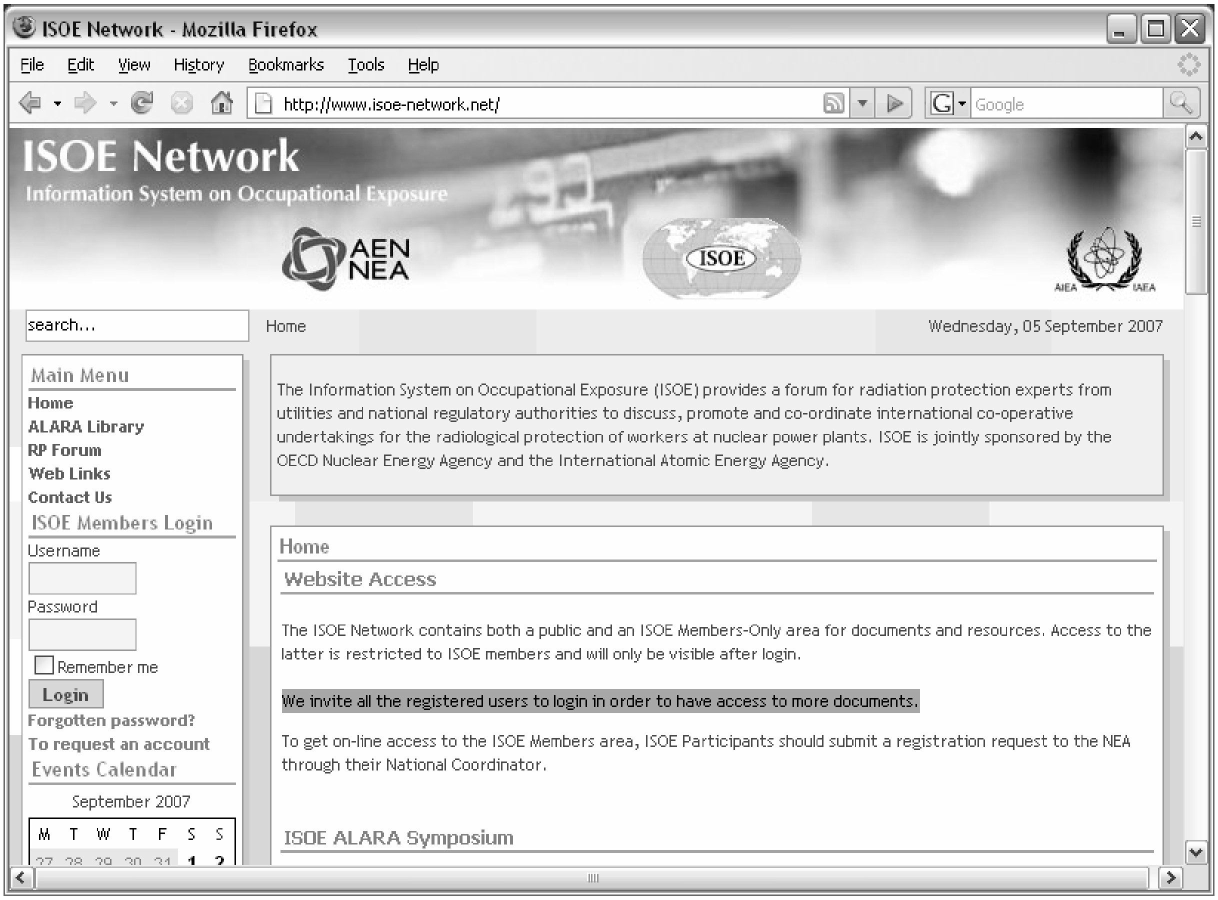
In response to these pressures, radiological protection personnel at nuclear power plants worldwide have found that occupational exposures are best managed through effective job planning, implementation and review to ensure that exposures are "as low as reasonably achievable" (ALARA). A prerequisite for applying the principle of optimisation to occupational radiological 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 OECD Nuclear Energy Agency (NEA) launched the Information System on Occupational Exposure (ISOE) in 1992 after a two-year pilot programme. As a joint programme for technical information exchange among interested countries, ISOE provides a forum for radiological protection professionals 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 nuclear electricity utilities 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-OECD/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 programme, culminating in the world's largest occupational exposure database for nuclear power plants, and an information network for sharing dose reduction information and experience. Since its launch, ISOE participants have used this system of databases and communications networks to exchange occupational exposure data and information for dose trend analyses, technique comparisons, as well as cost-benefit and other analyses promoting the application of the ALARA principle in local radiological protection programmes.

This Sixteenth Annual Report of the ISOE Programme presents the status of the ISOE programme for the year 2006.

"... 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)



ISOE Network Information Exchange Website (www.isoe-network.net)

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EXECUTIVE SUMMARY

Since 1992, the Information System on Occupational Exposure (ISOE), jointly sponsored by the OECD/NEA and IAEA, has supported the optimisation of worker doses in nuclear power plants through an information and experience exchange network for radiation protection professionals of nuclear power plants and national regulatory authorities worldwide, and through the development and publication of relevant technical resources. This 16th Annual Report of the ISOE Programme (2006) presents the status of the ISOE programme for the calendar year 2006.

ISOE membership is open to nuclear electricity utilities and to radiation protection regulatory authorities. Four ISOE Technical Centres (Europe, North America, Asia and IAEA) manage the programme's day-to-day technical operations. At the end of 2006, the ISOE programme included 71 participating utilities in 29 countries (336 operating units; 42 shutdown units), as well as the regulatory authorities of 25 countries. The ISOE occupational exposure database itself included information on occupational exposure levels and trends at 401 operating reactors in 29 countries, covering about 91% of the world's operating commercial power reactors.

Based on the occupational exposure data supplied by ISOE members, the 2006 average annual collective doses and 3-yr rolling averages (2004-2006) for operating power reactors were:

	2006 average annual collective dose (man·Sv)	3-year rolling average for 2004-2006 (man·Sv)
Pressurised water reactors (PWR/VVER)	0.71	0.75
Boiling water reactors (BWR)	1.32	1.41
Pressurised heavy water reactors (PHWR/CANDU)	1.15	1.06
All reactors, including gas cooled (GCR) and light water graphite reactors (LWGR)	0.85	0.88

In addition to information from operating reactors, the ISOE database contains dose data from 80 reactors which are shutdown or in some stage of decommissioning. As these reactor units are generally of different type and size, and at different phases of their decommissioning programmes, it is difficult to identify clear dose trends. An initiative was launched in 2006 to improve the data collection for shutdown and decommissioned reactors in order to facilitate better benchmarking. Details on occupational dose trends for operating reactors, and reactors undergoing decommissioning are provided in Section 2 of the report.

While ISOE is well known for its occupational exposure data and analyses, the programme's strength comes from its objective to share such information broadly amongst its participants. In 2006, the ISOE Network website (www.isoe-network.net) was upgraded to provide the ISOE membership with a "one-stop" web-based information and experience exchange portal on dose reduction and ALARA resources. This restricted-access portal provides members with on-line access to ISOE technical resources, including the ISOE occupational exposure database and web-based user forums. Following the successful migration of the MADRAS database statistical analysis package to the website in 2005, the development of data input modules for the on-line submission of members' occupational exposure data was initiated in 2006.

The annual ISOE International ALARA Symposia on occupational exposure management at nuclear power plants, co-sponsored by OECD/NEA and IAEA, continued to provide an important forum for ISOE members and for vendors to exchange practical information and experience on occupational exposure issues. The 2006 ISOE International ALARA Symposium, organised by the European Technical Centre, was held in Essen, Germany. The technical centres also continued to host regional symposia, including the 2006 ISOE Asian Regional ALARA Symposium (Yuzawa, Japan) and the 2006 ISOE North American ALARA Symposium (Orlando, USA). 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.

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 voluntary site benchmarking visits for dose reduction information exchange between ISOE regions. The combination of ISOE symposia and technical visits provides a means for radiation protection professionals to meet, share information and build links between ISOE regions to develop a global approach to work management.

While the ISOE Working Group on Data Analysis (WGDA) continued its activities in support of the technical analysis of the ISOE data and experience, the ad-hoc Working Group on Strategic Planning (WGSP) completed its work to identify possible improvements to ISOE products, activities and organisation. The objective was to develop a strategy that builds on programme strengths to make ISOE a primary information source for occupational radiation protection professionals. An important activity in 2006 was the conduct and analysis of a survey directed at the ISOE end user. Survey feedback was used in the development of proposals for improving ISOE activities, products and organisation, and in developing renewed ISOE Terms and Conditions.

Principal events in ISOE participating countries are summarised in Section 6 of this report. Details of ISOE accomplishments, participation and programme of work for 2006-2007 are provided in the Annexes.

SYNTHESE DU RAPPORT

Depuis 1992, le programme ISOE (système d'information sur les expositions professionnelles), conjointement sponsorisé par l'AEN de l'OCDE et l'AIEA, 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 seizième rapport annuel du système ISOE (2006) fait le point sur le programme ISOE à la fin de l'année 2006.

ISOE est ouvert à l'adhésion d'exploitants d'électricité et des autorités réglementaires de radioprotection. Quatre centres techniques ISOE (Europe, Amérique du Nord, Asie et AIEA) gèrent au jour le jour les opérations techniques du programme. À la fin 2006, 71 exploitants de 29 pays participaient au programme ISOE (336 réacteurs nucléaires en fonctionnement ; 42 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 401 réacteurs en exploitation dans 29 pays, représentant ainsi près de 91 % de l'ensemble des réacteurs de puissance en fonctionnement dans le monde.

Selon les données sur les expositions professionnelles fournies par le programme ISOE, la dose collective moyenne annuelle pour 2006 et la dose collective moyennée sur trois ans (2004-2006) des réacteurs en fonctionnement étaient de :

	Dose collective moyenne annuelle 2006 (Homme·Sv)	**Dose collective moyennée 3 ans pour 2004-2006 (Homme·Sv)**
Réacteurs à eau pressurisée (REP/VVER)	0.71	0.75
Réacteurs à eau bouillante (REB)	1.32	1.41
Réacteurs à eau lourde pressurisée (PHWR/CANDU)	1.15	1.06
Tous les réacteurs, y compris les graphite gaz (GCR) et les réacteurs à eau graphite (RBMK)	0.85	0.88

Par ailleurs, la base de données ISOE contient également des données concernant les doses collectives de 80 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. Une initiative a été lancée en 2006 pour améliorer la collecte de données pour l'arrêt des réacteurs arrêtés afin de faciliter une meilleure comparaison. Des détails sur l'évolution de la dose des réacteurs en exploitation, et des réacteurs en cours de démantèlement sont fournis à la section 2 de ce rapport.

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. En 2006, le site internet du Réseau ISOE (www.isoe-network.net) a été mis à jour pour fournir aux participants 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 fournit aux membres un accès en ligne aux produits d'ISOE, y compris un forum de discussions entre les participants et l'accès à la base de données sur les expositions professionnelles. Après la migration réussie de l'application MADRAS d'analyses statistiques des données sur le site Web en 2005, le développement informatique des modules de saisie des données d'expositions professionnelles sur le Web a été lancé en 2006.

Les symposiums ISOE ALARA annuels internationaux sur la gestion des expositions professionnelles dans les centrales nucléaires, co-sponsorisés par l'AEN de l'OCDE 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 2006 organisé par le centre technique ISOE européen s'est tenu à Essen, en Allemagne. Les centres techniques continuent également à organiser des symposiums régionaux pour satisfaire les besoins au niveau régional : un symposium en Asie (Yuzawa, Japon) et un symposium en Amérique du Nord (Orlando, USA). 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.

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 entre les régions ISOE des informations sur les réductions des doses revêt une importance croissante. L'organisation conjointe de symposiums ISOE 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.

Alors que le groupe de travail ISOE sur l'analyse des données (WGDA) a poursuivi ses activités d'appui pour l'analyse technique des données et de l'expérience, le groupe de travail ad-hoc sur la planification stratégique (WGSP) a terminé son travail visant à identifier des améliorations possibles des produits, des activités et de l'organisation d'ISOE. L'objectif était de développer une stratégie basée sur les forces du système ISOE, pour le faire devenir une source essentielle d'information pour la communauté des professionnels de la radioprotection. Une activité importante en 2006 a été la réalisation et l'analyse d'un sondage auprès des utilisateurs ISOE. Les résultats de l'enquête ont été utilisés pour élaborer des propositions pour l'amélioration des activités ISOE, des produits et de l'organisation, et dans le processus de renouvellement du texte de référence des « Conditions de mise en œuvre » du système ISOE.

Les développements récents et les principaux événements qui ont eu lieu dans les pays participants à ISOE sont résumés dans la section 6 de ce rapport. Les détails concernant les réalisations, la participation et le programme de travail d'ISOE pour 2006-2007 sont fournis dans les annexes.

ZUSAMMENFASSUNG

Seit 1992 bildet das Information System on Occupationat Exposure, unterstützt durch die OECD/NEA und die IAEA, ein Netzwerk zum weltweiten Informations- und Erfahrungsaustausch unter Strahlenschutzfachleuten aus Kernkraftwerken und Aufsichtsbehörden für die Optimierung des beruflichen Strahlenschutzes in Kernkraftwerken. Dieser 16. Jahresbericht beschreibt den Stand des ISOE- Programms für das Kalenderjahr 2006.

Die ISOE – Mitgliedschaft steht Kernkraftwerksbetreibern und strahlenschutzverantwortlichen Regulierungsbehörden offen. Vier Technische Zentren (Europa, Nord-Amerika, Asien and IAEA) sind mit den technischen Aufgaben zur Durchführung des ISOE- Programms betraut. Ende 2006 waren 71 Kernkraftwerksbetreiber aus 29 Ländern mit 336 in Betrieb befindlichen und 42 stillgelegten Kernkraftwerken sowie Behörden aus 25 Ländern am Programm beteiligt. . Die ISOE-Datenbank enthielt Informationen über Dosisbelastungen und Dosistrends in 401 Kernkraftwerken. Das entspricht 91 % der weltweit existierenden kommerziellen Kernkraftwerksanlagen.

Auf Basis dieses Datenmaterials ergibt sich für die mittlere jährliche Kollektivdosis (2004- 2006) der in Betrieb befindlichen KKW folgendes Bild:

	Mittl. jährl. Dosis 2006 (man·Sv)	**3-jährl. rollierende mittl. Dosis 2004-2006 (man·Sv)**
DWR- Anlagen (DWR/VVWER)	0.71	0.75
SWR- Anlagen	1.32	1.41
Schwerwassermoderierte KKW (PHWR/CANDU)	1.15	1.06
Alle KKW, inkl. gasgekühlte (GCR) und LWR mit Graphitmoderator (LWGR)	0.85	0.88

Zusätzlich enthält die Datenbank Informationen von 80 KKW, die endgültig abgeschaltet sind oder sich in einem Rückbaustadium befinden. Da sich diese Anlagen grundsätzlich nach Größe und Typ unterscheiden und sich in verschiedenen Phasen der Stilllegung befinden, ist es schwierig, klare Dosistrends zu identifizieren. In 2006 wurde eine Initiative zur Verbesserung der Datenerfassung gestartet, um eine gesteigerte Vergleichbarkeit der Datensätze zu ermöglichen. Detailiierte Informationen über Dosistrends in allen erfassten KKW sind Abschnitt 2 dieses Berichts zu entnehmen.

Neben der Nutzung der ISOE- Datenbank stellt der persönliche Informationsaustausch unter den Teilnehmern eine wesentliche Stärke des ISOE- Programms dar. In 2006 wurde das internetgestützte ISOE- Netzwerk (www.isoe-network.net) ertüchtigt, um den Teilnehmern ein benutzerfreundliches Instrument zum Erfahrungsaustausch im Sinne des ALARA- Prinzips zu bieten. Der Online-Zugang zum Netzwerk ist in Abhängigkeit vom Mitgliedsstatus geregelt. Das beinhaltet auch die Berechtigung zur Einspeisung und Auswertung von Informationen.

Ein weiteres Forum zum Erfahrungsaustausch stellen die jährlichen internationalen ISOE ALRA Symposien dar, die von OECD/NEA und IAEA unterstützt werden und von Kernkraftwerksbetreibern, Behörden, Hersteller- und Servicefirmen genutzt werden können. In 2006 fand das internationale ALARA Symposium in Essen, Deutschland, statt. Die Technischen Zentren organisierten außerdem regionale ALARA Symposien in Yuzawa, Japan, und Orlando, USA. Dies setzt eine Tradition im Sinne eines Gedankenaustausches zur Förderung des ALARA- Prinzips fort.

Die Unterstützung der schnellen Bearbeitung von Anfragen zu speziellen Themen durch die Technischen Zentren ist von steigender Bedeutung. Dabei besteht auch die Möglichkeit zur Organisation von Benchmark-Besuchen auf Wunsch einzelner Anlagen. Die Kombination dieser Möglichkeiten zum Erfahrungsaustausch stellt ein professionelles Instrument zum weltweiten Austausch über Themen des Strahlenschutzes im Rahmen des Betriebsmanagements dar.

Die ISOE- Arbeitsgruppe „Datenanalyse" setzt ihre Tätigkeit zur Unterstützung technischer Analysen mit Hilfe der Datenbankinformationen fort, die ad-hoc-Arbeitsgruppe „Strategische Planung" hat ihre Arbeiten zur Entwicklung von Vorschlägen für die Optimierung des ISOE-Programms (Produkte, Aktivitäten, Organisation) abgeschlossen. Ziel war es dabei, des ISOE-Programm als primäre Informationsquelle für Fachleute im beruflichen Strahlenschutz weiterzuentwickeln. Eine bedeutende Aktion war in diesem Zusammenhang eine Umfrage zur Erfassung der Bedürfnisse der ISOE- Endanwender. Dabei wurden auf Basis des Feedbacks der Endanwender Vorschläge für die Verbesserung der Produkte des ISOE- Programms erarbeitet, die auch zu einer Überarbeitung der ISOE- Satzung führten.

Wesentliche Ereignisse in den ISOE- Teilnehmerländern sind zusammenfassend in Abschnitt 6 dieses Berichts dargestellt. Detailinformationen zu ISOE- Teilnehmern, Arbeitsergebnissen und dem Arbeitsprogramm 2006-2007 sind den Anhängen zu entnehmen.

正 文 摘 要

自 1992 年以来，由经合组织核能机构和国际原子能机构联合运行的“职业照射信息系统”就一直通过世界各地核电厂和国家监管当局的辐射防护专业人员信息和经验交流网络以及通过制订和发表相关技术资源，支持开展核电厂工作人员剂量优化工作。《职业照射信息系统计划第 16 期年度报告》（2006 年）介绍了该计划在 2006 年的状况。

核电公司和辐射防护监管当局均可申请参加“职业照射信息系统”。该系统的四个技术中心（欧洲、北美洲、亚洲和原子能机构）管理着该计划的日常技术工作。截至 2006 年底，“职业照射信息系统”计划包括 29 个国家的 71 个参与电力公司（336 台在运机组，42 台关闭机组）以及 25 个国家的监管当局。“职业照射信息系统”的职业照射数据库本身载有关于 29 个国家 401 座在运反应堆职业照射水平和趋势的资料，涵盖世界上 91%的在运商业动力堆。

根据“职业照射信息系统”成员提供的职业照射数据，在运动力堆的 2006 年度平均集体剂量和三年（2004－2006 年）滚动平均数据如下：

	2006 年平均集体剂量（人・希）	**2004－2006 年三年滚动平均集体剂量（人・希）**
压水堆（压水堆/水水堆）	0.71	0.75
沸水堆	1.32	1.41
加压重水堆（加压重水堆/坎杜堆）	1.15	1.06
包括气冷和轻水石墨反应堆在内的所有反应堆	0.85	0.88

除来自在运反应堆的资料外，“职业照射信息系统”数据库还载有 80 座已关闭或处于某一退役阶段的反应堆的剂量数据。由于这些反应堆通常类型不同，规模各异，而且都处在退役计划的不同阶段，因此，很难确定清晰的剂量趋势。2006 年发起了一项旨在改进有关已关闭和退役反应堆数据收集工作的倡仪，以促进更准确地确定基准。本报告第二部分提供了在运反应堆和正在退役的反应堆职业剂量趋势的详细资料。

虽然“职业照射信息系统”以其职业照射数据和分析著称，但该计划的强项在于其促进各参与方广泛共享此类信息的目标。2006 年，对“职业照射信息系统”网网站（www.isoe-network.net）进行了升级，目的是为“职业照射信息系统”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为各成员提供对“职业照射信息系统”技术资源包括该系统职业照射数据库和网基用户论坛的在线访问。继 2005 年马德拉斯数据库统计分析包向该网站成功转移之后，2006 年开始建立在线提交各成员职业照射数据的数据输入模板。

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照射管理问题年度职业照射信息系统“合理可行尽量低原则”国际专题讨论会继续为该系统各成员和制造商提供交流职业照射问题实用信息和经验的重要论坛。由欧洲技术中心组织的 2006 年度职业照射信息系统“合理可行尽量低原则”国际专题讨论会在德国埃森举行。技术中心还继续主办了几次地区专题讨论会，包括 2006 年度职业照射信息系统“合理可行尽量低原则”亚洲地区专题讨论会（日本汤泽）和 2006 年度职业照射信息系统“合理可行尽量低原则”北美洲专题讨论会（美国奥兰多）。这些专题讨论会继续坚持为促进交流思想和管理方案提供全球论坛的传统，以保持职业辐射照射实现“合理可行尽量低”原则。

技术中心为响应对快速技术反馈的特别请求以及通过为“职业照射信息系统”各地区之间进行减少剂量信息交流而自愿组织的现场基准访问所提供的支助正变得越来越重要。“职业照射信息系统”专题讨论会与技术访问两者的结合，为辐射防护专业人员汇聚一堂共享信息以及建立“职业照射信息系统”各地区之间的联系以制订全球工作管理方案提供了手段。

在“职业照射信息系统”数据分析工作组继续其支持该系统数据和经验技术分析活动的同时，战略规划特别工作组已经完成了有关确定“职业照射信息系统”的产品、活动和组织中需要作出何种改进的工作。这样做的目的是制订一项战略，以使该计划的强项能够促进“职业照射信息系统”成为职业辐射防护专业人员的主要信息来源。2006 年的一项重要活动是开展了针对“职业照射信息系统”最终用户的调查，并对调查结果进行分析。调查反馈已被用于就改进“职业照射信息系统”的活动、产品和组织工作提出建议以及制订新的“职业照射信息系统”的“工作范围”。

本报告第六部分概述“职业照射信息系统”参加国的主要活动。各附件提供有关“职业照射信息系统”取得的成就、参加活动的情况和 2006－2007 年工作计划的细况。

概　略

1992 年以来、OECD/NEA と IAEA が共同出資をしている ISOE プログラムは、原子力発電所の放射線防護専門家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 16 年次報告書(2006)は、2006 年末における ISOE プログラムの状況を示したものである。

ISOE メンバーの資格は電気事業者と規制当局に開かれている。4 つの技術センター（欧州、北米、アジア、IAEA）はプログラムの技術的な運営を日々管理している。2006 年末では、ISOE プログラムには 29 ヵ国の 71 加盟電気事業者（336 基は運転中； 42 基は操業停止）並びに 25 ヵ国の規制当局が参加している。ISOE 職業被ばくデータベース自体には 29 ヵ国の 401 基の運転中原子炉の職業被ばくレベル及び傾向に関する情報が含まれおり、全世界の商用運転中の動力炉の 91%が扱われている。

ISOE メンバーから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 2006 年及び 3 年平均年間集団線量(2004-2006 年)は以下の通りである。

	2006 年 平均集団線量 (man·Sv)	2004-2006 年 3 年平均 (man·Sv)
加圧水型原子炉 (PWR/VVER)	0.71	0.75
沸騰水型原子炉 (BWR)	1.32	1.41
加圧重水型原子炉 (PHWR/CANDU)	1.15	1.06
ガス冷却炉 (GCR)と軽水黒鉛炉(LWGR)を含む全ての原子炉	0.85	0.88

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 80 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。効果的なベンチマーキングの促進のために操業停止と廃止措置の原子炉のデータ収集改善は 2006 年に開始された。運転中原子炉及び廃止措置段階の原子炉の職業被ばく傾向の詳細は報告書の第 2 章に記載されている。

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。2006 年に ISOE ネットワーク・ウェブサイト（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窓口を ISOE メンバーに提供するために更新された。 この制限されたアクセスの入口によって、ISOE 放射線防護データベース及び会員制ウェブフォーラムを含む ISOE 技術資源へのオンラインアクセスがメンバーに提供さ

れる。2005 年における MADRAS データベース統計解析ソフトのウェブサイトへの移行の成功を受けて、メンバーの職業被ばくデータのオンライン提出のためのデータ入力モジュールの開発が 2006 年に開始された。

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、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 ISOE メンバーとベンダーに重要なフォーラムの提供を継続した。 欧州技術センターによる 2006 ISOE 国際 ALARA シンポジウムはドイツのエッセンで開催された。 また、技術センターは、2006 年 ISOE アジア ALARA 地域シンポジウム（湯沢、日本）と 2006 ISOE 北米地域シンポジウム（オーランド、米国）を含む地域シンポジウムのホストを継続した。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ための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継続した

迅速かつ技術的なフィードバックを求める特別なリクエストに対する回答、そして ISOE 地域間の線量低減情報交換のための自主的なサイト・ベンチマーキング訪問の実施を通じて、技術センターが提供する支援の重要性が高まりつつある。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、情報を共有するための手段を提供し、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 地域間の連結を築いている。

ISOE データ分析ワーキンググループ（WGDA）は、ISOE データと経験の技術分析の活動を継続し、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の作業を完了した。 その目的は、職業被ばく防護の専門家のために ISOE を主要な情報資源にするため、強化プログラムの構築をするための戦略を開発することである。2006 年の重要な活動は、ISOE エンドユーザー向けの調査の実施及び分析である。調査のフィードバックは ISOE の活動、成果、組織、ISOE 規約の改訂における強化の計画作成の為に使用された。

本報告書の第 6 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－ 2007 年の作業計画を附属書に提示する。

ОСНОВНЫЕ ИТОГИ

С 1992 года в рамках Информационной системы по профессиональному облучению (ИСПО), которая совместно спонсируется АЯЭ/ОЭСР и МАГАТЭ, оказывается содействие деятельности по оптимизации получаемых работниками АЭС доз облучения путем использования сети по обмену информацией и опытом, предназначенной для специалистов служб радиационной защиты на АЭС и национальных компетентных органов во всем мире, а также путем разработки и публикации соответствующих технических ресурсов. Настоящий 16-й ежегодный доклад программы ИСПО (2006 год) отражает положение дел с осуществлением программы ИСПО в 2006 календарном году.

Членство ИСПО открыто для ядерных энергопредприятий и регулирующих органов, ведающих вопросами радиационной защиты. Управление повседневной технической деятельностью по программе обеспечивается четырьмя техническими центрами ИСПО (Европа, Северная Америка, Азия и МАГАТЭ). В конце 2006 года программа ИСПО включала 71 участвующее энергопредприятие в 29 странах (336 эксплуатируемых энергоблоков; 42 остановленных энергоблока), а также регулирующие органы 25 стран. База данных по профессиональному облучению ИСПО включала информацию об уровнях и тенденциях профессионального облучения на 401 действующем реакторе в 29 странах, охватывая приблизительно 91% действующих промышленных энергетических реакторов мира.

На основе данных о профессиональном облучении, полученных от членов ИСПО, в 2006 году значение средней годовой коллективной дозы и скользящей средней дозы за трехлетний период (2004-2006 годы) в отношении находящихся в эксплуатации энергетических реакторов составляли:

	Средняя годовая коллективная доза за 2006 год (чел.Зв)	**Скользящая средняя доза за трехлетний период, 2004-2006 годы (чел.Зв)**
Реакторы с водой под давлением (PWR/ВВЭР)	0,71	0,75
Кипящие водяные реакторы (BWR)	1,32	1,41
Корпусные тяжеловодные реакторы (PHWR/CANDU)	1,15	1,06
Все реакторы, включая газоохлаждаемые (GCR) и легководные реакторы с графитовым замедлителем (LWGR)	0,85	0,88

В дополнение к информации по находящимся в эксплуатации реакторам база данных ИСПО содержит также данные о дозах по 80 реакторам, которые находятся в состоянии останова или на некоторой стадии снятия с эксплуатации. Поскольку эти реакторные блоки как правило относятся к различным типам и имеют различные мощности и находятся на различных стадиях снятия с эксплуатации, четкие тенденции изменения дозы определить трудно. В 2006 году были приняты инициативные меры по совершенствованию сбора данных в отношении остановленных и снятых с эксплуатации реакторов, с тем чтобы содействовать их более качественному контрольному анализу. Подробная информация о тенденциях дозы профессионального облучения применительно к действующим реакторам и реакторам, находящимся в процессе снятия с эксплуатации, содержится в разделе 2 доклада.

В то время как ИСПО хорошо известна в связи с ее данными и анализами профессионального облучения, сильная сторона этой программы состоит в ее цели − широко распространять такую информацию среди своих участников. В 2006 году веб-сайт сети ИСПО (www.isoe-network.net) был модернизирован с целью предоставления членам ИСПО универсального Интернет−портала для обмена информацией и опытом по методам снижения дозы и ресурсам ALARA. Этот портал с ограниченным доступом предоставляет членам доступ к техническим ресурсам ИСПО, в том числе к базе данных по профессиональному облучению ИСПО и пользовательским веб-форумам. После успешного перемещения в 2005 году пакета статистического анализа на основе базы данных MADRAS на веб-сайт, в 2006 году была начата разработка модулей ввода данных для он-лайнового представления членами данных о профессиональном облучении.

Ежегодно проводимые ИСПО международные симпозиумы ALARA по управлению профессиональным облучением на АЭС, совместно организуемые ОЭСР/АЯЭ и МАГАТЭ, продолжали обеспечивать важный форум для членов ИСПО и для поставщиков, с тем чтобы они могли обменяться практической информацией и опытом по вопросам профессионального облучения. В Эссене, Германия, был проведен Международный симпозиум ИСПО ALARA 2006 года, организованный Европейским техническим центром. В технических центрах продолжалось проведение также региональных симпозиумов, в том числе Азиатского регионального симпозиума ИСПО ALARA 2006 года (Юдзава, Япония) и Североамериканского регионального симпозиума ИСПО ALARA 2006 года (Орландо, США). Эти симпозиумы продолжили традицию обеспечения глобального форума для содействия обмену идеями и данными об управленческих подходах к поддержанию профессионального радиационного облучения "на разумно достижимом низком уровне".

Возрастает важность поддержки, которую технические центры предоставляют в ответ на специальные запросы для осуществления быстрой технической обратной связи, а также посредством организации добровольных контрольных посещений для обмена информацией между регионами ИСПО по вопросам снижения дозы. Сочетание симпозиумов и технических посещений ИСПО предоставляет специалистам по радиационной защите возможность встретиться, обменяться информацией и установить связи между регионами ИСПО для выработки глобального подхода к управлению работой.

В то время как Рабочая группа ИСПО по анализу данных (РГАД) продолжала свою деятельность в поддержку технического анализа данных и опыта ИСПО, специальная Рабочая группа стратегического планирования (РГСП) завершила свою работу по определению возможных способов повышения качества продукции, деятельности и совершенствования организации ИСПО. Цель состояла в том, чтобы разработать стратегию, которая основывается на сильных аспектах программы, с тем чтобы сделать ИСПО основным источником информации для специалистов по радиационной защите персонала. Одним из важных направлений деятельности в 2006 году было проведение и анализ обследования, направленного на конечного пользователя ИСПО. Отклики, полученные в ходе проведения этого обследования, использовались для разработки предложений по совершенствованию деятельности, продукции и организации ИСПО, и для подготовки обновленных Положений и условий ИСПО.

Важнейшие события, произошедшие в участвующих в ИСПО странах, кратко излагаются в разделе 6 настоящего доклада. Подробные сведения о достижениях в рамках ИСПО, об участии в ней и о программе работы на 2006-2007 годы содержатся в приложениях.

RESUMEN EJECUTIVO

Desde 1992, el Information System on Occupational Exposure (ISOE), co-patrocinado por el OCDE/NEA y el OIEA, ha fomentado, a través de una red de intercambio de experiencia e información para los profesionales de la protección radiológica y de las autoridades reguladoras a escala mundial, la optimización de las dosis recibidas por los trabajadores de las centrales nucleares mediante el desarrollo y publicación de recursos de relevancia técnica. Este 16º Informe Anual del programa ISOE (2006) presenta el estado del programa ISOE al final de 2006.

La incorporación de compañías eléctricas y autoridades reguladoras en el ISOE está abierta. A finales de 2006, el programa ISOE contó con la participación de 69 compañías eléctricas de 29 países (332 centrales en operación; 41 en parada), así como de las autoridades reguladoras de 25 países. La base de datos de exposición ocupacional del ISOE incluyó información sobre niveles de exposición ocupacional y tendencias de 480 reactores (402 en operación y 78 en parada fría o en alguna etapa de desmantelamiento) de 29 países. Así, esta base de datos cubre el 91% del total de reactores comerciales a potencia (442) del mundo. Cuatro Centros Técnicos del ISOE (Europeo, Norteamericano, Asiático y del OIEA) asumen las funciones técnicas del programa.

Basándose en los datos aportados por el programa ISOE sobre exposición ocupacional, la media de dosis colectiva anual de 2006 y la media trienal de reactores a potencia fue de:

	Media de dosis anual colectiva en 2006 (Sv.p)	**Media de dosis trienal 2004-2006 (Sv.p)**
Reactores de agua a presión (PWR)	0.71	0.75
Reactores de agua en ebullición (BWR)	1.32	1.41
Reactores de agua pesada a presión (PHWR/CANDU)	1.15	1.06
Todos los reactores, incluyendo los refrigerados por gas (GCR) y los de agua ligera grafito (LWGR)	0.85	0.88

Además de la información de los reactores en operación, la base de datos del ISOE contiene datos de dosis de los 80 reactores en parada o en alguna etapa de desmantelamiento. Como los reactores representados en la base de datos son de diferentes tipos y tamaños y, por lo general, están en diferentes fases de sus respectivos programas de desmantelamiento, es difícil identificar tendencias dosimétricas claras. No obstante, para mejorar esta situación, en 2006 se adoptó una iniciativa que facilita la recopilación de datos de los reactores en parada y desmantelamiento proporcionando una mejor comparativa. El apartado 2 de este documento presenta información detallada sobre tendencias de dosis ocupacionales para reactores a potencia y reactores en fase de desmantelamiento.

El ISOE es bien conocido por sus datos y análisis de exposición ocupacional y su fuerza radica en el objetivo de compartir ampliamente esta información entre sus participantes. Este intercambio de información fomenta el conocimiento de lecciones aprendidas basadas en la experiencia, el crecimiento y optimización de las habilidades y el incremento de valor añadido por la participación del ISOE.

En 2006, la red web del ISOE (www.isoe-network.net) ha sido modernizada para proporcionar a los miembros del ISOE un portal "one-stop" de intercambio de información y experiencia en reducción de dosis y recursos ALARA. Este portal de acceso restringido proporciona a los miembros acceso a los productos del ISOE, foros de comunicación entre participantes y acceso on-line a la base de datos de exposición ocupacional del ISOE. Tras el traslado satisfactorio del paquete de datos a la página web en 2005, se acometió la fase 2 durante el 2006 con el desarrollo de módulos para el envío on-line de datos por parte de los miembros.

El Simposio ALARA Internacional Anual del ISOE sobre la gestión de la exposición ocupacional en centrales nucleares, co-patrocinado por el OCDE/NEA y el OIEA, sigue siendo un importante foro para los profesionales de la protección radiológica del sector nuclear y las autoridades reguladoras para intercambiar información práctica y experiencia en asuntos de exposición ocupacional. El Simposio ALARA Internacional de 2006 del ISOE, organizado por el Centro Técnico Europeo, se celebró en Essen, Alemania. Los centros técnicos siguieron coordinando Simposios regionales, incluyendo el Simposio Regional Asiático del ISOE de 2006 (Yuzawa, Japón) y el Simposio Regional Norteamericano del ISOE de 2006 (Orlando, EEUU). Éstos continúan con la tradición de proporcionar un foro global para la promoción del intercambio de ideas y propuestas de gestión para mantener los niveles de exposición ocupacional tan bajos como razonablemente sea posible.

De creciente importancia es el apoyo que brindan los centros técnicos en respuesta a los requerimientos específicos de "feedback", así como la organización de visitas voluntarias para el intercambio de información sobre reducción de dosis entre regiones ISOE. La combinación de Simposios ALARA del ISOE tanto nacionales como internacionales, y las visitas técnicas, proporcionan un valioso foro de encuentro, discusión e intercambio de información para los profesionales de la protección radiológica, generando uniones y sinergias entre las regiones ISOE para desarrollar, con carácter global, un acercamiento a la gestión del trabajo.

Mientras el Working Group on Data Análisis (WGDA) continuó con sus actividades de apoyo al análisis técnico de los datos del ISOE y experiencias operativas, el ad-hoc Working Group on Strategic Planning (WGSP) completó su cometido de identificar posibles mejoras en los productos, actividades y organización del ISOE. El objetivo era desarrollar una estrategia de intensificación del potencial del ISOE para hacer del ISOE una fuente primaria de información y una red de comunicación para los profesionales del área de la protección radiológica. Una actividad importante llevada a cabo en 2006 fue la elaboración y análisis de una encuesta dirigida al usuario final del ISOE, cuyo resultado se usó para el desarrollo de propuestas para mejorar las actividades, productos, comunicaciones y organización del ISOE y la renovación del ISOE Terms and Conditions.

Los desarrollos recientes y eventos principales de los países participantes del ISOE se resumen en el apartado 6 del presente informe. Los detalles de logros, participaciones y programa de trabajo 2006-2007 se muestran en los anexos.

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

Since 1992, the Information System on Occupational Exposure (ISOE), jointly sponsored by the OECD/NEA and IAEA, has supported the optimisation of worker doses in nuclear power plants through an information and experience exchange network for radiation protection professionals of nuclear power plants and national regulatory authorities worldwide, and through the development and publication of relevant technical resources.

The ISOE programme includes a global occupational exposure data collection and analysis programme, culminating in the world's largest occupational exposure database for nuclear power plants, and an information network for sharing dose reduction information and experience. Since the launch of ISOE, participants have used this 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.

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 (2004-2007). Four ISOE Technical Centres (Europe, North America, Asia and IAEA) manage the day-to-day technical operations in support of the membership in the four ISOE regions (see Annex 3 for country-technical centre affiliation). 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; and
- 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.

At the end of 2006, the ISOE programme included 71[1] Participating utilities in 29 countries (336 operating units; 42 shutdown units), as well as the regulatory authorities of 25 countries. In addition to the detailed occupational exposure data provided directly by participating utilities, participating authorities may 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 481 reactor units (401 operating; 80 in cold-shutdown or some stage of decommissioning) in 29 countries, covering about 91% of the world's operating commercial power reactors (439).[2] Occupational exposure data collected annually from participants is made available to all ISOE members, according to their status as a participating utility or authority, through the ISOE database provided to members through the ISOE Network website and on CD-ROM.

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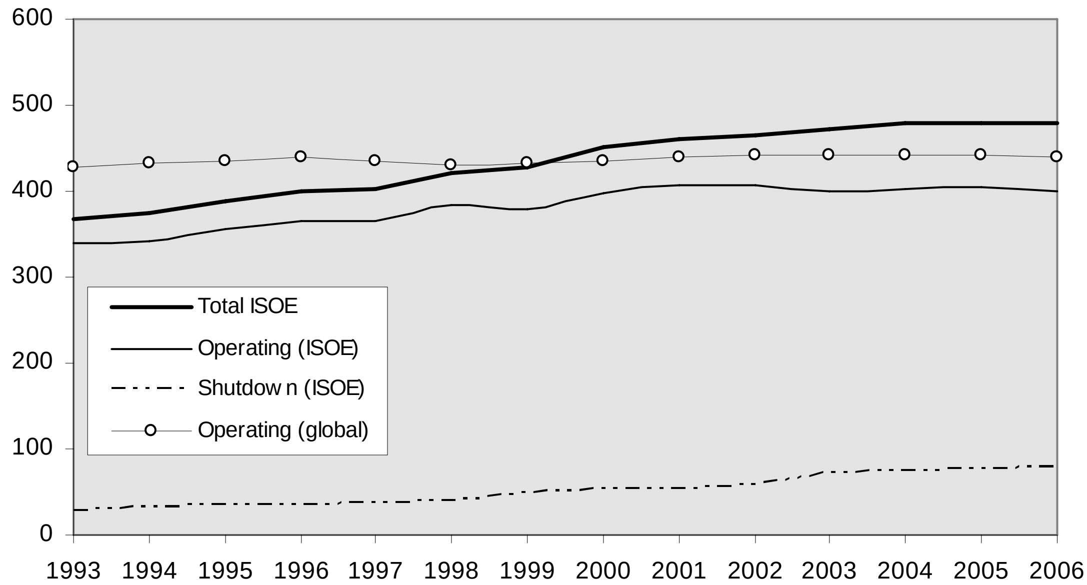
1. Represents the number of lead utilities; in some cases, a plant may be owned/operated by multiple enterprises.
2. The largest blocks of reactors not included in the database are in India and the Russian Federation (LWGRs).

Figure 1: Total number of reactors included in ISOE (1993-2006)



During 2006, the following changes were noted with respect to the status of ISOE participants:

- Units starting commercial operations:
  - Russian Federation: Kalinin 3 (VVER, 1000 MWe)
  - Ukraine: Khmelnitski 2 (VVER, 1000 MWe)
  - Ukraine: Rovno 4 (VVER, 1000 MWe)
  - Japan: Higashidori 1 (BWR, 1100 MWe)
- Unit restart after long-term shutdown:
  - Canada: Pickering A1 (CANDU, 515 MWe)
- Units shutdown definitively:
  - Spain: Jose Cabrera (PWR) (shutdown 30/04/2006)

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

Table 1: Participation summary (as of December 2006)

Operating reactors participating in ISOE						
Country	**PWR**[1]	**BWR**	**PHWR**	**GCR**	**LWGR**	**Total**
Armenia	1	–	–	–	–	1
Belgium	7	–	–	–	–	7
Brazil	2	–	–	–	–	2
Bulgaria	4	–	–	–	–	4
Canada[2]	–	–	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	–	–	–	55
Korea, Republic of	16	–	4	–	–	20
Lithuania	–	–	–	–	1	1
Mexico	–	2	–	–	–	2
The Netherlands	1	–	–	–	–	1
Pakistan	1	–	1	–	–	2
Romania	–	–	1	–	–	1
Russian Federation	15	–	–	–	–	15
Slovak Republic	6	–	–	–	–	6
Slovenia	1	–	–	–	–	1
South Africa	2	–	–	–	–	2
Spain	6	2	–	–	–	8
Sweden	3	7	–	–	–	10
Switzerland	3	2	–	–	–	5
Ukraine	15	–	–	–	–	15
United Kingdom	1	–	–	–	–	1
United States	41	20	–	–	–	61
Total	**234**	**73**	**28**	**–**	**1**	**336**
Operating reactors not participating in ISOE, but included in the ISOE database						
Country	**PWR**	**BWR**	**PHWR**	**GCR**	**LWGR**	**Total**
United Kingdom	–	–	–	22	–	22
United States	28	15	–	–	–	43
Total	**28**	**15**	**–**	**22**	**–**	**65**
Total number of operating reactors included in the ISOE database						
	PWR	**BWR**	**PHWR**	**GCR**	**LWGR**	**Total**
Total	**262**	**88**	**28**	**22**	**1**	**401**

1. Includes VVER.
2. Includes 4 reactors in laid-up state (long-term shutdown).

Definitively shutdown reactors participating in ISOE							
Country	**PWR**	**BWR**	**PHWR**	**GCR**	**LWGR**	**Other**	**Total**
Bulgaria	2	–	–	–	–	–	2
Canada	–	–	2	–	–	–	2
France	1	–	–	6	–	–	7
Germany	3	1	–	1	–	–	5
Italy	1	2	–	1	–	–	4
Japan	–	–	–	1	–	1	2
Lithuania	–	–	–	–	1	–	1
Russian Federation[3]	2	–	–	–	–	–	2
Spain	1	–	–	1	–	–	2
Sweden	–	2	–	–	–	–	2
The Netherlands	–	1	–	–	–	–	1
Ukraine	–	–	–	–	3	–	3
United States	5	3	–	1	–	–	9
Total	**15**	**9**	**2**	**11**	**4**	**1**	**42**
Definitively shutdown reactors not participating in ISOE but included in the ISOE database							
Country	**PWR**	**BWR**	**PHWR**	**GCR**	**LWGR**	**Other**	**Total**
Germany	6	3	–	1	–	1	11
United Kingdom	–	–	–	18	–	–	18
United States	5	3	–	1	–	–	9
Total	**11**	**6**	**–**	**20**	**–**	**–**	**38**
Total number of definitively shutdown reactors included in the ISOE database							
	PWR	**BWR**	**PHWR**	**GCR**	**LWGR**	**Other**	**Total**
Total	**26**	**15**	**2**	**31**	**4**	**1**	**80**

Total number of reactors included in the ISOE database							
	PWR	**BWR**	**PHWR**	**GCR**	**LWGR**	**Other**	**Total**
Total	**288**	**103**	**30**	**53**	**5**	**2**	**481**

Number of **Participating Countries**:	**29**
Number of **Participating Utilities:**[4]	**71**
Number of **Participating Authorities**	**27**

3. LWGRs from Russian Federation are not ISOE participants.
4. 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, 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 in occupational doses at nuclear power plants.

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 2006 averages maintaining the levels reached in last few years. In spite of some yearly variations, the clear downward dose trend in most reactors has been maintained.

A summary of average annual collective dose of 2006 by reactor type is provided in Table 2. 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 3 and 4 respectively. These results are based primarily on data reported and recorded in the ISOE database during 2007, supplemented by the individual country reports (Section 6) as required. Figures 2 to 5 show the 2006 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 1992-2006, with the average annual doses for 2006 maintaining a fairly low level. In all figures, the "number of units" refers to the number of units for which data has been reported for the year in question.

Table 2: Summary of average collective doses for 2006

	2006 average annual collective dose (man·Sv)	3-year rolling average for 2004-2006 (man·Sv)
Pressurised water reactors (PWR/VVER)	0.71	0.75
Boiling water reactors (BWR)	1.32	1.41
Pressurised heavy water reactors (PHWR/CANDU)	1.15	1.06
All reactors, including gas cooled (GCR) and light water graphite reactors (LWGR)	0.85	0.88

In the European region, the 2006 average collective dose per reactor for PWRs and VVERs was around 0.58 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 1.00 man·Sv. The trends over time of the 3-year rolling average annual collective dose, which provides a better representation of the general trend in dose, shows a light continuity of the decrease for PWRs and VVERs, going from 0.74 man·Sv per reactor for 2002-2004 to 0.65 man·Sv per reactor for 2004-2006. The trend for BWRs appears to be more stable, with 1.01 man·Sv per reactor for 2002-2004 and 1.00 man·Sv per reactor for 2004-2006. The 3-year rolling average annual collective doses per reactor for BWRs are quite similar in all European countries, the minimum being Sweden with 0.91 man·Sv, and the maximum Switzerland with 1.08 man·Sv.

For European PWRs, the data from individual countries shows that with respect to the 3-year rolling average annual collective dose for 2004-2006, three main groups can be distinguished:

- Belgium, Spain and United Kingdom: 0.3 to 0.4 man·Sv per reactor.
- Sweden, Switzerland and The Netherlands: around 0.5 to 0.6 man·Sv per reactor.
- France and Germany: around 0.7 to 1 man·Sv per reactor.

Regarding VVERs, the Czech Republic showed the lowest 3-year rolling average annual collective dose per reactor in 2004-2006 with 0.17 man·Sv, followed by the Slovak Republic (0.32 man·Sv), Hungary (0.40 man·Sv) and Finland (0.82 man·Sv).

In the Asian region, the average annual collective dose per reactor for PWRs shows a stable trend in general between 0.5-0.6 man·Sv in Korea and around 1.0 man·Sv in Japan. The BWR average collective dose per reactor in Japan for 2006 decreased 3 years in a row, and the value of 1.33 man・Sv is the lowest value in the past. The average annual collective dose for PHWRs in Korea was 0.58 man·Sv per reactor. This value is lower by about 23% compared to 2005, and 30% compared to 2004.

Countries participating to ISOE through the IAEATC have shown a general decrease in the collective dose for PWR and VVER reactors, with the average annual collective dose per reactor decreasing from 0.90 man·Sv in 2005 to around 0.61 man·Sv in 2006. Conversely, an increasing trend in CANDU reactor dose from 1.08 man·Sv in 2005 to 2.52 man·Sv in 2006 is observed due to a large annual dose observed in Pakistan related to the ANPP outage. Deviations from this trend were usually due to particular tasks related to replacement of components and/or to unexpected maintenance operations. Nevertheless, two issues could lead to further specific analyses. The first is related to the total collective dose distribution between utility employees and contractors (also referred to as external or itinerant workers). As described in the country reports (Section 6), the contractors' doses exhibit wide variation, ranging from a small fraction to as high as 50-60% of the operator's dose. Such discrepancies could be further investigated as regulations at different levels focus increasing attention on contractors. A second issue can be derived from the observation of the maximum individual dose. While the mean individual dose is quite low, values above 10 mSv are relatively frequent, with some values approaching 20 mSv/yr. Attention should be paid to these values and to the need for an examination of the practicality of possible ways for further reduction. As some important operations (such as maintenance, replacement) are planned for several units in 2007-2008, the questions raised here provide a good opportunity for validating, as a first step, the data within the IAEATC region and, in a second phase, for fostering comparisons with the three other ISOE regions.

Finally, in the United States, dosimetry (TLD) results for PWRs show an increasing trend due to major plant modifications completed in 2006, including containment sump modifications, reactor head replacements, and reactor temperature detector (RTD) bypass line replacements. TLD results for US BWRs show a decreasing trend reflecting shorter outage duration, successful dryer replacements, effective source term reduction initiatives and the impact of ALARA plant modifications.

More detailed discussion and analyses of dose trends in various countries can be found in Section 6 of this report. However, it is noted that 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.

Table 3: Average annual collective dose per unit, by country and reactor type, 2004-2006 (man·Sv)

	PWR, VVER			BWR			PHWR		
	2004	2005	2006	2004	2005	2006	2004	2005	2006
Armenia	1.16	0.84	0.86						
Belgium[1]	0.41	0.41	0.39						
Brazil	0.48	0.62	0.56						
Bulgaria	1.04	0.78	0.40						
Canada[2]							0.82	1.30	1.12
China	0.57	0.60	0.49						
Czech Republic	0.16	0.18	0.15						
Finland	1.25	0.38	0.82	0.74	1.14	1.10			
France	0.79	0.78	0.69						
Germany	0.90	1.32	0.86	1.06	1.01	1.14			
Hungary	0.38	0.47	0.35						
Japan[3]	1.25	0.97	1.09	1.61	1.39	1.33			
Mexico				3.54	1.68	1.48			
Pakistan	0.58	0.42	0.02				1.59	1.43	4.48
Rep. of Korea	0.65	0.56	0.54				0.83	0.75	0.58
Rep. of South Africa	0.43	1.13	0.80						
Romania							0.66	0.73	0.56
Russian Fed.	1.00	1.00	0.70						
Slovak Republic	0.29	0.40	0.28						
Slovenia	0.69	0.07	0.86						
Spain	0.31	0.42	0.38	0.46	2.32	0.41			
Sweden	0.58	0.63	0.51	0.63	1.06	1.08			
Switzerland	0.48	0.66	0.35	1.44	0.99	0.80			
The Netherlands	0.79	0.20	0.62						
Ukraine	1.18	1.01	n/a						
United Kingdom	0.03	0.36	0.52						
United States[1]	0.72	0.78	0.87	1.57	1.70	1.46			
Average	**0.77**	**0.77**	**0.71**	**1.46**	**1.47**	**1.31**	**0.84**	**1.19**	**1.15**
By Region[4]:									
Europe	0.66	0.70	0.58	0.84	1.18	1.00			
Asia	1.01	0.80	0.86	1.61	1.39	1.33	0.83	0.75	0.58
North America	0.72	0.78	0.87	1.68	1.70	1.46	0.82	1.30	1.12
IAEA	0.95	0.90	0.61				1.13	1.08	2.52

	GCR			LWGR		
Lithuania				3.41	2.11	3.06
United Kingdom	0.04	0.06	0.12			

	2004	2005	2006
Global Average	0.89	0.91	0.85

1. Data for 2006 provided directly from country: Belgium, USA.
2. Dose is calculated for 18 reactors.
3. Data for 2005 provided directly from country: Japan (BWR).
4. See Annex 3 for country composition of the four ISOE regions.

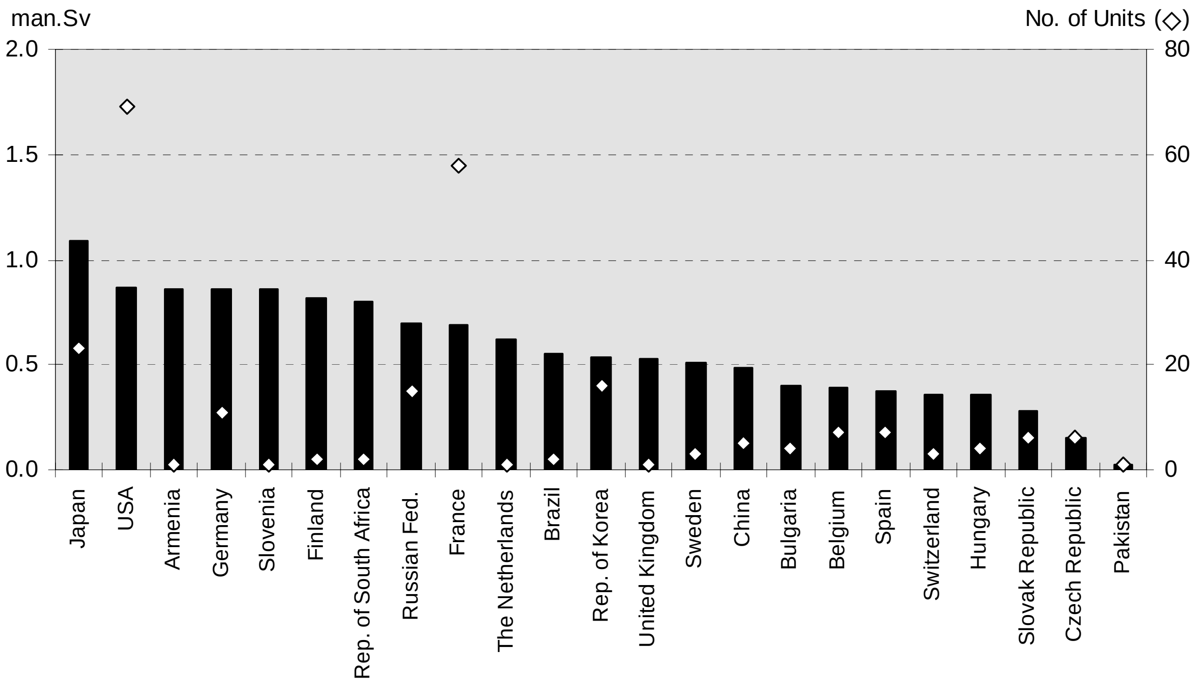
Table 4: 3-year rolling average annual collective dose per unit, by country and reactor type, 2002-2006 (man·Sv)

	PWR, VVER			BWR			PHWR		
	'02-'04	'03-'05	'04-'06	'02-'04	'03-'05	'04-'06	'02-'04	'03-'05	'04-'06
Armenia	0.99	0.96	0.96						
Belgium	0.40	0.40	0.40						
Brazil	0.76	0.74	0.55						
Bulgaria	0.77	0.85	0.74						
Canada							0.92	1.05	1.08
China	0.69	0.67	0.55						
Czech Republic	0.18	0.18	0.17						
Finland	1.01	0.70	0.82	0.61	0.81	0.99			
France	0.88	0.82	0.75						
Germany	1.06	1.08	1.02	0.92	1.00	1.07			
Hungary	0.65	0.54	0.40						
Japan	1.11	1.10	1.10	2.02	1.78	1.44			
Mexico				2.45	2.37	2.23			
Pakistan	0.29	0.34	0.34				2.64	2.28	2.50
Rep. of Korea	0.56	0.57	0.58				0.78	0.82	0.72
Rep. of South Africa	0.76	0.86	0.79						
Romania							0.68	0.74	0.65
Russian Fed.	1.14	1.06	0.80						
Slovak Republic	0.30	0.33	0.32						
Slovenia	0.69	0.52	0.54						
Spain	0.41	0.39	0.37	1.40	1.67	1.07			
Sweden	0.54	0.58	0.57	1.07	0.97	0.91			
Switzerland	0.44	0.49	0.50	1.07	1.16	1.08			
The Netherlands	0.47	0.42	0.54						
Ukraine	1.39	1.21	n/a						
United Kingdom	0.22	0.25	0.31						
United States	0.84	0.81	0.79	1.64	1.63	1.58			
Average	0.84	0.80	0.75	1.64	1.57	1.41	0.96	1.05	1.06
By Region:									
Europe	0.74	0.70	0.65	1.01	1.05	1.00			
Asia	0.90	0.89	0.89	2.02	1.74	1.41	0.78	0.82	0.72
North America	0.84	0.81	0.79	1.69	1.67	1.62	0.92	1.05	1.08
IAEA	1.06	0.99	0.84				1.66	1.51	1.58

	GCR			LWGR		
Lithuania				4.03	3.49	3.00
United Kingdom	0.07	0.06	0.07			

	'02-'04	'03-'05	'04-'06
Global Average	0.99	0.95	0.88

Figure 2: 2006 PWR/VVER average collective dose per reactor by country (man·Sv)



Note: No data reported for Ukraine in 2006

Figure 3: 2006 BWR average collective dose per reactor by country (man·Sv)

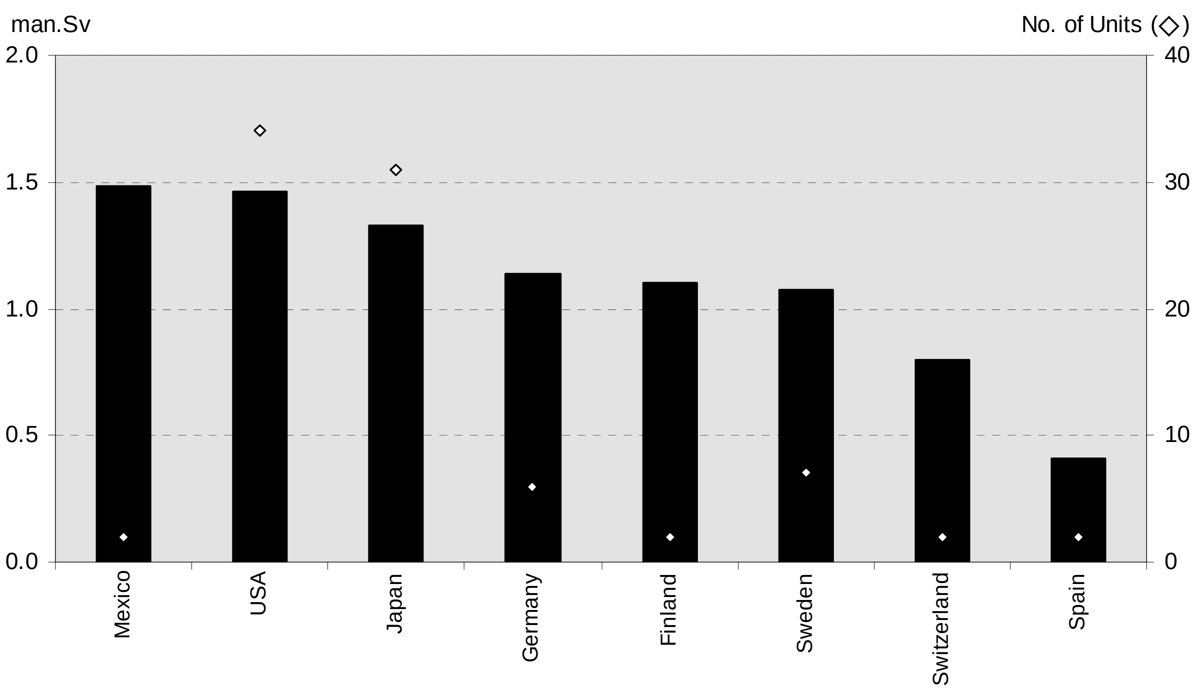


Figure 4: 2006 PHWR average collective dose per reactor by country (man·Sv)

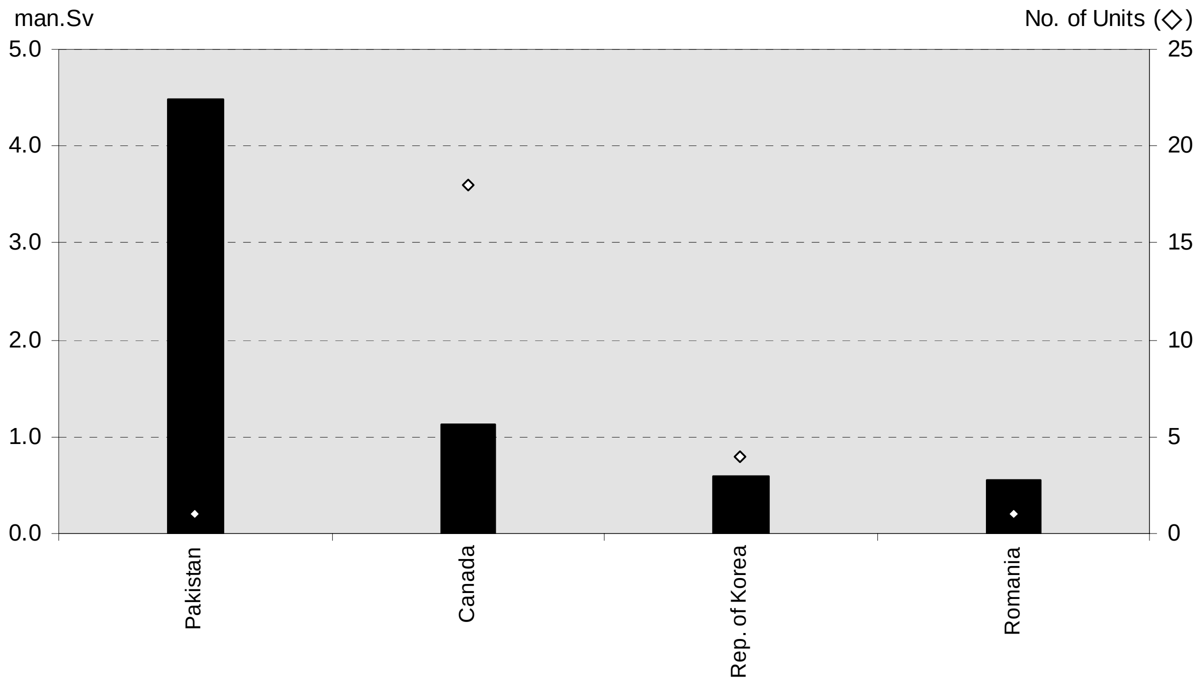


Figure 5: 2006 average collective dose per reactor type (man·Sv)

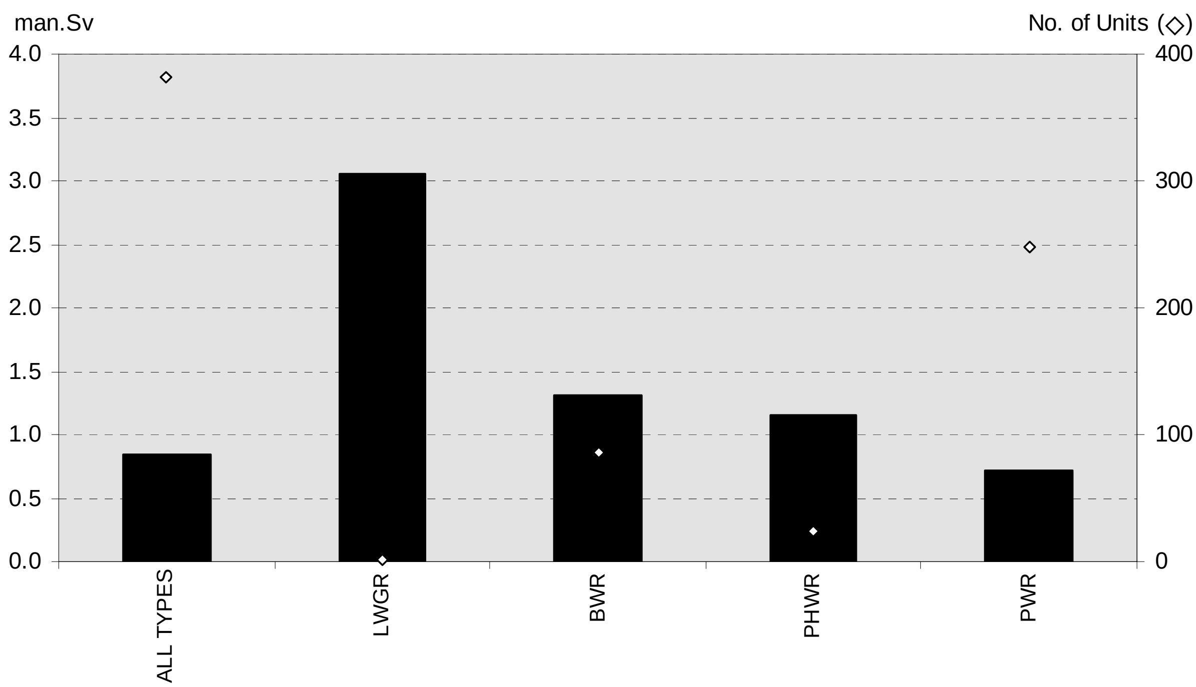


Figure 6: Average collective dose per reactor for all operating reactors included in ISOE by reactor type, 1992-2006 (man·Sv)

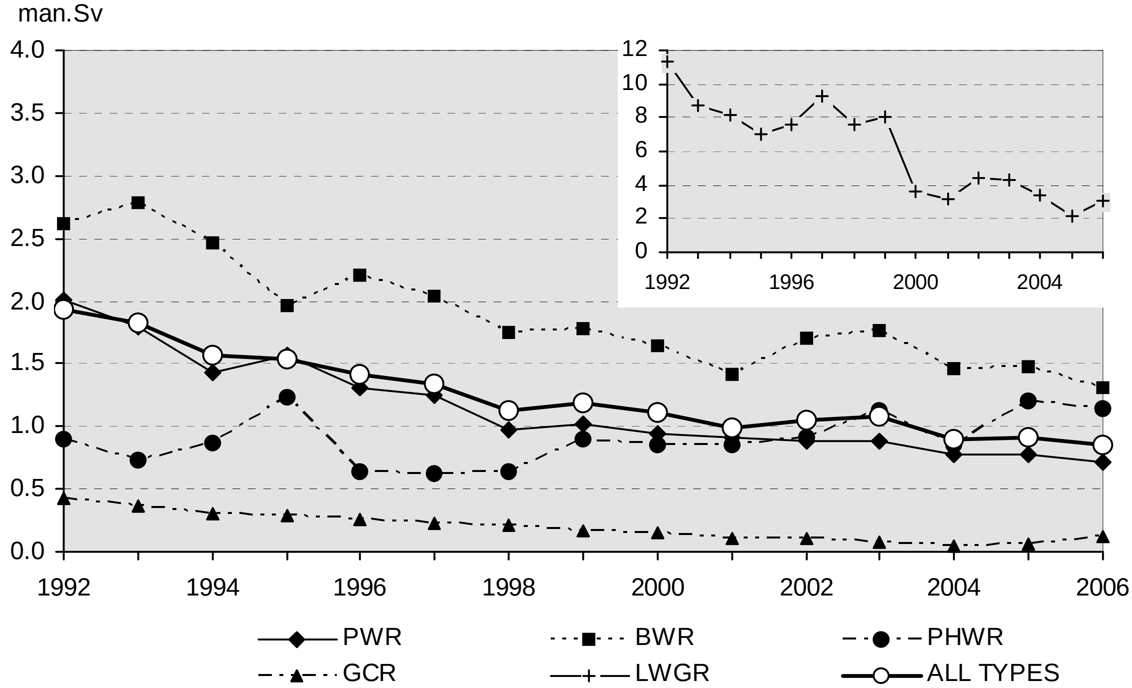
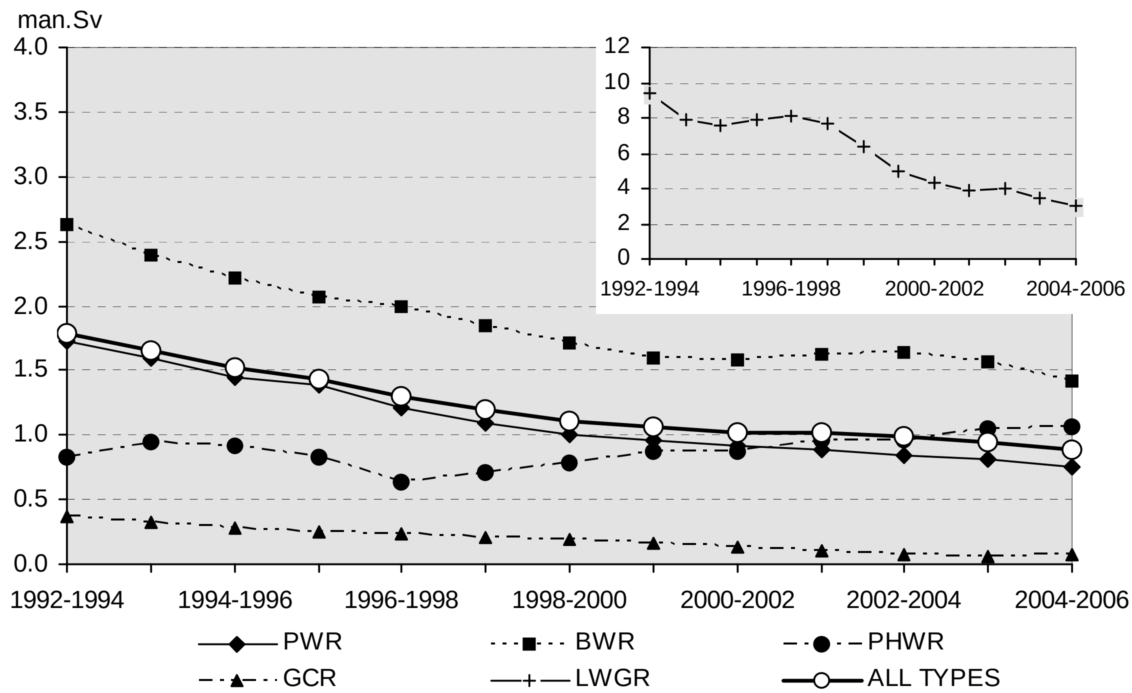


Figure 7: 3-year rolling average per reactor all operating reactors included in ISOE by reactor type, 1992-2006 (man·Sv)



Note: Inset chart shows average collective dose for LWGRs.

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

In addition to information from operating reactors, the ISOE database contains dose data from 80 reactors which are shut-down or in some stage of decommissioning. This section provides a summary of the dose trends for those reactors reporting during the 2004-2006 period. These reactor units are generally of different type and size, at different phases of their decommissioning programmes, and supply data at various levels of detail. For these reasons, and because these figures are based on a limited number of shutdown reactors, it is impossible to draw definitive conclusions. An initiative was launched in 2006 under the ISOE Working Group on Data Analysis to improve the data collection for shut-down and decommissioned reactors in order to facilitate better benchmarking.

Table 5 shows the average annual collective dose per unit by country and type of reactor for the years 2004-2006, based primarily on data reported and recorded in the ISOE database for this period, supplemented by the individual country reports (see Section 6) as required. Figures 8-11 summarise the average collective dose per reactor for shutdown reactors for the years 1993-2006 by type (PWR, BWR and GCR). In all figures, the “number of units” refers to the number of units for which data has been reported for the year in question.

Table 5: Number of shutdown units and average annual dose (man·mSv) per unit by country and reactor type for the years 2004-2006 for reporting reactors

	2004		2005		2006	
	No.	Dose	No.	Dose	No.	Dose
PWR						
France	1	5	1	6	1	6
Germany	2	213	3	175	3	174
Italy	1	90	1	31	1	10
United States	6	244	8	124		n/a
VVER						
Bulgaria	2	35	2	27	2	24
Germany [1]	5	36	5	37		n/a
Russian Fed.	2	178	2	232	2	126
BWR						
Germany	1	325	1	272	1	483
Italy	2	27	2	5.0	2	12
Sweden	1	64	2	63	2	52
The Netherlands	1	97	1	3	1	0.25
United States	4	175	5	160		n/a
GCR						
France	6	4	6	9	6	6
Germany	2	19	2	19		n/a
Italy	1	54	1	0	1	0.4
Japan	1	50	1	100	1	30
United Kingdom	10	38	14	56	14	60
LWGR						
Lithuania			1	364	1	352

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

Figure 8: Average collective dose per shutdown reactor: PWR/VVERs

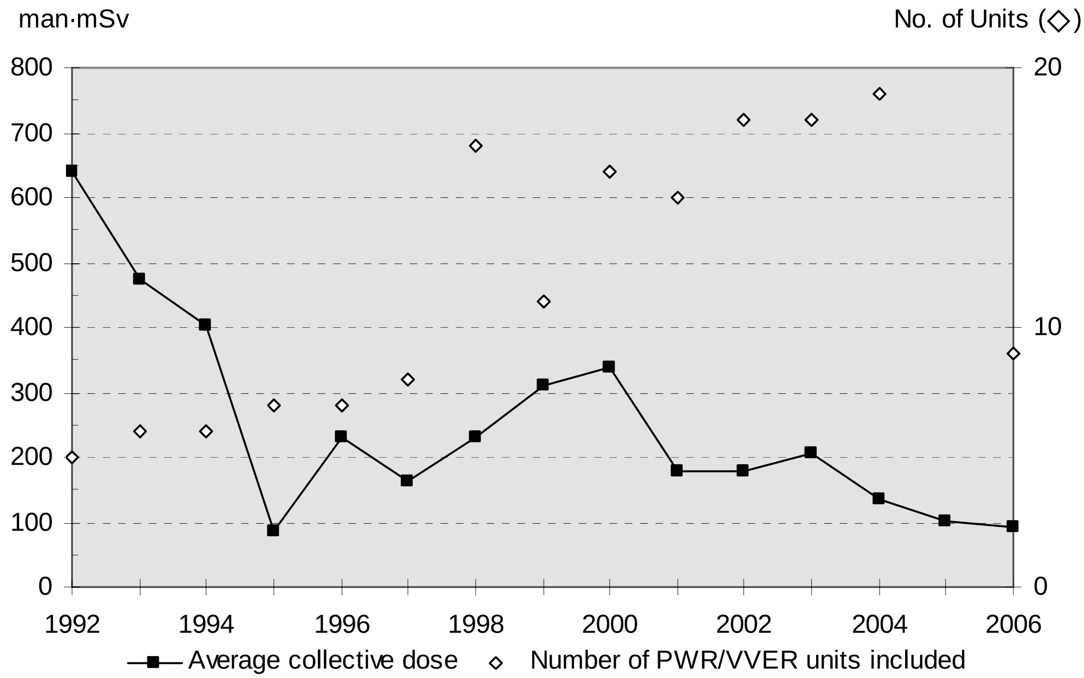


Figure 9: Average collective dose per shutdown reactor: BWRs

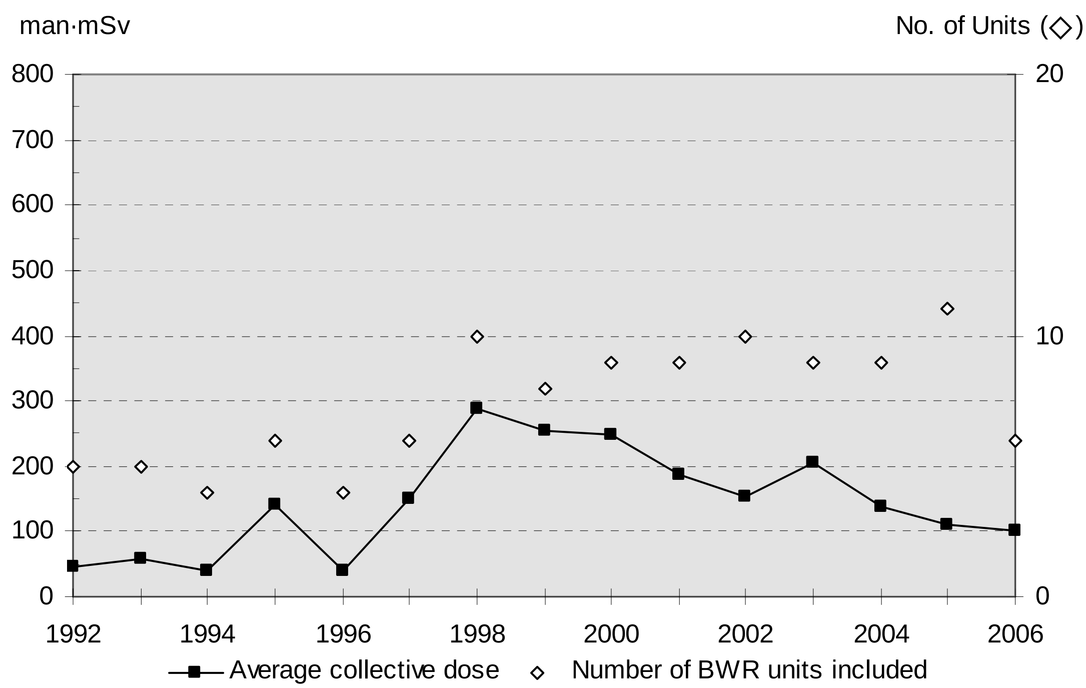


Figure 10: Average collective dose per shutdown reactor: GCRs

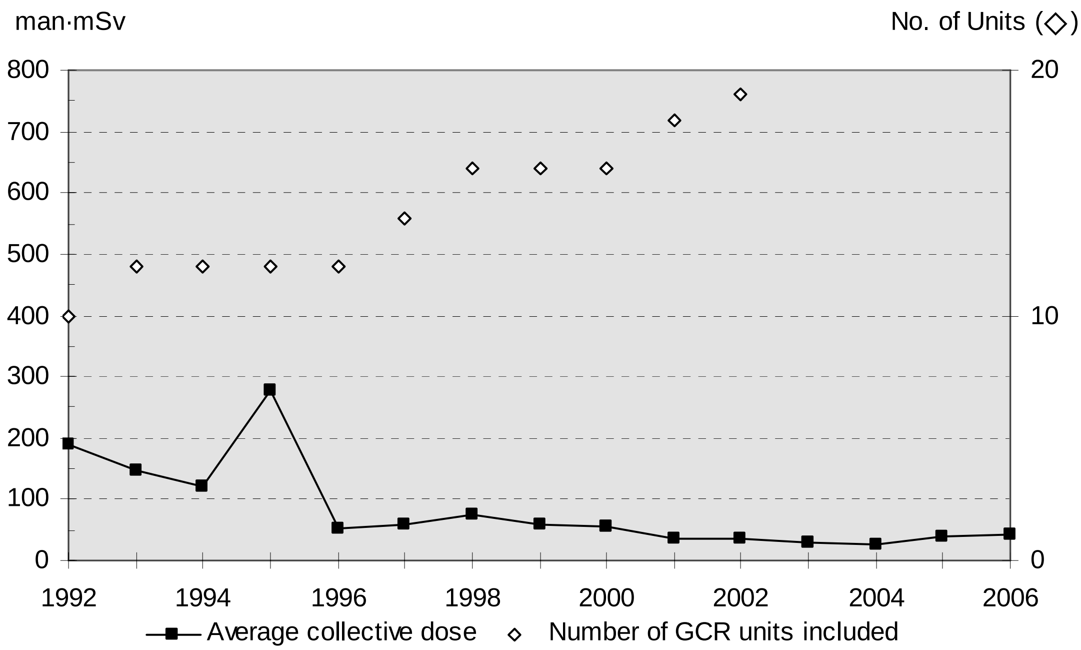
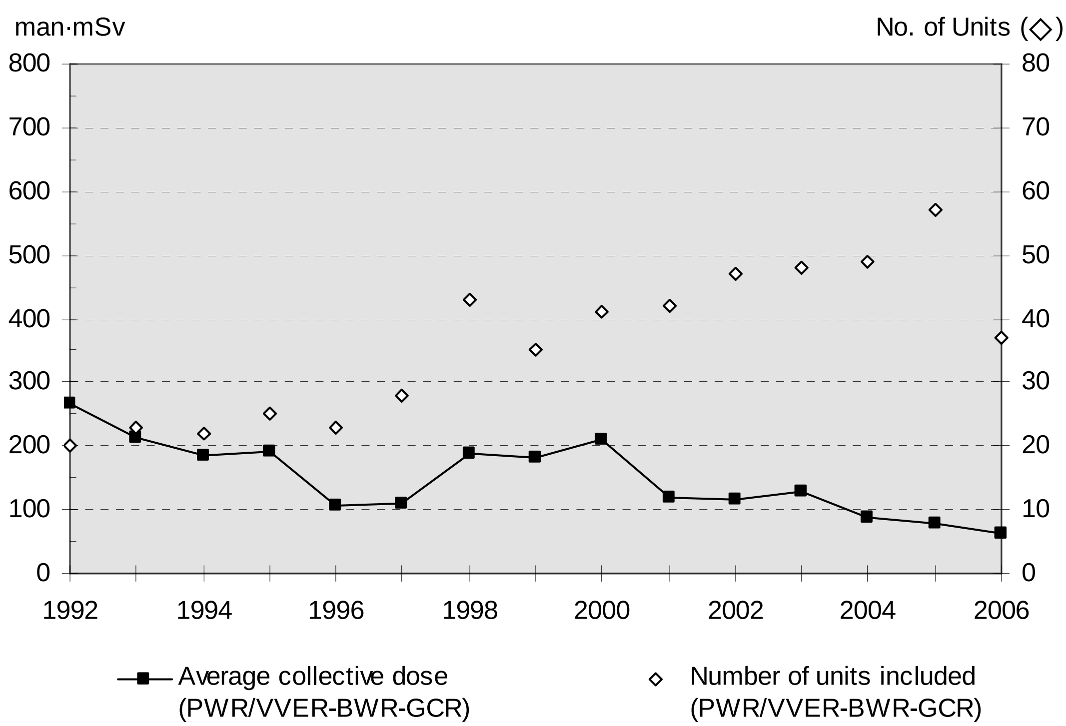


Figure 11: Average collective dose per shutdown reactor: PWR/VVER, BWR, GCR



3. ISOE BENCHMARKING VISITS

The ISOE programme has expanded into organising voluntary site benchmarking visits for dose reduction information exchange amongst the Participating utilities in the 4 technical centre regions. These visits may be organised at the request of a utility with the assistance of a technical centre(s), and included in programme of work for the coming year. The intent of such visits is to identify good radiation protection practices at the host plant in order to share such information directly with the visiting plant. While both the request for and hosting of such visits under ISOE are voluntary on the utilities and the technical centres, all post-visit reports are to be made available to the ISOE members (according to their status as utility or authority member) through the ISOE Network website in order to facilitate the broader distribution of this information to within ISOE. Highlights of visits conducted during 2006 are summarised below.

3.1. Benchmarking visits organised by ATC

ATC participated in a benchmarking visit to the USA organised by the Nuclear Safety Research Association in Japan. This involved visits to the USNRC as well as the Limerick, Susquehanna, Dresden and Cook NPPs. Information relevant to occupational exposure reduction in Japan was exchanged, and differences in ALARA approaches between USA and Japan were investigated, especially concerning the improvement work and inspection situation, as it is thought that the large amount of work during outages in Japan contributes to the increase of occupational exposure. The Nuclear Safety Research Association also arranged a visit to Finland and France to investigate ALARA activities in Europe. ATC requested co-operation in the benchmarking visit to Finland.

3.2 Benchmarking visits organised by ETC

The European Technical Centre performed three benchmarking visits in 2006: two in the USA at the Calvert Cliffs and Vogtle NPPs (October 2006) on remote monitoring systems and one in Switzerland at Beznau NPP (July 2006).

Remote Monitoring System at Calvert Cliffs NPP and Vogtle NPP

The Remote Monitoring System (RMS) allows the remote follow-up, generally outside the controlled area in the Central Monitoring Station (CMS), of worker exposure conditions. Characteristics of monitoring include:

- localisation and identification of the worker;
- type of work and data related to the estimated dose (in particular alarm threshold for collective dose, individual dose and dose rate);
- dose rate;
- exposure duration; and
- individual dose.

The flexibility of the system allows monitoring of trends over time of dose rate in any place, which tends to support a great number of applications, such as the follow-up of filter fouling factors or fuel element transfer. Moreover, data (measurements) generated by air contamination monitoring devices can also be transmitted and monitored in the CMS.

Remote monitoring of this information in the CMS provides an effective and proactive follow-up of exposed workers by a reduced number of persons. Health physicist (HP) technicians do not need to be physically present at the job site, leading to a decrease of their exposure and, possibly, of their number. However, when a CMS technician detects a gap (such as a fast increase of the dose rate, exceeding the estimated dose, air contamination, etc), the presence of HP technicians near the exposed personnel is essential. The CMS technicians can communicate by audio connection with the nearby HP technician(s) and the worker(s) concerned by the discrepancy.

The use of video to record specific tasks allows improved work preparation, improvement of technical gesture and movement, and training for specific equipment (particularly during the pre-job briefing). In addition, the central monitoring of information allows storage of the radiological characteristics of the whole work and facilitates dose estimation.

In terms of acceptance of this technology in the work environment, based on the Vogtle NPP experience, it appears that a progressive development of RMS can be suitably achieved through interaction and effective discussions with, and reliance on, working groups (according to specialty). Detailed attention has to be given to the process of acceptance of the RMS tool by the whole HP department. Additionally, an adequate balance should be found between the time spent by the HP technicians in the CMS room and at the work site. Most HP technicians at the Calvert Cliffs and Vogtle sites viewed RMS as a valuable tool for providing real time data.

The potential benefits of RMS technology extend beyond radiological protection purposes. Other departments could also have interest in RMS technology for training, work planning and monitoring of work performed.

Beznau NPP

A benchmarking visit to Beznau NPP (Switzerland) was undertaken to exchange information relating to the plant's organisation of radiation protection functions. Several operational factors contributing to Beznau's good dosimetric results were observed, including:

- Installation of new steam generators in 1993 and 1999, containing less nickel and cobalt than previous ones, and therefore less activation;
- optimisation of installation of biological shielding[1] during outages at the beginning of the 2000s;
- optimisation of chemistry of the primary circuit; and
- systematic monitoring and cleaning of contamination and hot spots;

In addition to these technical factors, several organisational factors contributing to the good results were also noted, specifically:

- stability of staff;
- collaboration and dialogue between radiation protection staff and other jobs;

1. Absorbing material placed around a radioactive source to reduce the radiation to a level safe for humans.

- good co-operation of all members of the ALARA team, of varying skills and from different departments.
- clear and minimal objectives, adapted to the different levels of hierarchy;
- motivation not based on remuneration; and
- integration of chemistry and radiation protection in the same department, which thus share the same objectives.

The whole site is remarkable for its cleanliness: cleaning is permanent, operators are obliged to clean their workstation at the end of their job, leaks are systematically repaired, and hot spots are rare. One of the consequences of this cleanliness is that no internal contamination has been detected for about 30 years.

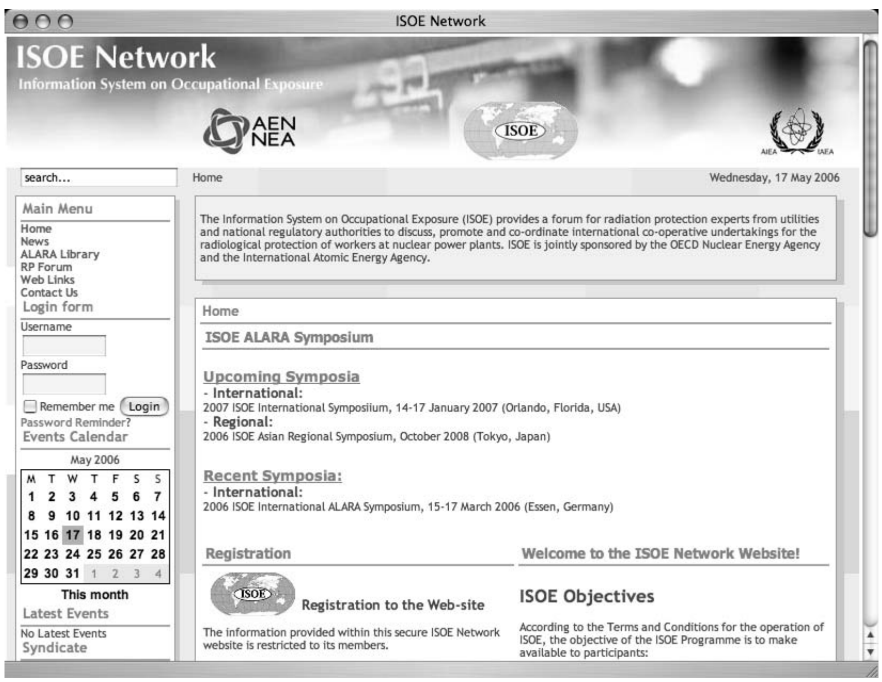
Detailed reports on the above visits are available to ISOE members through the ISOE Network.

4. THE ISOE NETWORK

While the ISOE programme is well known for its collection of occupational exposure management experience, data and analyses, the system's strength comes from the broad exchange of such information amongst participants. The exchange of radiation protection-related information between ISOE members is supported through the web-based ISOE Network.

The ISOE Network (www.isoe-network.net) is an international information exchange website on dose reduction and ALARA resources for ISOE members, providing rapid and integrated access to ISOE resources through a simple web browser interface. An enhanced version of the network was formally launched in 2006 with the objective to provide the ISOE membership with a "one-stop" web-based portal for ISOE information and experience exchange. The network, containing both public and members-only resources, provides ISOE members with access to a broad and growing range of ALARA resources, including ISOE publications, reports and symposia proceedings, web forums for real-time communications amongst participants, members address books, and online access to the ISOE occupational exposure database.

Figure 12: Homepage of the ISOE Network



4.1 Overview of the ISOE Network

Visitors to the ISOE Network homepage are presented with a summary of the latest information of relevance to the ISOE membership such as upcoming ISOE activities, recent ISOE international and regional ALARA symposia, and news from NEA and IAEA. The user will also see on the left-hand side of the homepage a navigation menu and a user login window. While some resources on the ISOE

Network are available to the public, such as ISOE official publications, only registered ISOE members have access to the detailed ISOE and ALARA resources available (such as the occupational exposure database and the user forums), which will only appear in the navigation menu after login. Members who have registered for website access can enter their username and password to access these additional resources, described in more detail below.

ALARA Library

The ALARA Library, one of the most used website features, provides ISOE members with a comprehensive catalogue of ISOE and ALARA resources to assist radiation protection professionals in the management of occupational exposures. The ALARA Library includes a broad range of general and technical publications, reports, presentations and proceedings, including:

- ISOE official publications, such as the ISOE Annual Reports;
- ISOE Newsletters;
- ISOE ALARA symposia proceedings, presentation and papers;
- ISOE site benchmarking visit reports on radiation protection practices;
- technical centre information sheets;
- ISOE technical reports (such as pressuriser replacements);
- ISOE meeting documents; and
- training resources.

The ALARA Library and website are linked to a search engine to assist the user in locating information of relevance to their specific issue or problem. The technical centres provide regular content for posting in the library. At the end of 2006, the ALARA Library provided on the order of 400 ISOE ALARA symposia papers, 100 technical ISOE reports and publications, 4 benchmarking visit reports, and 150 RP manager contacts.

ISOE occupational exposure database

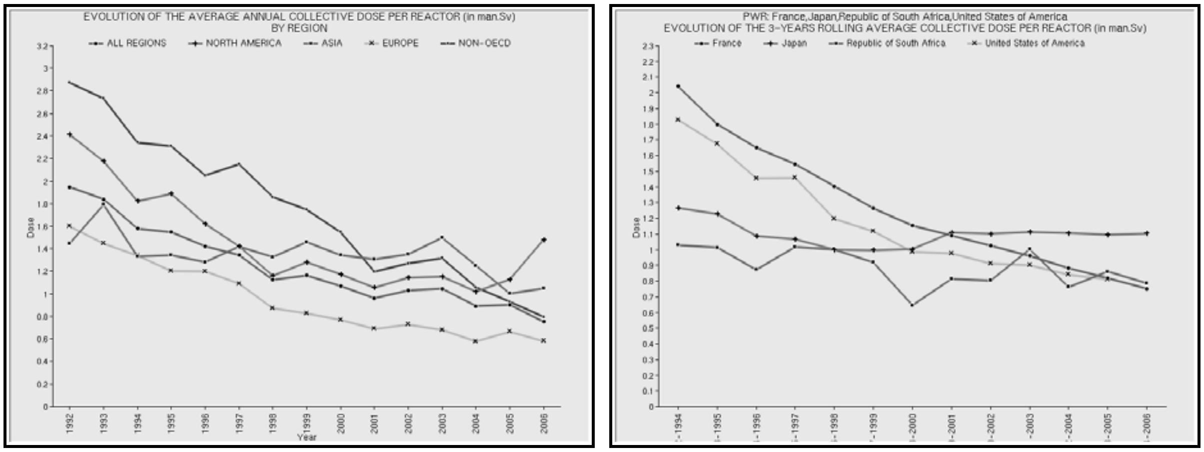
In order to increase user access to the occupational exposure data within ISOE, the ISOE occupational exposure database, previously only available on CD-ROM as an annual update, is now available to members through the ISOE Network. During 2005, the database statistical analysis module, known as MADRAS, was successfully migrated to the network, with resources and lead development by NEA and assistance from the European Technical Centre. Access to the MADRAS application requires only a web-browser and internet connection. Upon login, the user will be presented with a set of pre-defined data queries to assist in benchmarking studies and trend analysis (see Table 6). Major categories of pre-defined analyses include:

- benchmarking at unit level;
- average annual collective dose per reactor;
- annual total collective dose;
- annual collective dose per TWh;
- contribution of outside personnel and outages to total collective dose;
- evolution[1] of the number of reactor units;
- 3-year rolling average for collective dose per reactor; and
- miscellaneous queries.

Outputs from these analyses are presented in graphical and tabular format, and can be printed or saved locally by the user for further use or reference.

1. Trends or developments over time.

Figure 13: Sample database outputs available through the ISOE Network



An important improvement facilitated by the on-line database is the increased frequency of updates compared with the CD-ROM version of the database. Previously, database updates were available only annually to most users, after the completion of the annual data collection period. The web version is updated routinely during the data collection period as new data is submitted by the membership and incorporated by ETC (the website administrator). While the CD-ROM version of the ISODAT database will continue to be produced annually, the web-enabled MADRAS module now serves as the main data analyse application.

The ISOE programme is also moving to further enhance database use through the development of data input modules to allow on-line entry and submission of the ISOE data questionnaires. It is expected that this will be implemented and operational in the 2007-2008 timeframe.

RP Forum, Address Book and Web Links

While the ALARA Library presents a comprehensive resource for the user, if more specific information is needed, the user can also access the RP Forum to submit a specific question, comment or other information relating to occupational radiation protection that can be addressed by other users of the website. In addition to a common user group for all members, the forum contains a dedicated regulators group, common utilities group, and several utilities sub-groups organised by reactor type: PWR, BWR or CANDU. All questions and answers entered in the RP Forum are searchable using the website search engine, increasing the potential audience of any entered information.

To further strengthen linkages between ISOE members, the network also provides an ISOE Address Book so that members can contact each other directly to exchange information and experience. Finally, the ISOE Network provides links to the websites of the four ISOE Technical Centres, as well as the NEA and IAEA.

Access to the ISOE Network

While some of these resources are open to the public, such as ISOE official publications, access to most resources is restricted to ISOE members. All members are encouraged to contact their National Co-ordinators and the NEA Secretariat (Annexes 4, 6) in order to receive a user account and gain access to the ISOE Network resources. At the end of 2006, the ISOE Network had approximately 400 registered users from ISOE participating utilities, national authorities and international organisations.

Table 6: Types of data analysis queries available in the ISOE database

Benchmarking at Unit Level: • Annual collective dose: 1 unit vs. up to 4 other units • Annual collective dose: 1 unit vs. its sister unit group and up to 2 other sister unit groups • Annual collective dose: 1 unit vs. its sister unit group and its reactor type group • Collective dose/GWh: 1 unit vs. its sister unit group and its reactor type group • Collective dose per job: 1 unit vs. its sister unit group and up to 2 other sister unit groups • Dose per job: 1 unit (up to 4 jobs) • Collective dose/occupational category: 1 unit vs. its sister unit group and up to 2 other sister unit groups • Annual dose index: 1 unit vs. up to 4 other units • Collective dose per task for 1 unit • Number of units in sister unit groups • List of reactors by sister unit group
Average Annual Collective Dose Per Reactor: • Evolution of the average annual collective dose by country for 1 reactor type • Average annual collective dose per reactor by type and by country for 1 year • Average annual collective dose per reactor by type and by region for 1 year • Evolution of average annual collective dose per reactor by region • Evolution of average annual collective dose per reactor by reactor type • Evolution of average annual collective dose per reactor by reactor type for 1 region
Annual Total Collective Dose: • Evolution of cumulated annual collective dose by region • Evolution of total annual collective dose and number of operating reactors • Evolution of total annual collective dose by region • Evolution of total annual collective dose by reactor type • Breakdown of total collective dose by region for 1 year • Breakdown of total collective dose by reactor type for 1 year
Annual Collective Dose per TWh: • Annual collective dose per TWh by reactor type and by region for 1 year • Evolution of the gross production by region for 1 reactor type • Evolution of average annual collective dose per TWh by region • Evolution of average annual collective dose per TWh by reactor type
Contribution of Outside Personnel and Outages to Total Collective Dose: • Contribution of outside personnel to total collective dose by country and reactor type • Contribution of outages to total collective dose for 1 reactor type
Evolution of the Number of Reactor Units: • Characteristics of operating reactors during a specific year • Evolution of the total number of operating reactors by region • Evolution of the total number of operating reactors by reactor type • Characteristics of reactors definitively shutdown, as of a specific year
3-Years Rolling Average Collective Dose Per Reactor: • Evolution of the 3-years rolling average collective dose by country for 1 reactor type
Miscellaneous: • Evolution of the ratio (outside personnel collective dose / total annual collective dose) for 1 plant unit • Evolution of the ratio (outside personnel collective dose / total outage collective dose) for 1 plant unit • Evolution of the dose rates on cold leg of primary piping for a plant unit • Evolution of the dose rates on hot leg of primary piping for a plant unit • Evolution of the BWR dose rates for a plant unit • Evolution of outage dose vs. outage duration for a plant unit • Evolution of the collective dose for 1 plant unit vs. average collective dose for some countries • Evolution of the collective dose vs. operational plant units for 1 country • Evolution of the average collective dose per reactor by reactor type for some countries

5. SUMMARY OF ISOE PROGRAMME ACHIEVEMENTS FOR 2006

In 2006, the ISOE programme continued to focus on the collection and analysis of occupational exposure data and on the effective exchange of operational radiation protection information and experience. The programme also specifically addressed the issues of improved information exchange and strategic programme direction, including enhanced inter-regional co-operation and co-ordination. This was facilitated through a direct survey of end users and the ongoing migration of technical resources to the ISOE Network website. These initiatives have helped position the ISOE programme to better address the operational needs of its end users (radiation protection professionals) in the area of occupational radiation protection and ALARA practices at nuclear power plants.

5.1 Management of the official ISOE databases

Official database release: ETC continued to manage the official ISOE occupational exposure database (ISOEDAT). The first release of the 2005 database with data from 1969 to 2005 (partial) was made available in June 2006 simultaneously through the ISOE Network (to all members), and via the secure ETC FTP server (to European Utilities and other technical centres for distribution). Since then, regular updates were made on the Network and FTP server. The end-of-year release of the 2005 database and ISOE software on CD-ROM was provided to all participants following the November 2006 annual ISOE Steering Group meeting. Concerning the collection of 2006 data, the first data was received in February 2007 (the earliest that data has been submitted). While the official deadline for submission of data is four months after the end of the annual collection period, the majority of data was received from the participants by June 2007.

Development of ISOEDAT online: The ISOEDAT Web Working Group, with resources and lead development by NEA and assistance from ETC, developed the web-enabled MADRAS statistical analysis and interface modules as part of the ISOEDAT web migration project (Phase 1). At the end of this development phase, ETC performed extensive verification and validation testing, including verification against the Microsoft ACCESS version. In 2006, following the successful completion of these tests, the web-enabled MADRAS module was implemented on the ISOE Network as a Member's only resource. Development of data input modules (Phase 2) began in 2006 with the assistance of the Korean Institute for Nuclear Safety (KINS).

Use of the ISOE 3 reporting system: The use of the ISOE 3 reporting system continued to be low throughout 2006. At its 2006 annual meeting, the Steering Group agreed to strategically address the objective of the ISOE 3 reporting system through better use the ISOE Network. The focus will be on enhancing the exchange of radiation protection information and experience through the effective use of the ISOE Network resources.

5.2 ISOE publications and reports

The ISOE programme continued to disseminate data and information through a variety of publications throughout 2006. The following ISOE publications and reports were produced and published in 2006. All products are available through the ISOE network as appropriate.

- **ISOE Annual Report 2005:** The 15th Annual Report was prepared for publication and distribution following approval by the Steering Group in 2006.
- **ISOE News:** One issue of the ISOE News (March 2006), summarising information from within the ISOE family was prepared and distributed during 2006 to promote ISOE at utilities and regulatory authorities.
- **Symposia proceedings:** In lieu of a formal printed publication, all presentations and papers from the 2006 ISOE International ALARA Symposium in Essen, Germany were made available to ISOE Members through the ISOE Network.
- **Benchmark visit reports:** Following the great interest of the utilities concerning the Sizewell B Benchmarking Report, ETC requested authorisation from the other visited plants in Europe (Ringhals, Doel, Almaraz) to make available the corresponding visit reports on the ISOE Network website.
- **ISOE user survey:** A high level summary of the ISOE user survey was made available to the ISOE membership through the ISOE Network.
- **Contribution to the draft UNSCEAR Report:** ISOE contributed a summary of occupational exposure data for the latest draft UNSCEAR Report on Occupational Exposure.

5.3 Information sheets, technical reports and information exchange

Technical centre information sheets: During 2006 several new information sheets were issued, as listed below. All of these can be found on the ISOE Network website. A complete list of information sheets is provided in Annex 2.

Table 7: Summary of technical centre information sheets from 2006

Yearly analyses	**Centre**	**Number**
Japanese dosimetric results: FY 2005 data and trends	ATC	ATC-29
Preliminary European dosimetric results for 2005	ETC	ETC-44
US BWR ; PWR outage duration and dose trends per unit; CANDUs maintenance outage	NATC	NATC 2006/01, 2006/02, 2006/03
3 years rolling average dose (PWR, BWR and CANDUs)	NATC	NATC 2006/ 04-06
Special analyses		
Conclusions and recommendations from the Essen Symposium	ETC	ETC-43

Information Exchange Activities:

In 2006, there was a decrease in the number of the requests for information exchange received through the technical centres, being largely replaced by the use of the RP Forum system on ISOE Network (mainly between European participants). Specific requests to the centres included:

- ATC: A request from the Kansai Electric Power Co., Inc. about reactor vessel head replacement.
- ETC: A request from Ringhals NPP (Sweden) on using lead aprons in radiation fields near Co-60 sources was sent to the ISOE Network. A synthesis of the answers was prepared and will be made available in an information sheet restricted to Participating utilities.
- IAEA-TC: Presentation of ISOE (organisation, objectives, products) during the:
  - Regional Co-ordination Meeting for Developing Technical Capabilities for the Protection of Health and Safety of Workers Exposed to Ionising Radiation (Bangkok, Thailand, Feb 2006);

– Regional Co-ordination meeting on "Increasing Worker Awareness and Involvement in RP Programmes" (Islamabad, Pakistan, April 2006).

New technical centre documents and reports:

ATC prepared a draft "ISOE handbook" describing the ISOE organisation, dose trends analysis, and worldwide ALARA regulations to promote the ISOE programme among Japanese Utilities.

5.4 ISOE ALARA Symposium (international and regional)

Direct interaction remains an important component of information exchange within the ISOE programme, as demonstrated by the international and regional ISOE 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 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 is 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. Presentations and outcomes of the symposia are available through the ISOE Network.

International symposia

The 2006 ISOE International ALARA Symposium was held in March 2006 in Essen, Germany. Co-organised by the European Technical Centre and VGB Powertech, the symposium gave the opportunity for 150 participants from 23 countries in Europe, North America and Asia to meet and discuss topics of common interest. Reports on several major maintenance and modification works that have been performed for the first time were presented (for example, the first pressuriser replacement in the US). The lessons learned from other studies, particularly from in depth analysis or from ergonomic studies on insulation works or non destructive testing, clearly showed once again that actions to reduce doses cannot be restricted to technical actions: work management, human resources and stakeholder involvement are also major factors. Participants also had the opportunity to work in small groups on topics of relevance to the needs of plant health physicists, such as the use of dose constraints as an operational management tool, the use of outside workers, and loss of competencies. To encourage regional information and experience exchange, three distinguished technical presentations were invited to the 2007 ISOE International Symposium (USA, 2007).

Three meetings devoted to specific audiences were organised prior to the symposium, namely:

- Senior Regulatory Body representatives meeting;
- Radiation Protection Managers meeting; and
- research reactor European ALARA sub-network participants meeting (first time participation in the ISOE Symposium).

The regulatory body meeting was structured around a survey from CSN (Spanish regulator) on the organisation and practices of national regulatory bodies, particularly concerning operational radiation protection inspections in NPPs (summary available on the ISOE Network). The radiation protection managers meeting noted that feedback exchange systems work well inside expert groups in each world region or sub-region, but that inter-regional exchange needs improving.

Regional symposia

The Second ISOE Asian ALARA Symposium took place in Yuzawa, Japan in October 2006 with the involvement of about 40 participants. The Symposium was organised by the ATC, and sponsored by NEA and IAEA. Such symposia will be held every year to encourage continued information exchange and communication.

The 2006 ISOE North American ALARA Symposium, sponsored by the NATC, NEA and IAEA, was held in January 2006 in Orlando, USA with the participation of about 110 representatives from 6 countries. The Symposium theme was "Successes in Reducing Occupational Exposures at Nuclear Power Plants". The Symposium was followed by meetings of US NRC Regions 1, 2 and 3 and the PWR ALARA committee.

5.5 ISOE-organised benchmarking visits

As noted in Section 3, the ISOE programme has expanded into organising voluntary site benchmarking visits for dose reduction information exchange among the 4 technical centre regions. Following the June 2006 meeting of the WGDA and ISOE Bureau, a proposal was prepared for Steering Group consideration on the co-ordination of ISOE benchmarking visit activities, and the sharing of follow-up reports amongst the ISOE membership, with the objective of providing, as much as possible, the output from these visits to ISOE members. The ISOE Steering Group approved the proposal in November 2006.

5.6 ISOE Network website management

Network website management

Following direction of the Steering Group in 2005, the new ISOE network was formally launched in early 2006 with both an open and Members-only areas, including the Phase 1 migration of the ISOE database to the web (MADRAS on-line). The ISOE Network was developed by ETC and NEA, and is managed by ETC. The Network has been promoted through various means including the ISOE Newsletter, symposia, user survey and National Co-ordinators.

All National Co-ordinators were requested during 2006 to provide to the NEA Secretariat information on local ISOE members (name, organisation and email) in order to set up user accounts. User login information was made available to all registered users through automatic password retrieval from the NEA website (link provided on the ISOE Network). Feedback on the Network was requested of all members with notification of their new accounts, and solicited as part of the ISOE User Survey. As of end of 2006, about 400 individuals from ISOE utilities and regulatory authorities had been set up with usernames and passwords.

5.7 ISOE management and programme activities

As part of the overall operations of the ISOE programme, ongoing technical and management meetings were held throughout 2006, including:

- 2006 Mid-year meetings (20-24 June 2006)
  - Working Group on Data Analysis
  - 1st Technical Centre Co-ordination meeting
  - ISOE Bureau
- 2006 ISOE Annual Session (6-10 November 2006)
  - ISOE Bureau
  - 2nd Technical Centre Co-ordination meeting
  - Working Group on Data Analysis
  - 1st National Co-ordinators meeting
  - 16th ISOE Steering Group meeting
- Ad-hoc meetings
  - Working Group on Strategic Planning
  - WGDA ISOEDAT Web Working Group

ISOE Steering Group

The ISOE Steering Group continued to focus on the management of the ISOE programme, reviewing the progress of the programme in 2006, approving the Programme of Work for 2007, and providing input into the development of new ISOE Terms and Conditions, which will come into effect on 1 January 2008.

ISOE Working Group on Data Analysis

The ISOE Working Group on Data Analysis (WGDA) reinstated a cycle of semi-annual meetings to more proactively develop technical products of use to the ISOE membership. The WGDA defined a series of short and medium term tasks focussing largely on the integrity and consistency of the ISOE database and dataset, and extracting useful analyses from the existing data.

ISOE Working Group on Strategic Planning

The ISOE Working Group on Strategic Planning (WGSP) completed its investigation of strategic issues and options for the ISOE programme, and development of recommendations for the renewal of the ISOE Terms and Conditions at the end of 2007. An important feature of the work during 2006 was the conduct and analysis of a survey directed at the ISOE end user, in order to better characterise their needs with regards to the ISOE programme. The results provided input into the development of WGSP proposals for improvements to ISOE activities and products, communications, organisation and renewed Terms and Conditions. The work of this group as successfully completed with the delivery of its report to the Steering Group in November 2006.

Meeting of technical centres and National Co-ordinators

In order to improve the co-ordination between the technical centres, harmonise practices and solve technical problems, the 1st Technical Centre Co-ordination Meeting was held to look at co-ordination issues, and to undertake preliminary analysis of the ISOE user survey. It was agreed that these meetings should be held regularly to improve co-ordination between centres.

The 1st Meeting of the ISOE National Co-ordinators was held in conjunction with the November 2006 Steering Group meeting to provide a forum for the National Co-ordinators to discuss their role and exchange ideas on how best to fulfil their responsibilities.

6. PRINCIPAL EVENTS OF 2006 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 2006. 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 2006 and which may have influenced the occupational exposure trends. These are presented as reported by the individual countries.[1]

ARMENIA

Principal events

Summary of national dosimetric trends

For the year 2006 the dosimetric trends at the Armenian NPP have slightly increased for collective dose, which is conditioned by works related to the reactor neutron fluency detector changing during the outages.

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

Years	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Collective dose	4.18	3.46	3.41	1.51	1.57	0.96	0.66	0.95	0.86	1.08	0.82	0.85

The contractors collective dose is 0.02 man·Sv.

Events influencing dosimetric trends

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

1. Due to various national reporting approaches, dose units used by each country have not been standardised.

Number and duration of outages

One outage (47 days). Maintenance and repairing works in safety systems (in-service inspections, etc) were performed. The planned exposure doses were agreed with the regulatory body. The planned collective dose before outage was 0.92 man·Sv. The real collective dose during the outage was 0.65 man·Sv. Distribution of dose within different department of ANPP was follows:

- for the repair works: 58%;
- for the decontamination work: 12.6%;
- for the works for non destructive testing: 8.38%.

Issues of concern in 2007

Some activities related to the management of medium level radioactive wastes in 2007 are foreseen which can impact on general dosimetric trends.

Regulatory plans

To review the licensing and inspection programmes, especially related to the water-chemical regime and water purification systems of ANPP.

BELGIUM

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
PWR	7	0.39

Principal events

Summary of national dosimetric trends

Collective doses for the year 2006 (man·mSv)

Tihange NPP	**Tihange 1**	**Tihange 2**	**Tihange 3**	**Total**
Plant Personnel	22.7	130.8	69.6	223.1
Contractor's Personnel	50.3	522.8	576.1	1149.2
Total	**73.0**	**653.6**	**645.7**	**1372.3**
Doel NPP	**Doel 1 + 2**	**Doel 3**	**Doel 4**	**Total**
Plant Personnel	83.7	119.5	49.2	278.9
Contractor's Personnel	374.2	486.3	233.3	1129.1
Total	**457.9**	**605.8**	**282.5**	**1408.0**

Collective doses at Tihange are decreasing compared to 2005. There were 2 outages in 2006 (Tihange 2 and 3) as in 2005 (Tihange 1 and 2). The 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 Doel and Tihange is due to outages. The collective dose for the waste treatment in Doel was 61.7 man·Sv for 2006.

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	No outage	–	–
Tihange 2	Outage duration: 48 days, No exceptional work	1273	559.8
Tihange 3	Outage duration: 46 days, No exceptional work	1241	585.5
Doel 1	Outage duration 25 days, inspection reactor penetrations and steam generator primary	900	159.46
Doel 2	Outage duration 30 days, baffle bolts and rotor primary pump	891	258.09
Doel 3	Outage duration 43 days, splitpins and inspection 2 steam generators primary	866	555
Doel 4	Outage duration 44 days, changing thimbles and great maintenance flux plotting machine	1107	250

Technical plans for major work in 2007

- Tihange 1 / 3: Normal outage: Tihange 2: No outage
- Doel 1 / 2 / 3 : Normal outage: Doel 4 : No outage (first fuel cycle of 1.5 year)

BRAZIL

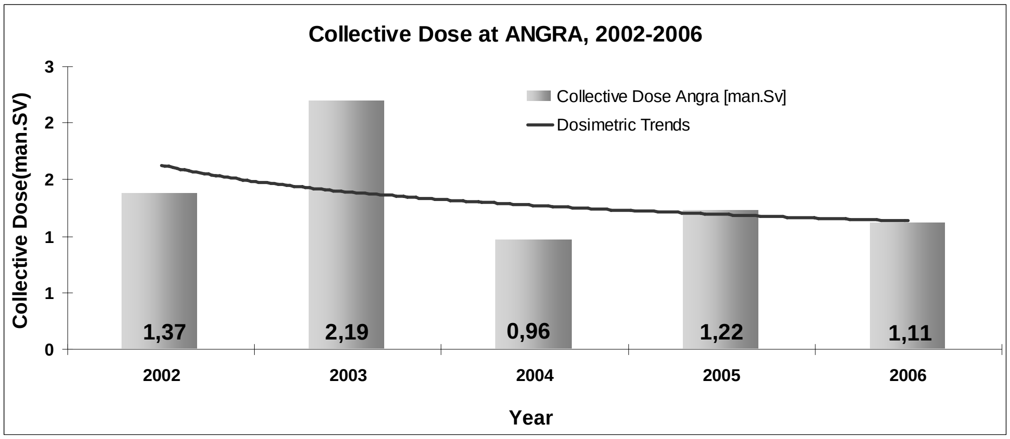
Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
PWR	2	0.555

Principal events

Summary of national dosimetric trends

The total collective dose at Angra in 2006 was 1.11 man·Sv (Unit 1: 0.94 man·Sv, Unit 2: 0.17 man·Sv). The total number of exposed radiation workers was 3 069 (Unit 1: 1 572, Unit 2: 1 497).



The collective dose was reduced in comparison to the preceding year. The main reasons for the collective dose reduction were: extensive use of temporary shielding and mobile shielding structures, the good performance of the forced oxidisation, zinc addition into the primary coolant system, and the better practices presented by the workforce.

Events influencing dosimetric trends

The main contributions to the collective dose (CD) at Angra were two planned refuelling outages and one forced outage. The highest radiation risk activities were replacement of the core fuel assemblies (fuel handling) and steam generator eddy current inspections.

Number and duration of outages

- 1P13a: 17 days (forced outage for turbine special maintenance).
- 1P14: 46 days (standard maintenance outage with refuelling).
- 2P4: 66 days (forced outage started on December 2005, and continued with a standard maintenance outage with refuelling).

Component or system replacements

- Replacement of the engine of Turbine LP#1 (Unit 1).
- Replacement of the main transformer (Unit 2).

Unexpected events

Replacement of the main transformer due to damages caused by explosion of gases generated inside the transformer.

New/experimental dose-reduction programmes

Increase of shielding use and ALARA considerations for "Rad Math", meaning the improvement of low dose rate reduction over traffic areas in order to reduce the collective dose produced by a low dose rate to a large workforce.

Organisational evolution:

- Angra 2 WANO peer review mission; WANO corporate peer review mission.

Issues of concern in 2007

- Special steam generator maintenance outage P14a (Unit 1).
- Refuelling outage 15th cycle (Unit 1).
- Refuelling outage 5th cycle (Unit 2).
- Preparations for steam generator replacement – planned for 2008.

Technical plans for major work in 2007

- Improve training for personnel in human performance area.
- Perform self-evaluation of the radiological protection organisation.
- Perform self-evaluation for the radiological protection supervisors' performance.
- Angra 1 WANO peer review mission.
- Preparation to introduce remote monitoring technology resources, by combining use of teledosimetry, video and camera monitoring and well trained supervisors.

Regulatory plans for major work in 2007

- Prepare a radiological protection plan for Angra 1 steam generator replacement project.
- Angra 3 licensing and restart of erection process.
- Completion of Unit 2 of radioactive waste management centre.
- Construction of the 3rd unit of the radioactive waste management centre.

BULGARIA

Dose information

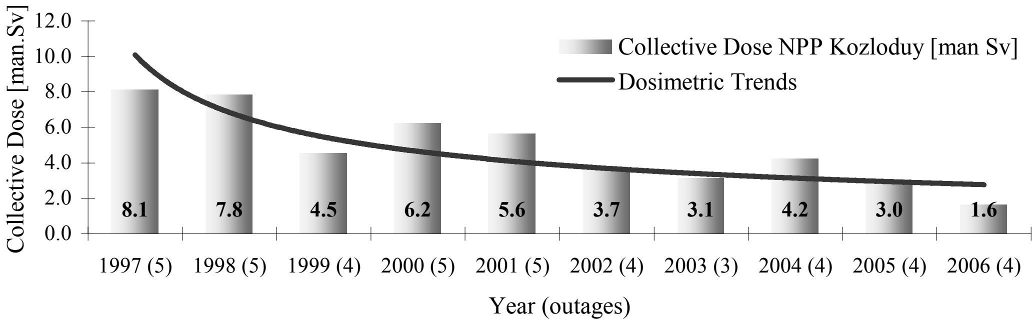
Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
VVER-440	2	0.308
VVER-1000	2	0.492
Reactors in cold shutdown or in decommissioning		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
VVER-440	2	0.024

Principal events

Summary of national dosimetric trends

The total collective dose at NPP Kozloduy in 2006 was 1.648 man·Sv (1.113 man·Sv for utility employees; 0.535 man·Sv for contractors' employees). The average individual effective dose was 0.45 mSv, and the maximum individual effective dose was 13.02 mSv.

Collective Dose at NPP Kozloduy, 1997-2006



Number and duration of outages

Unit No.	Outage information	Number of outages
Unit 3	43	for refuelling and maintenance
Unit 4	24	for refuelling and maintenance
Unit 5	76	for refuelling, maintenance and modernisation
Unit 6	79	for refuelling and maintenance and modernisation

Safety-related issues: one

Unexpected events: one

Organisational evolutions: Reduction of the plant personnel by ≈ 15 %

Issues of concern in 2007

- Completely new organisational structure for units 1, 2; economically independent from units 3, 4. Cold shutdown of units 3 and 4

Technical plans for major work in 2007: ***Some dismantling works on units 1, 2***

CANADA

Dose information

- 20,200 person·mSv for 18 units in 2006
- Average annual dose per unit = 1.121 person·Sv
- Higher doses due to major maintenance outage on operating units and unit refurbishments on unit under administrative shutdown

Dose Data (2006): Ontario Power Generation

	Pickering A (1-4)	Pickering B (5-8)	Darlington (1-4)
Total (W.B) dose (p-mSv)	2 824	4 840	3 200
Internal Dose (W.B) (p-mSv)	580	1 050	380
Maintenance (Planned & Forced Outages), Tot. WB dose (p-mSv)	2 254	3 602	2 820
Individual dose distributions	**Pickering (A&B)**		**Darlington**
# individuals (0-5.00 mSv)	7 345		4 636
# individuals (5.01-10.00 mSv)	368		153
# individuals (10.00-15.01 mSv)	48		18
# individuals (15.01-20.00 mSv)	11		0
# individuals (> 20.00 mSv)	0		0
Number of people badged	7 772		4 807
Number of people exposed	1 436		2 557

Dose Data (2006): Bruce Power, Gentilly-2, Point Lepreau

	Bruce A (1-4)	Bruce B (5-8)	Gentilly-2	Point Lepreau
Total (W.B) dose (p-mSv)	3 355.62	3 804.08	1 276.41	900.8
Internal Dose (W.B) (p-mSv)	662.94	277.22		155.8
Maintenance (Planned & Forced Outages), Tot. WB dose (p-mSv)				745.0
Individual dose distributions;	**Bruce (A&B)**			
# individuals (0-5.00 mSv)	2 274		569	773
# individuals (5.01-10.00 mSv)	479		79	23
# individuals (10.00-15.01 mSv)	53		7	5
# individuals (15.01-20.00 mSv)	0		0	0
# individuals (> 20.00 mSv)				
Number of people badged	5 142		1 800	
Number of people exposed	2 787		655	801

Events influencing dosimetric trends:

The following is a summary of dose performance by site. At Pickering-A (unit 1-4), Year end dose performance was better than target (70.6 rem/unit actual versus 83.8 rem/unit target): Unit 4 P641 outage dose performance was significantly below target mainly due to good RP practices and low tritium concentration in the vaults and moderator room as a result of better damper settings and improved dryer performance.

At Pickering-B (unit 5-8), Year-end dose was better than target (121.0 p-rem/unit actual versus 151.0 p-rem/unit target): The P671 outage dose is better than target due to reduced radiation fields in/around the Boilers (5x less compared to P681), RB fields lower, and Boiler Tube plugging was removed from scope. Reduced fields were attributed to implementation of 0.45 micron filtration in previous outage, and passing LRV purging balance header.

At Darlington (unit 1-4), Year end performance was better than target (80.0 p- rem/units actual versus 87.0 p-rem/unit target): D611 started on October 25 and was returned to service as planned. Significant dose savings have been achieved on a number of D631 jobs due to use of shielding and other ALARA measures in work planning and execution. Lower dose rates during D611 boiler inspections were attributed both to Siva Blasting and implementation of 0.1 micron filtration in 2004. Additional dose savings arose because no tube plugging was required, and Eddy Current Testing equipment performance was excellent.

At Point Lepreau, the annual maintenance outage lasted 40 days and included feeder inspections (160 mSv), replacement of two feeders (110 mSv) and boiler tube inspections (100 mSv). Improvements in techniques and equipment for performing feeder inspections resulted in significant dose reduction from previous years.

CHINA

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
PWR	5	0.486

Principal events

Summary of national dosimetric trends

For Daya Bay NPP, the annual collective dose for 2006 is 1197.1 man·mSv. For Lingao NPP, the annual collective dose for 2006 is 721.0 man·mSv. For Qinshan 1 NPP, the annual collective dose for the year 2006 is 512.22 man·mSv, or 0.206 man·Sv /TWh.

Unit	Duration	Collective dose (man·mSv)	Remark
Daya Bay unit 1	11th refuelling outage: 9 Mar. 2006 to 12 May 2006. Total: 65 days	1 052.6	
Lingao unit 1	4th refuelling outage: 27 Jan. 27 2006 to 28 Feb 2006. Total: 33 days.	385.3	
Lingao unit 2	3rd refuelling outage: 17 Dec. 2005 to 21 Jan 2006. Total: 36 days.	500.6	Collective dose: 200.8 man·mSv
	4th refuelling outage: 28 Dec. 2006 to 29 Jan. 2007. Total: 33 days.	584.3	Collective dose: 37.2 man·mSv
Qinshan 1	9th refuelling outage: 19 June 2006 to 17 July 2006. Total 29 days	478.9	

Events influencing dosimetric trends

For Daya Bay NPP, there was a long refuelling outage during 2006. The 9th refuelling outage duration in Qinshan 1 NPP was 29 days, the shortest one in the history of Qinshan 1 NPP.

Technical plans for major work in 2007

For Qinshan 1 NPP, the 10th refuelling outage will be performed in 2007, and the RPVH will be replaced.

CZECH REPUBLIC

There are 6 VVER type reactors at Czech Republic operated by Czech Power Company ČEZ, a.s. Four units (VVER 440 MWe model 213) are at Dukovany site. Two units VVER 1000 (MWe model V320) are in commercial operation at Temelín site since October 2004.

Summary of national dosimetric trends

Plant and units	CED per plant [Sv]	CED per unit [Sv]
Dukovany 1-4	0.610	0.153
Temelín 1-2	0.242	0.121
Total	0.852	0.142

Events influencing dosimetric trends

The main contributions to the collective dose at both NPPs were planned outages. There were no unusual, extraordinary radiation or other events influencing dosimetric trends in 2006 at either Dukovany or Temelín NPPs. The most radiation risk activities were related to removal and reassembly of reactor upper parts, especially reactor plenum, and removal and treatment of in-core neutron flux detectors at Temelín NPPs.

All presented values of CED were determined from film dosimeters. No radiation worker was internally contaminated above recording level 0.1 mSv.

Issues of concern in 2007

At both NPPs, no radiologically important issues are planned in 2007; only standard working operation during refuelling outages are expected.

The deregulation process in the last two years has led to large changes in the control procedure, financing and organisational structures of the whole ČEZ company with effect to radiation protection structure, as well. One centralised RP department was created as a result of these changes. The responsibilities for the processes of personal dose monitoring, environmental releases monitoring and ALARA principle implementations were centralised, too.

Dukovany NPP

Summary of dosimetric trends

The collective effective dose (CED) at Dukovany NPP in 2006 was 0.610 man·Sv. The CEDs were 0.060 man·Sv and 0.550 man·Sv for utility and contractors' employees, respectively. The total number of exposed workers was 1 809 (533 utility employees and 1 276 contractors).

The total value of CED in 2006 has been the second lowest value during the whole time of Dukovany NPP operation. Very low values of CED during the outages represent results of good primary chemistry water regime, well-organised radiation protection structure and strict implementation of ALARA principles during the working activities related to the works with high radiation risk. The maximal individual effective dose 8.65 mSv was reached by one of the contractor employees performing insulation work during the planned outages.

Number and duration of outages

	Outage information	CED [man·Sv]
Unit 1	30 days, standard maintenance outage with refuelling	0.161
Unit 2	30 days, standard maintenance outage with refuelling	0.094
Unit 3	30 days, standard maintenance outage with refuelling	0.167
Unit 4	44 days, standard maintenance outage with refuelling	0.161

Temelín NPP

Summary of dosimetric trends

The collective effective dose at Temelín NPP in 2006 was 0.242 man·Sv. The CEDs were 0.034 man·Sv and 0.208 man·Sv for utility and contractors' employees, respectively. The total number of exposed radiation workers was 1 508 (442 utility employees and 1 066 contractors).

Major evolutions

The main contributions to the collective effective dose were 2 planned refuelling outages.

	Outage information	CED* [man·Sv]
Unit 1	76 days, standard maintenance outage with refuelling	0.107
Unit 2	88 days, standard maintenance outage with refuelling	0.141

** Values from Electronic Personal Dosimeters*

Very low values of collective effective doses during the outages represent results of good primary chemistry water regime, well organised radiation protection structure and strict implementation of ALARA principles during the working activities related to the works with high radiation risk. The maximal individual effective dose of 7.67 mSv was obtained by a contractor employee carrying out decontamination.

FINLAND

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
BWR Olkiluoto	2	1.1005
VVER Loviisa	2	0.831

Principal events

Summary of national dosimetric trends

Dose trends at Finnish NPPs [man·Sv]

	2006	2005	2004	2003	2002
Olkiluoto 1 (BWR)	1.875	0.456	1.062	0.274	0.809
Olkiluoto 2 (BWR)	0.326	1.830	0.452	0.758	0.312
Average	**1.1005**	**1.143**	**0.757**	**0.516**	**0.560**
Loviisa 1 (VVER-440)	0.682	0.468	2.003	0.609	1.041
Loviisa 2 (VVER-440)	0.980	0.343	0.489	0.332	1.573
Average	**0.831**	**0.406**	**1.246**	**0.471**	**1.307**

Events influencing dosimetric trends 2006

Olkiluoto

At Unit 1 the annual outage was an extensive service outage and at unit 2 a short refuelling outage with durations of 22 days and 8 days respectively. The collective dose of OL2 outage was 0.247 man Sv and OL1 1.770 man·Sv. The outage at Unit 1 was almost similar as Unit 2 in 2005 resulting in the all-time highest collective dose accumulation.

The most significant task in the perspective of dose accumulation was the turbine island modernisation at Unit 1. This project included:

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

Loviisa

At Unit 1 the annual outage was a short maintenance outage and at Unit 2 a four-year maintenance outage with durations of 26 days and 33.5 days respectively. Planned durations were 20 and 30 days. The main delays were caused on both units by repair work performed on reactor main flanges. Collective outage doses were 0.648 and 0.936 man·Sv respectively.

In 2006 major maintenance work was performed on reactor components at Unit 2. On the RPV head two control rod drive mechanism nozzles were repaired. Concerning the reactor internals, defective locking bolts of the core baffle plate were changed. On both units, the main contributors to collective doses were cleaning, decontamination, component inspections and insulation renewal.

Unexpected events

During the 2006 refuelling outage at Loviisa 2 an increased amount of contamination alarms at the personnel contamination monitors were noticed. Investigations showed that the source of the loose radioactivity was poorly packed and decontaminated reactor cleaning tool pipes that were transported from the reactor hall to the auxiliary building material corridor. During the transport radioactive debris from the pipes had fallen on the transport route. From the transport route the contamination was spread out to various corridors and rooms inside the RCA by passing workers. A small amount of radioactivity was even found from the yard just outside the RCA in front of the material corridor. Apparently in spite of normal contamination measurement routines of transport vehicles some contamination was let through. Radioactive particles from the yard were removed and the RCA was decontaminated immediately. The event was classified as INES 1.

Technical plans for major work in 2007

Olkiluoto

The valve replacement in shut down cooling system 321 V4 will be done at Unit 2 in 2007.

Loviisa

In 2007 both outages will be short refuelling outages with no significant maintenance. Renewal of plant I&C systems will continue as planned.

Regulatory plans for major work in 2007.

The renewal process for the operation license will be carried out for Loviisa NPP during 2007. At Olkiluoto 1 and 2, the regulatory work linked with the modernisation of the installed RP instruments will continue. The inspections concerning the construction phase of the Olkiluoto 3 Unit will also continue as well as the review work of the system specific descriptions.

FRANCE

Dose information

Collective doses

The average collective dose was 0.69 man·Sv per reactor in 2006 for a target of 0.77 man·Sv. The average 2006 collective dose for the 3-loop reactors (34 reactors) was about 0.78 man·Sv; the average 2006 collective dose for the 4-loop reactors (24 reactors) was about 0.55 man·Sv.

In 2006, there were 26 short outages, 22 standard outages, and 5 ten-yearly outages. One Steam Generator Replacement started at the end of 2006 (Bugey 4). The collective dose from the outage represents 81% of the annual collective dose. The collective dose from the operating period represents 19% of the annual collective dose. The collective neutron dose is about 0.39 man·Sv (0.31 man·Sv from the spent fuel transport)

Individual doses

At the end of 2006, only 13 workers from highly exposed specialities (insulation, scaffolding, welding, mechanics) were recorded with over 16 mSv on 12 rolling months. There were 17 workers over 16 mSv, and no workers with a 12 month dose over 18 mSv.

Principal events

Events influencing dosimetric trends, number of outages

EDF 3-loop reactors

In 2006, the lowest collective dose for a standard outage was Blayais 1 with 0.44 man·Sv; the lowest dose for a short outage was Gravelines 6 with 0.18 man·Sv; the highest outage dose was Chinon 2 with 2.19 man·Sv for a ten-yearly outage.

In 2006, 1 reactor had no outage and 2 reactors had an unscheduled outage; the lowest annual dose was Fessenheim 1 with 0.14 man.Sv. In 2006, the main contributors were 17 short outages, 13 standard outages, 3 ten yearly outages, one Steam Generator Replacement (Bugey 4) and one reactor head vessel replacement (Golfech 2).

EDF 4-loop reactors

In 2006, the lowest collective dose for a standard outage was CHOOZ 1 with 0.82 man·Sv; the lowest collective dose for a short outage was Chooz 2 with 0.29 man·Sv; the highest dose for an outage was Paluel 1 with 1.92 man.Sv for a ten yearly outage.

In 2006, 5 reactors had no outage and 1 reactor had an unscheduled outage; the lowest annual dose was Cattenom 2 with 0.69 man·Sv. In 2006, the main dose contributors were 9 short outages, 9 standard outages and 2 ten-yearly outages.

RP Incidents

Cruas NPP, January 2006

A contractor received in January 2006 the dose result from the October 2005 filmbadge (7.1mSv). With this value, the total on 12 rolling months was 22.90 mSv, exceeding the 20 mSv limit. The October 2005 dose from the electronic dosimeter was 2.4 mSv and the electronic dose on 12 rolling month is under 20 mSv. No explanation was found to justify such a difference between the film badge value and the electronic dosimeter value.

Tricastin NPP, 3 April 2006

A contractor worker wearing gloves was nevertheless wounded and contaminated his finger. He went to the hospital but a permanent contamination remained in his finger. The induced dose was lower than a hundredth of the dose limit.

Issue of concern in 2007

A special involvement of EDF management in industrial radiography: in France, the number of radio- NDT is very high (about 40 000 /year in EDF NPP), without any over exposure, but to limit the risk, the main taken actions are:

- Special posting
- A specific gamma detector to warn the operator if the source is out of the camera
- Homogeneity of the practices on all sites
- Special plans of all the installations

Future activities in 2007

- *3-loop reactors:* 15 short outages, 16 standard outages and 2 ten yearly outages
- *4-loop reactors:* 6 short outages, 9 standard outages and 2 ten yearly outages

The main task in 2007 is to manage the most important radiological risks like Very High Radiation Areas and Industrial Radiography.

New targets

The target in the field of collective doses is lower than 0.73 in 2007 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” and less than 30 workers over 16 mSv on 12 rolling months.

GERMANY

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
PWR	11	0.82
BWR	6	1.00
Reactors in cold shutdown or in decommissioning		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
PWR	3	0.14
BWR	2	
VVER	5	

Principal events

Political situation

On 18 September 2005, a new parliament was elected. As a result, a grand coalition was formed by the social democrats, which are anti-nuclear, and the conservatives, which are pro-nuclear. In its coalition agreement of 18 November 2005 the coalition laid down that the red-green agreement of June 2000 on the nuclear phasing out (and resulting Atomic Energy Act) will not be changed. Nevertheless, there is a continuous discussion on the issue, which restarted due to the Russian-Ukrainian dispute on the delivery of gas.

According to the original schedule of the mentioned agreement of June 2000, which is based on NPP specific remaining production capacities, the units KWB-A Biblis A, GKN-I Neckarwestheim I, KKB-Brunsbüttel and KWB-B Biblis B should be shut down by 2009. But recently, RWE Power submitted a request for the transfer of unused production capacities of NPP Mülheim-Kärlich, which was finally shutdown, to KWB-A, which would, if agreed by the German government, result in a prolongation of the life time of KWB-A. As the conservative lead ministry for economy and of the "Kanzleramt" will probably agree to such a transfer the social democrat lead ministry for the environment, nature conservation and reactor safety will reject the requested transfer – thus, up to now it is unclear, how the situation will evolve.

Situation in German NPPs

After shutdown of Obrigheim NPP in May 2005, in Germany 6 BWR and 11 PWR still are in operation. The total collective exposure of the plants in operation has stabilised on a low level of about 0.82 Pers·Sv for PWR and about 1 Pers·Sv for BWR, where, however, especially for PWRs the total collective exposure is dominated by single older units, which give rise to significant changes of the collective dose from one year to the next due to outage-free years on one hand and high back-fitting activities with collective exposures of several Pers·Sv on the other.

Also to be mentioned are moderate increases of the collective exposures, started in 2004 and continued in 2005 in the BWR units of "construction line 1972", which are due to repair, back-fitting activities and modifications in these units, which are balanced by lower collective exposures of the "construction line 1969". Individual personnel doses could be reduced in the last years also in older plants as a consequence of work planning influenced by the recent changes in the regulatory framework especially for utility personnel, which shows average doses below 1 mSv down to 0.1 mSv for Convoy-plants. At the same time plant related personnel dose of the contracted personnel shows only a slight decreasing trend but with the exception of three units (up to 2 mSv) also are in the range of 1 mSv and below for the work on one site. In case of higher individual exposures, the influence of the amount of back-fitting activities in older units can be identified.

With regard to the decommissioning and dismantling of German NPPs, it can be stated, that for Stade NPP the first and second licenses for decommissioning and dismantling were granted on 7 September 2005 and 15 February 2006. Thus, currently 10 units of power reactors (at 6 sites) are under immediate dismantling. Obrigheim NPP, shut down in 2005, is currently applying for license for direct dismantling. In 2004 and 2005 the collective dose admittedly has increased to about 1.5 Pers·Sv compared to 2003, but under the exception of 2003 with 1 Pers·Sv the collective doses still are lower than in the previous years. It has to be mentioned that the collective dose of such a small number of large decommissioning projects is strongly dependant on the activities performed in single plants regarding the current step of dismantling and regarding the speed of decommissioning.

Special developments

- The pilot project performed under the supervision of the authority for the realisation of legal dosimetry with EPDs will probably be finished in April 2007 and has to be followed by a project in a selected NPP for the application in practice.
- It is expected that in 2007 a new initiative for the development of a concept for an electronic RP passport will be launched.

Special events

Two special events are worth noting. As is known, on 25 July 2006 an event occurred at Forsmark Unit 1 affecting the availability of the emergency power. The information on this event gained high publicity in Germany due to media reports in early August. As a consequence the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety requested dedicated statements by the responsible authorities of the “Länder” on the relevancy of the Forsmark event to German NPPs. In a first response all operators stated that no similar event would be possible in German NPPs, but Brunsbüttel NPP changed its statement due to some deficiencies in their emergency power system about one week later. In general, the Forsmark event drew new attention on the safety of nuclear power plants in the public opinion and increased the pressure at Brunsbüttel NPP to upgrade its emergency power system, which currently is applied for.

During revision of Biblis Unit A mid-October 2006 deficiencies concerning the correct assembling of heavy load wall plugs were observed, which may have safety significance. Based on these findings Unit B was shut down, too, for inspection resulting in similar deficiencies. Tests of the load capacity by competent companies and under supervision of qualified experts of the authority show that the load capacity is still high. Based on an agreement between the RWE Power an the responsible authority on 1 November a detailed programme was started to first inspect in detail all affected wall plugs and to second repair those which were incorrectly assembled. It is expected, that both units will remain shut down for several months until the programme is completed.

Due to the findings at Biblis inspections were performed in Gundremmingen Units B and C, resulting in the finding of some wall plugs not mounted according to the specification. But, the specified carrying capacity was not compromised and safety is regarded by the responsible authority not to be affected.

HUNGARY

Dose information

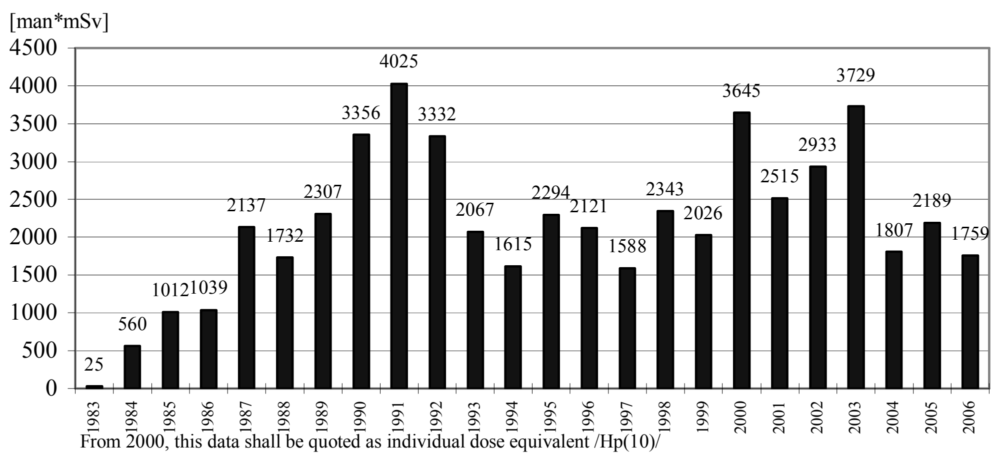
Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
VVER	4	0.526 (with electronic dosimeters); 0.440 (with film badges)

Principal events

Summary of national dosimetric trends

Upon the result of operational dosimetry the collective radiation exposure was 2 103 man·mSv for 2006 at Paks NPP (1 413 man·mSv with dosimetry work permit, and 690 man·mSv without dosimetry work permit). The highest individual radiation exposure was 16.1 mSv, which was well below the dose limit of 50 mSv/year, and our dose constraint of 20 mSv/year. The collective dose decreased in comparison to the previous year. The lower collective exposures were mainly ascribed to the one "so called" long outage at Unit 4.

Development of the annual collective dose values at Paks nuclear power plant (from the results of the film badge monitoring by the authorities):



Events influencing dosimetric trends

There was one general overhaul (long outage) in 2006. The collective dose of outage was 439 man·mSv on Unit 4.

Number and duration of outages: Unit 1, 30 days; Unit 2, 44 days; Unit 3, 29 days; Unit 4, 61 days.

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 by twenty years.

Safety-related issues

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.

On 15 October 2006 the actual removal of the damaged fuel assemblies from the pit No. 1 of Unit 2 was started. During the removal activities continuous radiation protection surveillance was provided, all the necessary measurements and inspections were performed, promoting thus the successful execution of the removal activities.

During the works related to removal of the damaged fuel assemblies the radiation conditions were favourable. Upon the result of operational dosimetry the collective dose was 47 man·mSv from 15 October to 31 December 2006 for the recovery. The highest individual radiation exposure was 1.748 mSv. Accordingly the dose-loads of the workers were low, both the collective dose and the individual maximum dose loads turned out to be appropriately low.

The radioactive releases were extremely low, the extra doses calculated from these, affecting the public might be deemed as negligible. Summarising the results of the nuclear environment monitoring results it can be stated, that the effect of the recovery works from radiation protection point of view was negligible in 2006.

Technical plans for major work in 2007: The recovery in the Pit 1 on Unit 2 will be ended in 2007.

ITALY

Dose information

Reactors in cold shutdown or in decommissioning		
Reactor type	**Number**	**Average annual collective dose per unit [man·mSv]**
PWR	1	9.99
BWR	2	25.18
GCR	1	0.4

Principal events

Events influencing dosimetric trends

- PWR: Removing asbestos insulating from Controlled Zone in Trino NPP
- BWR: Removing asbestos insulating from Controlled Zone in Caorso NPP, Garigliano NPP.

Technical plans for major work in 2007: The same as 2006 – Insulation removal.

JAPAN

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
PWR	23	1.09
BWR	32	1.33
All types	**55**	**1.23**
Reactors in cold shutdown or in decommissioning		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
GCR	1	0.03

Principal events

Summary of national dosimetric trends

Total collective dose in the fiscal year 2006 for all units was 67.43 man·Sv, and this was almost the same as the fiscal year 2005 value of 66.91 man·Sv. The average annual collective doses per unit for all units, BWRs, and PWRs were 1.20 man·Sv, 1.33 man·Sv and 1.09 man·Sv respectively. The BWR collective dose per unit for 2006 decreased 3 years in a row, and recorded the lowest value in the past. Though the average collective dose of PWR has increased slightly from the previous year, it shows a stable trend in around 1.0 man·Sv over the last several years.

Number and duration of outages

Periodical inspections were completed at 20 BWRs and 16 PWRs. The average duration for periodical inspection was 146 days for BWRs and 128 days for PWRs.

Major evolutions

The study was continued for the improvement of the inspection system of nuclear power plant, and the report was issued for the problem of the current inspection system and the methodology of the improvement.

Regulatory plans for major work in 2007

The preparation such as establishment of the standards and guidelines will be carried out in order to implement the improved inspection system.

REPUBLIC OF KOREA

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
PWR	16	0.54
CANDU	4	0.58
All types	**20**	**0.55**

Principal events

Summary of national dosimetric trends

For the year of 2006, 20 NPPs were in operation: 16 PWR units and 4 CANDU units. The average collective dose per unit for the year 2006 was 0.55 man·Sv lower than 0.60 man·Sv in 2005. As in previous years, the outages of units in 2006 contribute the major part to the collective dose, 72.8% of the collective dose was due to works carried out during the outages. There were in total 10 154 people involved in radiation works in 20 operating units and the total collective dose was 10.958 man·Sv.

Number and duration of outages

Periodical inspection was completed at 12 PWRs and 2 CANDUs. The total duration for periodical inspection was 417 days for PWRs and 50 days for CANDUs

Major evolutions

There was no major evolution having a significant impact upon radiation dose

Issues of concern in 2007

2007 ISOE Asian ALARA workshop was held in Seoul, Korea from September 12-14, 2007.

LITHUANIA

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
LWGR	1	3.0561
Reactors in cold shutdown or in decommissioning		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
LWGR	1	0.3523

Principal events

Summary of national dosimetric trends

In 2006, the occupational doses at the Ignalina NPP were at a level of 2004-2005 and in 2006 the collective dose was 3.408 man·Sv (3.0561 man·Sv for operating Unit 2 and 0.3523 man·Sv for Unit 1 at cold shutdown). In 2006, 2 492 INPP workers and 1 513 outside workers were working under the influence of ionising radiation in the controlled area of the INPP.

The planned annual collective dose for INPP personnel was 3.995 man·Sv, for outside workers – 1.415 man·Sv. But in fact there was no need to perform all planned repair works and therefore the collective dose for INPP personnel was 2.177 man·Sv (55% of planned), and for outside workers – 1.231 man·Sv (87% of planned). Overall collective dose for INPP personnel and outside workers was 3.408 man·Sv (63% of planned dose).

The average effective individual dose for INPP staff was 0.87 mSv, for INPP staff and outside workers – 0.85 mSv. The highest individual effective dose for INPP staff was 16.96 mSv, and for outside workers – 19.91 mSv.

Events caused the dosimetric trends

The main part of the overall collective dose was the collective dose received during the outage period of Unit 2. The collective dose was 2.337 man Sv, which means 69% of the INPP annual occupational collective effective dose. The main works that contributed to the collective dose during 2006 at the INPP are given in Table below:

Main works	Collective dose (man·mSv)
Repairing of the Main Circulation Circuit	415.33
Thermo - insulation works	386.34
Maintenance, Repairing, Replacement of the System of the Reactor vessel and Reactor equipment	261.59
Routine inspections	259.29
Preparation for the inspections	163.73
Containment isolation system	102.49
Lighting, general electrical equipment	69.22
Decontamination of premises	46.04
Radiological monitoring of workplaces	35.00
Shielding and temporary shielding	32.63
Scaffolding	16.94
Other works	198.31

Number and duration of outages

One planned outage at Unit 2 was in 2006 (Unit 1 of INPP was shutdown on 31 December 2004). The duration of outage at Unit 2 was 52 days. The collective dose was distributed as following: normal operation – 31.4% of the annual collective dose, outage of Unit 2 – 68.6% of the annual collective dose.

New plants on line/plants shut down

The project for increasing the capacities of existing Dry Spent Fuel Storage by an additional 18 places to store spent fuel from the Unit 2 was executed in 2006.

After a government decision, the Unit 1 of INPP was shutdown on 31 December 2004. Unit 1 was used according to technological regulations in a cooled condition with nuclear fuel in it.

Major evolutions

Operation of the new Cement Solidification Facility (CSF) for treatment of liquid radioactive waste and Temporary Storage Building (TSB) started in 2006. CSF and TSB were constructed at the INPP site in 2005.

Operation of the automated system AKRB-06 for control of assurance of radiation protection of workers and environment of the INPP launched in 2003 and after modernisation, continued in 2006. All modifications were agreed with the Radiation Protection Centre.

In 2006, the measures foreseen in the Plan of Implementation of the Decommissioning Programme for Unit 1 at the INPP were further implemented.

Goals for 2007:

- 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 2007:

- Collective dose shall not exceed 3.37 man·Sv;
- Collective dose during planned outage of Unit 2 shall not exceed 1.87 man·Sv;
- Collective dose during normal operation of Unit 2 shall not exceed 1.00 man·Sv;
- Collective dose during technical service of shutdown Unit 1 shall not exceed 0.50 man·Sv.

Component or system replacements

In 2006, works on the Project related to transportation of partly burned fuel from Unit 1 to use it in Unit 2 for electricity production were completed. There were 86 Fuel Assemblies unloaded from Unit 1, 28 of them were transported and loaded into Unit 2. These works will be continued in 2007 – 2009, that will allow reducing the nuclear fuel purchases up to 50%. It is planned that in the middle of 2009 all fuel will be unloaded from Unit 1.

Unexpected events

In 2006, Unit 2 had one unplanned shutdown of the reactor which occurred during start-up after outage, and 3 unloads (two of them were connected with turned out turbo generator No. 3 in July and September, and one occurred after turn out of the main circulation pump in January).

Organisational evolutions

During preparation for decommissioning of INPP, the changes in INPP structural departments are continuing. A major 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 2006 and plans in the coming year

Exercising the radiation protection state supervision and control at Ignalina NPP (INPP), in 2006 six inspections were carried out at Ignalina NPP and also two inspections were carried out at spent nuclear fuel interim dry storage facility. Also 10 outside organisations (contractors) have been supervised and controlled.

In 2006, with the assistance of Western experts, who were involved in the EU PHARE project's "Support to licensing activities related to the decommissioning of the Ignalina NPP to VATESI and Lithuanian TSOs (Sub-component 2 for RSC)" implementation, the following licensing documents, linked to the decommissioning of the Ignalina NPP, were reviewed from the radiation protection viewpoint:

- environmental impact assessment documents for erection of the new spent nuclear fuel interim storage facility;
- environmental impact assessment documents for the new solid radioactive waste treatment and storage facilities for Ignalina NPP;
- technical specifications for the landfill for short-lived very low level (VLL) radioactive waste disposal;
- technical specifications for the INPP Unit 1 turbine hall equipment dismantling and decontamination (D&D) project.

Exercising the radiation protection state supervision and control at Ignalina NPP in 2007, RPC is planning to carry out 5 inspections at Ignalina NPP and 10 inspections of outside organisations (contractors). The review of documents related to INPP decommissioning will continue.

In 2007, the quality assurance system with regard to review of the decommissioning documents at RPC will be assessed and improved. This will be done with support of experts in the framework of Ignalina Programme project "Support to Activities of the Radiation Protection Centre Related with Radiation Protection in Decommissioning of the Ignalina Nuclear Power Plant", which will be implemented in 2007-2009.

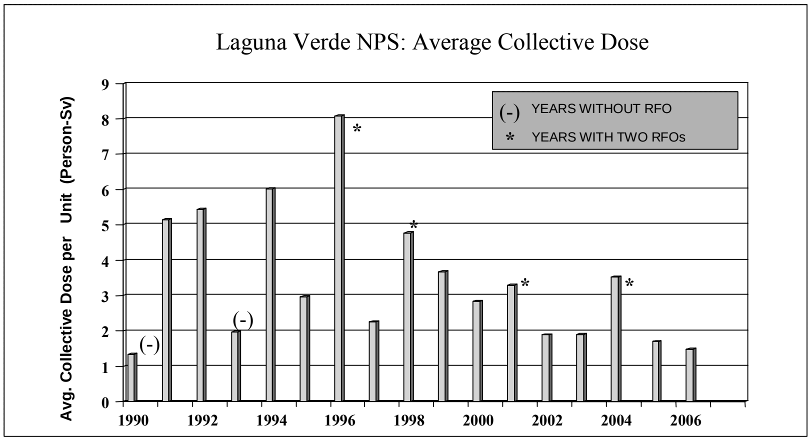
MEXICO

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
BWR	2	1.48

Principal events

Summary of national dosimetric trends

In 2006, Mexican utilities (Laguna Verde NPS) achieved their lowest historical average collective dose. The downwards trend has been maintained since 1996.



Events influencing dosimetric trends

Unit 2: Eight refuelling outage: 1.69 Person·Sv. The most remarkable activity included in this RFO was the replacement of the internals of the two recirculation pumps. This consumed around 34 Person·mSv. In order to be able to make the change of these internals, the huge motors of both recirculation pumps had to be removed to remote places; that made necessary in turn to eliminate interferences by dismantling a massive amount of supports, piping, ducts, valves and instrumentation located in the drywell, as well as putting them together once the activity finished and the motors were returned to their places.

Number and duration of outages: Unit 2, 8th Refuelling Outage – 27 days

Major evolutions

The bid for the expected power up rate (20% additional power) took place. The power up rate activities for both units will take place during the refuelling outages from 2008 to 2010.

Component or system replacements

Unit 2 internals of recirculation pumps were replaced.

Unexpected events

A trend to ^{60}Co increase in reactor water was noted for both units, mainly for Unit 1. It could be due to a collateral effect of hydrogen/noble metals injection that started up at Laguna Verde in 2005. However, during 2006 this fact did not affect field rates in a substantial manner.

Issues of concern in 2007

Cobalt 60 concentration in reactor water had increased in Unit 1 by about one order of magnitude, and in Unit 2 by a factor of 2. The collective dose results for U1 11th refuelling outage (March 2007) were strongly influenced by this fact: the BRAC point increased by a factor of 3, the dose rate in general areas of the drywell increased by about 50%; the collective dose goal for that outage (and quite probably for the rest of 2007) could not be accomplished.

It is believed that this situation is a result of noble metals and hydrogen injection that started up at the beginning of last cycle. Also, there are some evidences that a substitution of damaged stellited turbine blades by new ones (also stellited) for both units two cycles ago, might have to do with the problem. The causes and possible solutions are currently under analysis.

Technical plans for major work in 2007

- Analysis of the causes ^{60}Co increase, and corrective/preventive measures to be taken.
- On the other hand, a multidisciplinary task force was created at LVNPS to make a deep analysis on how collective dose due to in service inspections (ISIs) can be reduced.

ROMANIA

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
CANDU	1	0.561

Principal events

Summary of national dosimetric trends

Occupational exposure at Cernavoda NPP (February 1996 – December 2006)			
	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
2006	302.27	258.79	561.06

Events influencing dosimetric trends

In September 2006, the 26 day planned outage, between 9 September and 4 October, had a 51% (288.645 man·mSv) contribution to the collective dose for the year 2006 (561.06 man·mSv). In April 2006 (7-14) a 7 day unplanned outage due to very high boiler sodium (above level 1 action limit) had a significant contribution to the monthly collective dose (52 man·mSv) due to jobs/activities with significant radiological impact (especially from an internal dose point of view):

- repair of the equipment with leakages (from the moderator and primary heat transport systems);
- repair of four valves on a dousing system;
- repair of one valve on purification of heat transport system.

Major evolutions

During 2006 our National Regulatory Body, CNCAN, continued to issue new rules and regulations:

- Law no. 63/2006 for modification and completion of Law 111/1996 for safety development of nuclear activities.
- Ord. 184/2006 "Radiation Safety Regulations for decommissioning of uranium and/or thorium mining and /or milling facilities".
- Ord. 154/2006 "Guide for exterior illuminate of nuclear facilities".
- Ord. 141/2006 "Regulations for protection of nuclear power plants against inside fire and explosions".
- Ord. 135/2006 "Regulations for periodic review of nuclear safety of nuclear power plants".
- Ord. 136/2006 "Regulations for emergency core cooling system for CANDU nuclear power plants".
- Ord. 85/2006 "Regulations for protection of nuclear installations against sabotage from the inside".
- Ord. 407/2006 "Regulations for authorising execution of nuclear construction".
- Ord. 400/2006 "Regulations for near surface storage of radioactive waste".

Component or system replacements: 8 vertical neutron flux detectors

Radiation protection-related issues

- individual and collective doses for the replacement of the vertical neutron flux detectors were kept very low;
- in order to improve the contamination control two Small Articles Monitors were acquired and installed at the exit of radiological controlled area;
- in 2006 the modernisation of the Liquid Effluent Monitor was started by adding "on line monitor". The "off line monitor" will be refurbished during the first half of 2007. This way the system will be redundant and will provide a better control of radioactivity discharged into the Danube river;
- acquisition of a semi-portable tritium monitor Overhoff 421 NPPM, with gamma and noble gases compensation for more accurate detection and measurement of tritium contamination.

Unexpected events

Major leak of tritiated water from primary heat transport system during planned outage. There were no detectable effects on the environment. The individual internal doses received by the employees involved in the recovery of the spilled water did not exceed the investigation limit of 1 mSv committed dose.

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, 2005), individual and collective internal doses became a major concern. Corrective and preventive actions and recommendations targeted both work planning (exposure control) and technical aspects:

- Two procedures were issued ("ALARA Programme for CNE Cernavoda" and "Radiation Work Permit System") regarding ALARA planning of routine and maintenance activities in reactor building/boiler 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 boiler room);
- ALARA committee will be established until the end of 2006.
- awareness of RP in the station and ownership of dose were increased:
  - By placing in key high traffic areas of the plant specific information: charts, bulletin, newsletter on RP stations goals, ALARA initiatives, RP policies and procedures;
  - RP staff provide twice a month collective doses by stations departments;
  - established monthly targets for collective dose for station and work groups;
  - established performance indicators to improve station/work group performance
  - established aggressive internal dose reduction targets to lower the ratio internal dose/total dose;
  - lowered the threshold for the use of respiratory protection equipment to 0.03 mSv anticipated committed dose;
  - implemented a lower level for follow-up of internal exposure to tritium of 0.3 mSv committed dose (the investigation and removal level is 1 mSv committed dose).
- Adsorbtion/regeneration time for dryers of D_2O vapour recovery system, versus air humidity was optimised;
- in order to locate more accurate the defective equipments, acquired a performant installation to detect and measure the He leaks;
- analysed 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.
- for long term a heavy water detritiation facility project started. A pilot-plant is under commissioning to test the technology to be applied to reduce tritium concentration in our CANDU reactor moderator system.

Issues of concern in 2007

There will not be a planned outage during 2007. The major issue is the first criticality – in May – and commercial operation – in September – for Unit 2 (CANDU 6 project). Modernisation of the "Tritium in Air Monitoring" system will be finished at the end of planned outage 2008.

RUSSIAN FEDERATION

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
PWR (VVER)	15	0.700
Reactors in cold shutdown or in decommissioning		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
PWR (VVER)	2	0.126

Summary of national dosimetric trends

Collective doses

Personnel, contractors and total collective doses for of all operating VVERs are shown in the following Table.

Nuclear Power Plant		Personnel [man·Sv]	Contractors [man·Sv]	Total [man·Sv]
Balakovo	Unit 1, VVER-1000	0.274	0.244	0.518
	Unit 2, VVER-1000	0.210	0.193	0.403
	Unit 3, VVER-1000	0.072	0.067	0.139
	Unit 4, VVER-1000	0.561	0.581	1.142
	Total for Balakovo NPP	1.117	1.085	2.202
Kalinin	Unit 1, VVER-1000	0.729	0.214	0.943
	Unit 2, VVER-1000	0.481	0.134	0.615
	Unit 3, VVER-1000	0.164	0.066	0.230
	Total for Kalinin NPP	1.374	0.414	1.788
Kola	Unit 1, VVER-440	0.396	0.172	0.568
	Unit 2, VVER-440	0.549	0.293	0.842
	Unit 3, VVER-440	0.373	0.165	0.538
	Unit 4, VVER-440	0.431	0.222	0.653
	Total for Kola NPP	1.749	0.852	2.601
Novovoronezh	Unit 3, VVER-440	1.789	0.212	2.001
	Unit 4, VVER-440	1.266	0.125	1.391
	Unit 5, VVER-1000	0.357	0.026	0.383
	Total for Novovoronzh NPP	3.412	0.363	3.775
Volgodonsk	Unit 1, VVER-1000	0.015	0.116	0.131

In 2006, the total effective annual collective dose (personnel and contractors) of all Russian operational VVER type reactors was 10.497 man·Sv and decreased at 4.478 man·Sv in comparison with 2005. There are main factors influencing indicated collective dose reduction:

- Considerable decrease of maintenance and repair work at all Novovoronezh operating reactors, primarily at Novovoronezh 5. In 2005, the total duration of planned outages was 355 days at three operating Novovoronezh units. In 2006, it was only 115 days. As a result, the total outage collective dose decreased at 3.799 man·Sv for Novovoronezh 3-5.
- Reduction at 0.403 man·Sv of outage collective dose at Kalinin 2 in 2006. In 2005, there was 60 days major maintenance outage with a great number of repair work at the reactor pressure vessel head. In 2006, 46 days standard outage with only routine maintenance took place.

Individual doses

There were no events exceeding control level of 20 mSv of annual individual dose at any Russian nuclear plants with VVER type reactors in 2006.

The maximum annual effective individual doses were:

- Balakovo: 14.5 mSv was received by the contractor who carried out Units 1-4 steam generators repairing jobs.
- Kalinin: 19.5 mSv was received by the worker of the plant maintenance department involved in the repair of reactor vessel internals at Units 1-3.
- Kola: 18.1 mSv was received by the worker of the plant maintenance department during refuelling and repair of reactor vessel internals at Units 1-4.
- Novovoronezh: 17.2 mSv was received by the worker of the plant maintenance department involved in the repair of operating systems of reactor compartment at Unit 3-4.
- Volgodonsk: 5.4 mSv was received by the contractor who performed radiograph analysis of high pressure feed heater metal.

Indicated maximum individual doses were gradually received during 2006.

Planned outages duration and collective doses

Name of reactor	Duration [days]	Collective dose [man·Sv]
Balakovo 1	50	0.498
Balakovo 2	44	0.381
Balakovo 3 (*)	17	0.117
Balakovo 4	64	0.127
Kalinin 1	56	0.898
Kalinin 2	46	0.570
Kalinin 3	76	0.220
Kola 1	37	0.418
Kola 2	37	0.610
Kola 3	37	0.455
Kola 4	58	0.535
Novovoronezh 3	38	1.595
Novovoronezh 4	35	0.973
Novovoronezh 5	42	0.261
Volgodonsk 1	57	0.121

(*) At Balakovo 3 outage was not finished in 2006 calendar year.

Main dose-reduction activities in 2006

- Annual collective dose budget calculation procedure was developed for all Russian nuclear power plants.
- Comparative analysis of tungsten, lead and depleted uranium protective shields application in high radiation areas was performed.
- Local stages of "Best health physicist of NPPs" contest were held at all Russian nuclear power plants.
- Centralised delivery of electronic personnel dosimeters at NPPs was completed.

Issues of concern for 2007

- Preparatory activity aimed at implementation of 18 months fuel cycle for VVER-1000 reactors.
- Execution of research and development works for manufacturing of pilot lot of protective shield based on tungsten compounds.
- Arrangement and realisation of the final stage of "Best health physicist of NPPs" contest.
- Improvement of computer based personnel dosimetric control system

SLOVAK REPUBLIC

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
VVER	6	0.270
Reactors in decommissioning		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
GCR	1	*Not involved in ISOE*

Principal events

Summary of national dosimetric trends

Bohunice NPP (2 units – Bohunice 3 and 4):

The total annual effective dose in Bohunice NPP in 2006 calculated from legal film dosimeters was 676.89 man·mSv (employees 22.863 man·mSv, outside workers 654.023 man·mSv). The maximum individual dose was 11.82 mSv (contractor).

JAVYS NPP (2 units – Bohunice 1 and 2)

The total annual effective dose in JAVYS NPP in 2006 calculated from legal film dosimeters was 471.91 man·mSv (employees 54.30 man·mSv, outside workers 417.61 man·mSv). The maximum individual dose was 6.20 mSv (contractor).

Mochovce NPP (2 units):

The total annual effective dose in Mochovce NPP in 2006 calculated from legal film dosimeters was 468.909 man·mSv (employees 28.662 man·mSv, outside workers 440.247 man·mSv). The maximum individual dose was 7.799 mSv (contractor).

Events influencing dosimetric trends

Bohunice NPP:

The higher collective exposure in 2006 in comparison with previous years was expected as the large modernisation has been in progress in Bohunice NPP

Number and duration of outages

Bohunice NPP:

- Unit 3: 68.5 day standard maintenance outage combined with the modernisation works. The total collective exposure was 245.85 man·mSv
- Unit 4: 71.5 day standard maintenance outage combined with the modernisation works. The total collective exposure was 385.99 man·mSv

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

JAVYS NPP

- Unit 1: 29 day standard maintenance outage. The total collective exposure was 169.34 man·mSv
- Unit 2: 30 day standard maintenance outage. The total collective exposure was 209.10 man·mSv

Mochovce NPP:

- Unit 1: 33 day standard maintenance outage. The total collective exposure was 179.565 man mSv from electronic personnel dosimeters -EPDs. It is the best result in history of outages of the first unit. There was not recorded any dose from internal contamination.
- Unit 2: 62 day main maintenance outage. The total collective dose was 245.856 man·mSv from EPDs. No recorded dose from internal contamination.

New plants on line/plants shut down

On 31 Dec 2006, JAVYS NPP – "Bohunice Unit 1", was shut down ahead of schedule due to 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, at a cost of 250 million US dollars and after the plant had reached the internationally acceptable safety level.

Major evolutions

The privatisation process of the Slovak Electricity Company was finished on 1 April 2006. Bohunice V1 (Unit 1 and 2) was involved into the new state running company named JAVYS and Bohunice V2 (Unit 3 and 4) continued its operation in Slovak Electricity, plc. where the Italian company Enel has the majority.

Component or system replacements

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 Bohunice 3 + 4 (legal and operational) as the whole dosimetry service after the privatisation was left in JAVYS (Bohunice V1)
JAVYS NPP	• modernisation of discharge monitor in ventilation stack
Mochovce NPP	• installation of internal contamination monitor at the exits of the changing rooms

New/experimental dose-reduction programmes

Mochovce NPP:

A special procedure for "soft" decontamination of the primary circuit during shutdown process was introduced. Efficiency of the process is approximately 15% reduction of the dose rates median measured at the 54 points of the main circulation loops.

Organisational evolutions

Bohunice NPP:

After the privatisation of the Slovak Electricity Company the new organisational structures had to be developed. Because the systems and organisation in the previous company had been built in a common way, a lot of new contracts had to be established between two new companies saving the human and material resources.

Technical plans for major work in 2007

Bohunice NPP	• installation of devices for computerised assignment of film dosimeters to the workers and the control of their collection before entering to the radiation controlled area
JAVYS NPP	• installation of internal contamination monitors at the exits from the change rooms • installation of devices for computerised assignment of film dosimeters to the workers and the control of their collection before entering to the radiation controlled area
Mochovce NPP	• installation of the new portal personnel contamination monitor at the NPPs main gate, • reconstruction of the vehicle monitoring at the main gate

Regulatory plans for major work in 2007

- Licensing process of the completing of the Unit 3 and 4 NPP Mochovce.
- Implementation of new regulations in radiation protection (to be put in force in July 2007).
- Inspections of outages in all operated units.
- Assessment of Periodic Safety Review of the Bohunice NPP (Unit 3 and 4).
- Licensing process of the decommissioning of NPP V1 JAVYS.

SLOVENIA

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
PWR	1	0.86

Radiological performance indicators of Krško nuclear power plant for 2006 were:

- Collective radiation exposure was 0.86 man·Sv (0.15 man·mSv per GWh electrical output). Maximum individual dose was 13.53 mSv, average dose per person was 0.95 mSv.
- Planned outage (08/04/2006-14/05/2006), 37 days.
- Refuelling outage collective dose was 0.70 man·Sv.

Major outage activities:

Eddy current testing of 50% of SGs U-tubes, preventive replacement of secondary pipes, inspection of reactor head penetrations, RCP motor inspection, and replacement of cables and connectors for control rod position indication, replacement of both low pressure turbine rotors at the secondary side.

Other

Due to the replacement of turbine rotors the gross power output is now for 20 MWe higher, the total is 727 MWe.

Technical plans for major work in 2007:

Replacement of thermal insulation in the reactor building (RB), and RB sump strainers.

Regulatory authorities

Slovenian Nuclear Safety Administration (SNSA) and Slovenian Radiation Protection Administration (SRPA) performed regulatory control and inspection surveillance of Krško NPP operation.

REPUBLIC OF SOUTH AFRICA

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
PWR	2	0.797

Principal events

Summary of national dosimetric trends

During 2006, Koeberg Nuclear Power Station has successfully completed a refuelling outage on the Unit 2 reactor within 64 days. However, prior to the Unit 2 refuelling outage, the Unit 1 reactor was shutdown for 139 days to perform maintenance on the generator. The dose trend at Koeberg Nuclear Power Station increased due to an extended maintenance programme, higher work volumes than previously and a number of rework activities on the Unit 2 reactor.

Events influencing dosimetric trends

The average dose for Koeberg increased during 2006. Some work activities took longer to complete than planned and more people entered the radiological controlled zones during 2006 than previously. Maintenance due to rework resulted in additional dose i.e., various attempts to repair one valve during the refuelling outage on Unit 2 resulted in a collective dose of 116.528 man·mSv for the task. The dose for routine tasks on the Steam Generators was 30% higher than previously.

Number and duration of outages

One refuelling outage on Unit 2 (64 days) and 1 unplanned outage on unit 1 during the generator recovery project (139 days).

Component or system replacements: The Unit 1 generator was replaced successfully.

Unexpected events: The Unit 1 Generator became defective.

Issues of concern in 2007

Koeberg Nuclear Power Station has embarked on various initiatives to reduce dose. Dose reduction via application of additional shielding, improved work management, refinements to outage dose targets and radioactive waste reduction initiatives are planned for 2007.

Technical plans for major work in 2007

Zinc injection will be considered for reduction of the primary system source term at Koeberg Nuclear Power Station. The Radiation Protection Organisation at Koeberg Nuclear Power Station will be changed to improve integration with work management processes. Plans are being derived for the replacement of a reactor vessel head and the current direct reading dosimetry and exit control monitoring systems are being replaced with improved technology.

Regulatory plans for major work in 2007

The next plant safety re-assessment is being discussed with the regulator. The implementation of the work scope relating to such a safety re-assessment may result in higher personnel exposures in the future.

SPAIN

In the year 2006 the average dose per outage was been 0.371 person·Sv for PWR (5 units). Per plant, the annual collective doses and the outage collective doses are shown in the following Table:

NPP	Type	Outage Coll. Doses (person·Sv)	No. Days	Annual Coll. Doses (person·Sv)	Comments
J. Cabrera	PWR	0.087	27	0.336	
Almaraz I	PWR	0.498	35	0.549	
Almaraz II	PWR	0.389	25	0.440	
Ascó I	PWR	0.477	32	0.522	
Ascó II	PWR	–	–	0.091	No outage
Vandellos II	PWR	–	–	0.282	No outage
Trillo	PWR	0.404	36	0.429	
S.M Garoña	BWR	–	–	0.173	No outage
Cofrentes	BWR	–	–	0.646	No outage

With respect to the annual collective dose in PWRs, the PWR average for this year is 0.38 person·Sv and the three-year rolling average is 0.36 person·Sv. This last value indicates that the downward trend continues (decreasing from 0.39 to 0.36), 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 0.41 person·Sv decreasing from 0.46 (the previous year without outages) to 0.41. The three-year rolling average is 1.06 person·Sv, decreasing from 1.65 to 1.06, principally due to the lack of outages during this last year.

	PWR			BWR		
Year	Outages	Collective doses (person·Sv)	3 year rolling average	Outages	Collective doses (person·Sv)	3 year rolling average
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
2006	5	0.38	0.36	0	0.41	1.06

During this year **Trillo I** has had higher outage collective doses than usual due to problems found during the inspection of a main coolant pump which provoke its replacement. Cofrentes NPP had a forced outage during 10 days (from 23/04/2006 to 03/05/2006) in order to change damaged fuel elements. During this outage, doses in BRACS were taken with values according the expected evolution of the radiation values in the area after the decontamination carried out in 2005. In the next 16th refuelling outage (scheduled in April 2007), Cofrentes has planned to replace all 145 CRDM insertion/withdrawal tubes to repair small leakages caused by inter-granular corrosion in certain tubes.

Vandellos II NPP had two forced outages, 63 days in total, due to the detection of three loose pieces of a split-pin from the RPV vessel internals inside the Steam Generator plenum coming from the split pin. The first outage lasted 32 days (from 29/03/2006 to 29/04/2006) with a total collective dose of 37, 69 person·mSv. Repairs encompassed opening of the pressuriser and affected steam generator, tube sheet inspection and loose parts collection. The second one lasted 31 days (from 28/08/2006 to 27/09/2006) in order to replace the damaged split pin. Repairs encompassed opening of the pressuriser and RPV, core unload, split-pin replacement, fuel load, and RPV and pressuriser closure. Additionally, a RCP repair was developed. The dose produced during this forced outage was 178.73 person·mSv.

The definitive shutdown of José Cabrera NPP took place on 30 April 2006. The outage doses were principally due to the fuel movements. The main pre-decommissioning activities starting on 28 May 2006 were: fuel movement, decontamination of the primary system and conditioning of operation wastes. Collective dose associated to shutdown activities was 159 person·mSv since 30/6/2006 to the end of the year.

From the regulatory point of view, after a pilot phase, the new system to supervise NPP – Integrated System for Supervision of NPP (SISC) came into force on 1 January 2006. Jose Cabrera NPP presented the licensing documents for the authorisation of the Individualised Temporary Storage (ITS) for spent fuel (authorisation foreseen by end 2007). A new CSN Technical Instruction IS-10 – Criteria to inform of incidents in NPP was issued in November 2006.

CSN was involved in the preparation of the IAEA Mission to compare Spanish regulatory practices to international standards and good practices establishing an Action Plan. An IAEA visit took place in the first quarter of 2006 the Peer Review being scheduled for January 2008.

SWEDEN

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
PWR	3	0.51
BWR	7	1.09
All types	10	0.91
Reactors in cold shutdown or in decommissioning		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
PWR	0	0
BWR	2*	0.05

**Barsebäck 1 and 2 in final cold shutdown, planning for decommissioning.*

Principal events

Summary of national dosimetric trends

The total collective dose for the Swedish NPP 2006 was 9.14 man·Sv. The collective dose is comparable with 2005 but higher than in 2004. For the upcoming years we expect roughly the same or higher collective doses than in 2006 because of modernisation and upgrading at all the Swedish sites.

The average collective dose per PWR unit (3 units) was 0.51 man·Sv (highest 0.74 man·Sv and lowest 0.28 man·Sv) and the average collective dose per BWR unit (7 units) was 1.09 man·Sv (highest 2.99 man·Sv and lowest 0.32 man·Sv). The average personnel dose at the sites was in the range of 1.34 – 2.91 mSv and the highest individual dose was 19.7 mSv.

Events influencing dosimetric trends

Oskarshamn: Due to the Forsmark 1 event on 25 July 2006, Oskarshamn 1 was stopped at the beginning of August for modifying electrical systems to ensure correct function of safety systems. The unplanned stop lasted for 120 days and the resulting collective dose was 1.91 man·Sv due to maintenance and repair work that was performed during the unplanned outage. The performed work was originally planned to be performed during the outage 2007.

Gamma Source Terms: The overall situation at the Swedish NPP are as expected, but some plants have increasing trends, while others have decreasing. Focus is on turning over increasing source terms as well as upholding positive evolutions.

In general, there are several projects in progress for modernisation, plant life extension and power upgrades. The increase in number and extent of these projects has required an increasing amount of installation work to be done during operation, which will influence the dosimetric trends.

Number and duration of outages

Plant	Type of Reactor	Length of Outage (days)	Collective Dose (man·Sv)	Comments
Forsmark 1	BWR	8	0.17	
Forsmark 2	BWR	37	1.14	
Forsmark 3	BWR	12	0.18	
Oskarshamn 1	BWR	144	2.90	Extended 120 d (1.97 man·Sv) for modifying electrical safety systems
Oskarshamn 2	BWR	68	0.77	
Oskarshamn 3	BWR	42	0.27	
Ringhals 1	BWR	36	0.85	
Ringhals 2	PWR	28	0.59	
Ringhals 3	PWR	36	0.22	
Ringhals 4	PWR	27	0.48	

New plants on line/plants shut down

Barsebäck unit 1 and 2 are in final cold shutdown for decommissioning since 2005.

Major evolutions: None.

Component or system replacements

Forsmark: Replacement of the Low Pressure Turbines and installation of diversified/redundant Residual Heat Removal and Cooling Water systems at F2.

Ringhals: Modernisation of RPS (Reactor Protection System), installation of diversified/redundant Residual Heat Removal and Cooling Water systems at R1. Instrumentation and control (I&C) system replacement (Twice) is in progress at R2. Replacement of Guide Tube Support Pins was carried out at both R2 and R3.

Oskarshamn: Replacement of Turbine Generator, areas were reclassified from controlled to supervised areas.

Safety-related issues

Forsmark: A loss of external power at F1 occurred 25 July 2006, with only two safety diesel generators starting. The event had no radiological impact, but resulted in shutdown for two months. Necessary rework of the Containment Toroid forced F2 to have an unplanned outage for one month shortly after the planned outage.

Oskarshamn: Due to the Forsmark 1 event on 25 July 2006, Oskarshamn 1 was in cold shutdown in the beginning of August to modify electrical systems to ensure correct function of the safety systems.

Unexpected events

Forsmark: F3 encountered 3 fuel failures during 2006. Affected fuel elements were replaced during an extra shutdown in December. The fuel failures did not result in any significant uranium contamination since they did not evolve to any secondary failures.

New/experimental dose-reduction programmes

The Swedish nuclear power plants have together with SKB, the Swedish Nuclear Fuel and Waste Management Co, Studsvik Nuclear AB and Westinghouse Sweden Electric performed an update of an investigation on the Alpha Value (monetary value of the man·sievert, from 1991). The intention is to increase the alpha value from 4.5 million SEK/man·Sv (approx. 430 000 EUR/man·Sv) to 10 million SEK/man·Sv (approx. 950 000 EUR/man·Sv). A translated version of the report is accessible at ISOE Network.

Issues of concern in 2007

Oskarshamn: Oskarshamn 2 will perform a system decontamination in 2 loops of the main recirculation system before performing external NDT (Non Destructive Testing).

Barsebäck: A full system decontamination will be performed as an initial step for decommissioning.

Ringhals: Waste handling of large contaminated components progresses and Steam Generator no. 2 has been shipped to Studsvik Nuclear for volume and weight reduction and to minimise the quantity of radioactive waste for disposal.

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

Organisational evolutions

The Swedish Government has presented proposal for uniting SSI, the Swedish Radiation Protection Authority and SKI, the Swedish Nuclear Power Inspectorate to one authority.

Technical plans for major work in 2007

Forsmark: Replacement of all tubes in the Moist Separator/ Reheater in the turbine plant at F3 during the 2007 outage.

Ringhals: Modernisation of RPS (Reactor Protection System) and installation of a diversified/ redundant Residual Heat Removal and Cooling Water systems at R1 continues. During the first half of 2007 the Reactor Output are increased at R1 and R3.

Oskarshamn: Modernization in progress, PLEX of O2 - Plant Life Extension 2007-2011.

Regulatory plans for major work in 2007.

The legislation on clearance and radiation protection for personnel will continue to be reviewed under 2007. SSI has and will perform inspections at the NPP from an organisational point of view. SSI will also perform inspections of outages for most of the operating units. Moreover SSI, the Swedish Radiation Protection Authority, will focus on:

- power upgrades and system modernisation as regards to radiation levels, personnel doses, radioactive waste and radioactive discharge,
- resource and competence issues concerning staff retirement and plant use of external resources,
- 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		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
PWR	3	0.355
BWR	2	0.887
All types	5	0.602

Principal events

Summary of national dosimetric trends

The total annual collective dose for all five Swiss NPPs was 3 010 man·mSv (0.114 man·mSv/GWh net elec.). This is the second lowest collective dose since starting operation of the last NPP brought on line (Leibstadt). On the other hand there is neither positive nor negative trend visible on the five year average doses in the last decade. The highest maximum individual dose of 10.7 mSv is remarkably low. Only five out of the 3 815 persons working in the NPP received doses above 10.0 mSv. It seems that the dose constraint (10.0 mSv), which is defined by the NPP themselves, has a positive influence on the optimisation of radiation protection.

Events influencing dosimetric trends

The exact preparation of the outages, the slightly reduced dose rates on the components in the main cooling system, as well as the small numbers of leakers in the last year (2006: only one in NPP Gösgen) contributed to the positive development of the collective dose last year.

Number and duration of outages

The NPP Beznau 2 performed a short outage of 10 days (only fuel shuffling). The other NPP performed one planned outage each with duration of about 25 days (range 22-27 days).

Safety-related issues

In NPP Mühleberg the combined injection of Hydrogen and Platin (On-Line-Noble-Chemistry) in the primary system was performed to reduce crack corrosion. This action had the positive side effect of a 20% reduction of the dose rates on the reactor recirculation system.

Unexpected events

In NPP Gösgen the first fuel leaker since 8 years was detected and the defective rod was removed and replaced during the outage.

Technical plans for major work in 2007

Due to the reduced section thickness of the bent pipes in the main steam part of secondary system found in NPP Beznau an exact investigation programme for all pipes is planned for the outage 2007. Several parts of the main steam pipe between the steam generator and high pressure turbine have to be replaced in the next years. The origin of the thin pipe wall lies at the methods used by the manufacturer.

Regulatory plans for major work in 2007

Because of the new nuclear energy ordinance became effective 2005, all guidelines of the Swiss Federal Nuclear Safety Inspectorate (HSK) and several ordinances have to be revised or compiled, in total 35 guidelines. In the year 2007 the majority of guidelines should be completed. A new approach about reporting and rating events similar to the INES-rating system will be established by the HSK.

THE NETHERLANDS

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
PWR	1	0.623
Reactors in cold shutdown or in decommissioning		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv]**
BWR	1	0.00025

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 per 1 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. For the coming years every year some surveillance and maintenance activities will continue to be carried out. The collective annual dose in 2006 was 0.25 man-mSv.

The **Borssele plant** (450 MWe), operated by NV EPZ, is a baseload unit. Up to this year it has enjoyed 33 years of commercial operation. Major backfittings were completed in the plant in 1997. The annual outage in November lasted 43 days. It was a long outage with a lot of maintenance, inspection and modification works. Inspection of both steam generators took place, a turbine-upgrade and several modifications related to the latest 10 yearly evaluation were carried out. The plant electrical output has been raised to 515 MWe. The collective dose in the outage was 0.535 man·Sv. The annual collective dose amounted 0.623 man·Sv. In 2006 the average individual dose 0.54 mSv for plant and 1.02 mSv for contractor personnel. The highest annual individual dose was 3.68 mSv for plant and 8.38 mSv for contractor personnel. In 2007 a short (12 days) outage is foreseen.

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man.Sv]**
PWR	1	0.52
GCR (AGR)	14	0.15
GCR (Magnox)	8*	0.055
Reactors in cold shutdown or in decommissioning		
Reactor type	**Number**	**Average annual collective dose per unit [man.Sv]**
GCR (Magnox)	14	0.06

** Four reactors shut down for the last time on 31/12/06.*

Principal events

Summary of national dosimetric trends

With the exception of Sizewell B all of UK's nuclear power plants are gas-cooled. The year was characterised by a number of major outages at Nuclear Power Plants with significantly higher collective doses on two of the Advanced Gas Cooled Reactors (AGR) owned by British Energy.

Events influencing dosimetric trends

The average annual collective dose at the AGR sites was considerably higher during 2006 principally because of extended unplanned shutdowns at the AGRs at Hinkley Point and Hunterston. During inspections of these power plants cracks were discovered in the boiler pipework, requiring additional inspections and repairs. This additional work necessitated extensive work inside the reactor vessels, in areas of higher doserate.

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 1 man·Sv each. Sizewell B completed its eight refuelling outage that included replacement of the reactor pressure vessel head and replacement of the refuelling machine. The outage lasted 50 days and resulted in a collective dose of 0.48 man·Sv. The collective dose for the head replacement was 0.11 man·Sv.

Major evolutions

Amongst the Magnox reactor sites two plants Dungeness A and Sizewell A were permanently shutdown for decommissioning at the end of 2006. Of the original Magnox reactor fleet only two remain in power operation, Oldbury and Wylfa. Four sites are completely defuelled and are at various stages of decommissioning. Defuelling is in progress at Bradwell and Chapelcross. 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

In July 2006 the UK government-sponsored Committee on Radioactive Waste Management (CORWM) issued its long-awaited report on future radioactive waste disposal policy in UK. CORWM concluded that deep geological disposal was the preferred option for intermediate and high level radioactive wastes. Attention now turns to determining suitable locations for a waste repository.

Technical plans for major work in 2007

Further inspection and repairs to boiler pipework at the advanced gas cooled reactors in Hinkley Point and Hunterston are required during 2007, extending into 2008. It is predicted that doses at Hunterston may exceed 2 man.Sv for the remedial work, due to increasing vessel doserates and the need for long periods inside the Reactor Vessel.

UNITED STATES

The 2006 average annual collective dose for PWRs (69 operating units) and BWRs (34 operating units) is as follows:

	Average annual collective dose per unit in person·rem (man·Sv)		
	2004	2005	2006
PWR	72 (0.72)	78 (0.78)	87 (0.87)
BWR	157 (1.57)	179 (1.79)	146 (1.46)

Browns Ferry Unit 1 was not included in the 103 operating units in 2006.

US BWRs and PWRs continued to show an improving trend when the three-year rolling average collective dose (2004-2006) is considered. For the year 2006 alone, collective dose at US BWRs decreased compared to 2005, while the collective dose at US PWRs increased. Across the US fleet of reactors, one contributor to collective dose is equipment reliability initiatives related to operating license renewals and/or power uprate applications.

The US PWRs collective doses show an increasing trend due to major plant modifications completed in 2006 including containment sump modifications, reactor head replacements, and RTD bypass line replacements. US BWRs results show a decreasing trend due to shorter outage duration, effective source term reduction initiatives and impact of ALARA plant modifications.

U.S. Nuclear Regulatory Commission

All commercial nuclear power reactors operating in the United States must be licensed and monitored by the Nuclear Regulatory Commission (NRC). As of December 31, 2006, there are 103 commercial nuclear power reactors licensed to operate in 31 States. The 103 reactors licensed to operate during 2006 have accumulated 2,560 reactor-years of experience. An additional 385 reactor-years of experience have been accumulated by permanently shutdown reactors.

Strategic Plan

The NRC's FY 2004 – FY 2009 Strategic Plan focuses on five goals:

- **Safety** – Ensure protection of public health and safety and the environment.
- **Security** – Ensure the secure use and management of radioactive materials.
- **Openness** – Ensure openness in our regulatory process.
- **Effectiveness** – Ensure that NRC actions are effective, efficient, realistic, and timely.
- **Excellence** – Ensure excellence in agency management to carry out the NRC's strategic objective.

These goals support NRC's ability to maintain the public health, safety, and trust. Under each goal, strategic outcomes provide general barometer whether the goals are being achieved.

U.S. electricity generated by commercial nuclear power

In 2006, net nuclear-based electric generation in the United States produced a total of 787 billion kilowatt hours. In 2006, the average U.S. net capacity factor was 90%, up from 89% in 2005. Since 1995, the average capacity factor has increased approximately 14%.

International activities

The NRC engages in joint co-operative research programmes through over 70 bilateral and multilateral agreements with 24 countries and OECD, where NRC provides intellectual capital, expert analysis, and experience to our international partners. NRC uses these agreements to leverage access to foreign test facilities not otherwise available in the United States and to expand the knowledge base and contributes to the efficient and effective use of the NRC's resources in conducting research on high-priority safety issues.

Future U.S. Commercial Nuclear Power Reactor Licensing

The NRC expects and is preparing to perform new reactor licensing work in response to the Energy Policy Act of 2005 and associated Administration initiatives. The Act, whose overall goal is to promote "secure, affordable, and reliable energy," recognises that the country's ageing electric power supply system must expand and be replaced with clean energy sources.

The NRC staff is engaged in numerous ongoing interactions with vendors and utilities regarding prospective new reactor applications and licensing activities. Based on these interactions, the staff expects to receive a significant number of new reactor combined license (COL) applications over the next several years and has developed the infrastructure necessary to support the application reviews. Between calendar years 2007 and 2009, the NRC expects to receive 21 COL applications, encompassing 32 new nuclear units.

The NRC is performing several activities to ensure that it is prepared to review new applications. Additional information on the NRC's new reactor licensing activities is available on the NRC's Web site at http://www.nrc.gov/reactors/new-reactor-licensing.html.

Reactor License Renewal

Based on the Atomic Energy Act, the NRC issues licenses for commercial power reactors to operate for 40 years and allows these licenses to be renewed for up to an additional 20 years. The original 40-year term for reactor licenses was based on economic and antitrust considerations, not on limitations of nuclear technology. Due to this selected time period, however, some structures and components may have been engineered on the basis of an expected 40-year service life.

As of July 2006, approximately one-half of the licensed plants have either received or are under review for license renewal. The NRC Web site (http://www.nrc.gov) provides information on the plants that have received renewed licenses and the renewal applications that are under review. The Web site also provides information on the license renewal regulations and process.

NRC Reactor Oversight

The NRC regulates the operation of the nation's 104 nuclear power plants by establishing regulatory requirements for the design, construction and operation of such plants. To ensure that the plants are operated safely within these requirements, the NRC licenses the plants to operate, licenses the plant operators, and establishes technical specifications for the operation of each plant.

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

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

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

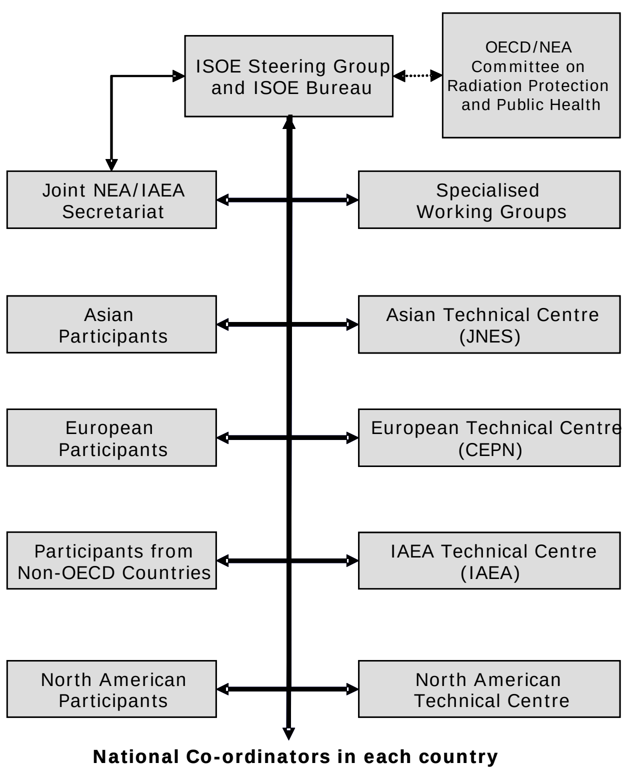
Annex 1

ISOE ORGANISATIONAL STRUCTURE AND PROPOSED PROGRAMME OF WORK FOR 2007

A.1 ISOE Organisational Structure

ISOE operates in a decentralised manner. A Steering Group composed of utility and regulatory authority representatives from all participating countries, supported by the joint NEA and IAEA Secretariat, provides overall direction. The ISOE Steering Group reports to the Steering Committee of the Nuclear Energy Agency through the NEA Committee on Radiation Protection and Public Health. Move information on the organisational structure can be found on the NEA website (www.nea.fr).

Four ISOE Technical Centres (Europe, North America, Asia and IAEA) manage the programme's day-to-day technical operations, serving as contact point for the transfer of information from and to participants. A national co-ordinator in each country provides a link between the ISOE participants and the ISOE programme. A list of National Co-ordinators is given in Annex 6.



A.2 ISOE Programme of Work for 2007

1) ISOE database management

Data collection and management

Collection of ISOE 1 and ISOE 2 data: ISOE participants will provide their 2006 ISOE 1 and ISOE 2 data using the ISOE Software under Microsoft ACCESS and/or through the new ISOE Network data input modules, subject to their availability and status.

Collection of ISOE 3 reports: While ISOE 3 reports will continue to be collected, all new and existing reports will be transferred to the ISOE Network ALARA library, and made searchable by keyword. The ISOE Network will be used to exchange and record other ISOE 3-type information, i.e., radiation protection-related information for specific operations or tasks, in order to achieve the ISOE 3 experience exchange objective through the implementation of an effective and widely-used web-based information exchange ALARA portal.

Management of the official ISOE databases

Official database release: In 2006, the ISOEDAT data viewing module, MADRAS, was implemented on the ISOE Network as the primary data viewing and analysis application. Further use of this will continue in 2007, including regular updates on the website; however, ISOEDAT final annual release will also continue to be distributed to participants on CD-ROM.

Development of ISOEDAT online: Phase 2 of the ISOEDAT migration to the web will continue with the further development, testing and implementation of the ISOEDAT data entry modules for ISOE 1 data questionnaires (NEA with ETC support).

2) ISOE management and programme activities

Regular meetings of the ISOE programme will continue according to the following schedule:

Meeting*	March	May	Sep	Nov
WGDA Expert Group on Work Management	X	X	X	
Technical Centre Co-ordination meeting		X		X
Working Group on Data Analysis		X		X
ISOE Bureau		X		X
17th ISOE Steering Group Meeting				X

* Ad-hoc meetings not included.

ISOE Working Group on Data Analysis

The Working Group on Data Analysis (WGDA) will:

- undertake identified technical analyses tasks, including reviewing the consistency and completeness of the ISOE databases;

- 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 annual reports;
- through the ISOEDAT web migration group, continue and complete work on the development, testing and implementation of the ISOEDAT web migration, Phase 2.

ISOE WGDA Expert Group on Work Management

The ad-hoc Expert Group on Work Management (EGWM) will develop a revision to the report *Work Management in the Nuclear Power Industry* (OECD/NEA 1997), in order to reflect the current state of knowledge, technology and experience in occupational radiation protection of workers at nuclear power plants. The outcome of the work will be a new ISOE publication on work management that will find broad use within the NPP radiation protection community. The EGWM will undertake its work by

- collecting information and practical experience available in the nuclear industry on applying work management approaches and procedures to the control of occupational exposures;
- identifying factors and aspects which play key roles in achieving these results and analysing and quantifying their impact on worker doses and operational costs;
- reviewing the implications for radiation protection criteria in new nuclear build.

A draft report will be presented to the ISOE Steering Group and WGDA in November 2007 for initial review, comment and further direction.

ISOE Publications and Reports

The following ISOE publications and reports will be produced and published in 2007. All products will be made available through the ISOE network as appropriate.

- **ISOE Annual Report 2006:** Publish the 16th Annual Report (2006) in September 2007.
- **ISOE Terms and Conditions:** Issue the revised ISOE Terms and Conditions (2007-2010).
- **ISOE News:** Continue to electronically issue current ISOE information through the ISOE News.
- **ISOE Symposia Proceedings:** ETC will update the ISOE Network with available symposia proceedings and presentations, as provided to the ETC by each centre.
- **Benchmark Visit Reports:** Reports of benchmarking visits organised under ISOE will be made available to the ISOE membership through the ISOE Network. Additionally, ETC will, for its benchmarking visits organised outside of ISOE resources, do its best to make the reports available to ISOE Participants after agreement of the plant visited.
- **ISOE Brochure:** Enhanced electronic version of the ISOE promotional brochure, linked to deeper layers of information on the ISOE Network.

3) ISOE ALARA Symposium (International and Regional)

- The 2007 ISOE International Symposium: 15-17 January 2007 in Ft. Lauderdale, USA.
- The 2007 ISOE Asian Regional Symposium: September 2007 in Korea.

4) ISOE Network Website Management and Technical Centre input

Network Website Management

Develop and implement Phase 2 of the ISOE Network (www.isoe-network.net) subject to Steering Group guidance and based on a cohesive strategy to improve accessibility, ease of use, functionality and completeness of information. This work will be undertaken by a small task team, and will include efforts to improve website usefulness, unify servers, simplify passwords, develop mechanisms for continued feedback and promote the system amongst all members. Training sessions on the use of the ISOE Network tools will be organised to meet user needs (organised by the ETC on request). Improvements in the ALARA Library Search Function will be undertaken by ATC and ETC.

Technical centre input for the ISOE Network

All technical centres will continue to make their information available for posting on the ISOE Network. The ETC will continue to post all information and products from all regions as it is made available. All current and new ISOE 3 information from MADRAS will be transferred to the website, maintaining information access according to user type (utility member access).

5) Information sheets, technical reports and information exchange

Technical centre information sheets planned for 2007:

Yearly analyses		**Centre**	**Number**
	Japanese dosimetric results: FY 2006 data and trends	ATC	ATC-30
	Preliminary European dosimetric results for 2006	ETC	n/a
	Update of the annual outage duration and doses in European reactors (1994-2006)	ETC	n/a
Special analyses			
	Findings and Conclusions of the project RAS/9/030 (ALARA implementation in NPPs in ROK, PRC, PAK and IR of IRAN)	IAEATC	

Information exchange activities:

The technical centres will continue to respond to special requests from users for technical feedback, and share this information with all participants as appropriate.

New technical centre documents and reports

ATC will produce an “ISOE Handbook” in Japanese.

6) ISOE-organised benchmarking visits

The following site benchmarking visits will be organised in 2007 by the technical centres in co-ordination with the ISOE WGDA and Steering Group:

ATC	One benchmarking visit in Finland/France Exchange of experts from Korea to USA (PWR, CANDU)
ETC	One benchmarking visit at Paks (Hungary)
IAEATC	None scheduled
NATC	One benchmarking visit to European PWR

7) Other topics

Promotion of ISOE Use

- All users will be notified of the updated website through targeted emails. Other potential users and stakeholders will receive the revised ISOE promotional brochure.
- A mechanism for gathering feedback from users and providing information to users will be implemented through the ISOE Network and other means as appropriate.
- Further information on ISOE will be distributed to non-OECD country participants through IAEA Technical Co-operation Projects to IAEA Member States.

Annex 2

LIST OF ISOE PUBLICATIONS

Reports

1. *Occupational Exposures at Nuclear Power Plants: Fifteenth Annual Report of the ISOE Programme, 2005*, OECD, 2007.
2. *Occupational Exposures at Nuclear Power Plants: Fourteenth Annual Report of the ISOE Programme, 2004*, OECD, 2006.
3. *Occupational Exposures at Nuclear Power Plants: Thirteenth Annual Report of the ISOE Programme, 2003*, OECD, 2005.
4. *Optimisation in Operational Radiation Protection,* OECD, 2005.
5. *Occupational Exposures at Nuclear Power Plants: Twelfth Annual Report of the ISOE Programme, 2002,* OECD, 2004.
6. *Occupational Exposure Management at Nuclear Power Plants: Third ISOE European Workshop, Portoroz, Slovenia, 17 – 19 April 2002,* OECD 2003.
7. *ISOE – Information Leaflet*, OECD 2003.
8. *Occupational Exposures at Nuclear Power Plants: Eleventh Annual Report of the ISOE Programme, 2001,* OECD, 2002.
9. *ISOE – Information System on Occupational Exposure, Ten Years of Experience*, OECD, 2002.
10. *Occupational Exposures at Nuclear Power Plants: Tenth Annual Report of the ISOE Programme, 2000*, OECD, 2001.
11. *Occupational Exposures at Nuclear Power Plants: Ninth Annual Report of the ISOE Programme, 1999*, OECD, 2000.
12. *Occupational Exposures at Nuclear Power Plants: Eighth Annual Report of the ISOE Programme, 1998*, OECD, 1999.
13. *Occupational Exposures at Nuclear Power Plants: Seventh Annual Report of the ISOE Programme, 1997*, OECD, 1999.
14. *Work Management in the Nuclear Power Industry*, OECD, 1997 (also available in Chinese, German, Russian and Spanish).
15. *ISOE – Sixth Annual Report: Occupational Exposures at Nuclear Power Plants: 1969-1996*, OECD, 1998.
16. *ISOE – Fifth Annual Report: Occupational Exposures at Nuclear Power Plants: 1969-1995*, OECD, 1997.
17. *ISOE – Fourth Annual Report: Occupational Exposures at Nuclear Power Plants: 1969-1994*, OECD, 1996.
18. *ISOE – Third Annual Report: Occupational Exposures at Nuclear Power Plants: 1969-1993*, OECD, 1995.
19. *ISOE – Nuclear Power Plant Occupational Exposures in OECD Countries: 1969-1992*, OECD, 1994.
20. *ISOE – Nuclear Power Plant Occupational Exposures in OECD Countries: 1969-1991*, OECD, 1993.

ISOE news

No. 9: March 2006	No. 4: December 2004
No. 8: December 2005	No. 3: July 2004
No. 7: October 2005	No. 2: March 2004
No. 6: June 2005	No. 1: December 2003
No. 5: April 2005	

ISOE information sheets

Asian Technical Centre	
No. 29: Nov 2006	Japanese Dosimetric Results : FY 2005 Data and Trends
No. 28: Nov 2005	Japanese Dosimetric Results : FY 2004 Data and Trends
No. 27: Nov 2004	Achievements and Issues in Radiation Protection in the Republic of Korea
No. 26: Nov 2004	Japanese occupational exposure during periodic inspection at PWRs and BWRs ended in FY 2003
No. 25: Nov 2004	Japanese dosimetric results: FY2003 data and trends
No. 24: Oct 2003	Japanese Occupational Exposure of Shroud Replacements
No. 23: Oct 2003	Japanese Occupational Exposure of Steam Generator Replacements
No. 22: Oct 2003	Korea, Republic of; Summary of national dosimetric trends
No. 21: Oct 2003	Japanese occupational exposure during periodic inspection at PWRs and BWRs ended in FY 2002
No. 20: Oct 2003	Japanese dosimetric results: FY2002 data and trends
No. 19: Oct 2002	Korea, Republic of; Summary of national dosimetric trends
No. 18: Oct 2002	Japanese occupational exposure during periodic inspection at PWRs and BWRs ended in FY 2001
No. 17: Oct 2002	Japanese dosimetric results: FY2001 data and trends
No. 16: Oct 2001	Japanese occupational exposure during periodical inspection at PWRs and BWRs ended in FY 2000
No. 15: Oct 2001	Japanese Dosimetric results: FY 2000 data and trends
No. 14: Sep 2000	Japanese Occupational Exposure During Periodical Inspection at LWRs Ended in FY 1999
No. 13: Sep 2000	Japanese Dosimetric Results: FY 1999 Data and Trends
No. 12: Oct 1999	Japanese Occupational Exposure During Periodical Inspection at LWRs Ended in FY 1998
No. 11: Oct 1999	Japanese Dosimetric Results: FY 1998 Data and Trends
No. 10: Nov 1999	Experience of 1st Annual Inspection Outage in an ABWR
No. 9: Oct 1999	Replacement of Reactor Internals and Full System Decontamination at a Japanese BWR
No. 8: Oct 1998	Japanese Occupational Exposure During Periodical Inspection at LWRs Ended in FY 1997
No. 7: Oct 1998	Japanese Dosimetric Results: FY 1997 data
No. 6: Sep 1997	Japanese Occupational Exposure during Periodical Inspection at LWRs ended in FY 1996
No. 5: Sep 1997	Japanese Dosimetric Results: FY 1996 data

No. 4: Jul 1996	Japanese Occupational Exposure during Periodical Inspection at LWRs ended in FY 1995
No. 3: Jul 1996	Japanese Dosimetric Results: FY 1995 data
No. 2: Oct 1995	Japanese Occupational Exposure during Periodical Inspection at LWRs ended in FY 1994
No. 1: Oct 1995	Japanese Dosimetric Results: FY 1994 data
European Technical Centre	
No. 44: 2006	Preliminary European dosimetric results for 2005
No. 43: 2006	Conclusions and recommendations from the Essen Symposium
No. 42: Nov 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: Nov 2004	Update of the annual outage duration and doses in European reactors (1993-2003)
No. 37: Jul 2004	Conclusions and recommendations from the 4th European ISOE workshop on occupational exposure management at NPPs
No. 36: Oct 2003	Update of the annual outage duration and doses in European reactors (1993-2002)
No. 35: Jul 2003	Preliminary European dosimetric results for 2002
No. 34: Jul 2003	Man-Sievert monetary value survey (2002 update)
No. 33: Mar 2003	Update of the annual outage duration and doses in European reactors (1993-2001)
No. 32: Nov 2002	Conclusions and Recommendations from the 3rd European ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants
No. 31: Jul 2002	Preliminary European Dosimetric Results for the year 2001
No. 30: Apr 2002	Occupational exposure and steam generator replacements - update
No. 29: Apr 2002	Implementation of Basic Safety Standards in the regulations of European countries
No. 28: Dec 2001	Trends in collective doses per job from 1995 to 2000
No. 27: Oct 2001	Annual outage duration and doses in European reactors
No. 26: Jul 2001	Preliminary European Dosimetric Results for the year 2000
No. 25: Jun 2000	Conclusions and recommendations from the 2nd EC/ISOE workshop on occupational exposure management at nuclear power plants
No. 24: Jun 2000	List of BWR and CANDU sister unit groups
No. 23: Jun 2000	Preliminary European Dosimetric Results 1999
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: Apr 1999	Preliminary European Dosimetric Results 1998
No. 19: Oct 1998	ISOE 3 data base – New ISOE 3 Questionnaires received (since September 1998) (restricted distribution)
No. 18: Sep 1998	The Use of the man-Sievert monetary value in 1997 (general distribution)
No. 17: Dec 1998	Occupational Exposure and Steam Generator Replacements, update

	(general distribution)
No. 16: Jul 1998	Preliminary European Dosimetric Results for 1997 (general distribution)
No. 15: Sep 1998	PWR collective dose per job 1994-1995-1996 data (general distribution)
No. 14: Jul 1998	PWR collective dose per job 1994-1995-1996 data (restricted distribution)
No. 12: Sep 1997	Occupational exposure and reactor vessel annealing
No. 11: Sep 1997	Annual individual doses distributions: data available and statistical biases
No. 10: Jun 1997	Preliminary European Dosimetric Results for 1996
No. 9: Dec 1996	Reactor Vessel Closure Head Replacement
No. 7: Jun 1996	Preliminary European Dosimetric Results for 1995
No. 6: Apr 1996	Overview of the first three Full System Decontamination
No. 4: Jun 1995	Preliminary European Dosimetric Results for 1994
No. 3: Jun 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: Apr 1994	Occupational Exposure and Steam Generator Replacement
IAEA Technical Centre	
No. 9: Aug 2003	Preliminary dosimetric results for 2002
No.8: Nov 2002	Conclusions and Recommendations from the 3rd European ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants
No. 7: Oct 2002	Information on exposure data collected for the year 2001
No. 6: Jun 2001	Preliminary dosimetric results for 2000
No. 5: Sep 2000	Preliminary dosimetric results for 1999
No. 4: Apr 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
No. 2: Apr 1999	IAEA Publications on occupational radiation protection
No. 1: Oct 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: Jul 2002	US BWR 2001 Occupational Dose Benchmarking Chart
No. 02-4: Jul 2002	US PWR 2001 Occupational Dose Benchmarking Chart
No. 02-2: Jul 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: Jul 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 and regional symposia

Asian Technical Centre	
Oct 2006 (Yuzawa, Japan)	2006 ISOE Asian Regional ALARA Symposium
Nov 2005 (Hamaoka, Japan)	First Asian ALARA Symposium
European Technical Centre	
Mar 2006 (Essen, Germany)	2006 ISOE International ALARA Symposium
Mar 2004 (Lyon, France)	Fourth ISOE European Workshop on Occupational Exposure Management at Nuclear Power Plants
Apr 2002 (Portoroz, Slovenia)	Third ISOE European Workshop on Occupational Exposure Management at Nuclear Power Plants
Apr 2000 (Tarragona, Spain)	Second EC/ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants
Sep 1998 (Malmö, Sweden)	First EC/ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants
North American Technical Centre	
Jan 2006 (Ft. Lauderdale, FL, USA)	2006 ISOE North American ALARA Symposium
Jan 2005 (Ft. Lauderdale, FL, USA)	2005 ISOE International ALARA Symposium
Jan 2004 (Ft. Lauderdale, FL, USA)	2004 North American ALARA Symposium
Jan 2003 (Orlando, FL, USA)	2003 International ALARA Symposium
Feb 2002 (Orlando, FL, USA)	North-American National ALARA Symposium
Feb 2001 (Orlando, FL, USA)	2001 International ALARA Symposium
Jan 2000 (Orlando, FL, USA)	North-American National ALARA Symposium
Jan 1999 (Orlando, FL, USA)	Second International ALARA Symposium
Mar 1997 (Orlando, FL, USA)	First International ALARA Symposium

Annex 3

ISOE PARTICIPATION AS OF DECEMBER 2006

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	Bruce A3, A4 (A1, A2)*	Bruce B5, B6, B7, B8
	Ontario Power Generation	Darlington 1, 2, 3, 4	Pickering A1, A4 (A2, A3)* Pickering B5, B6, B7, B8
	Hydro Quebec	Gentilly 2	
	New Brunswick Power	Point Lepreau	
		(laid-up)*	
China	Guangdong Nuclear Power Joint Venture Co., Ltd	Daya Bay 1, 2	
	Qin Shan Nuclear Power Co.	Qinshan 1	
	Ling Ao Nuclear Power Co. Ltd	Ling Ao 1, 2	
Czech Republic	CEZ	Dukovany 1, 2, 3, 4 Temelin 1, 2	
Finland	Fortum Power and Heat Oy	Loviisa 1, 2	
	Teollisuuden Voima Oy	Olkiluoto 1, 2	
France	Électricité de France (EDF)	Belleville 1, 2 Blayais 1, 2, 3, 4 Bugey 2, 3, 4, 5 Cattenom 1, 2, 3, 4 Chinon B1, B2, B3, B4 Chooz B1, B2 Civaux 1, 2 Cruas 1, 2, 3, 4 Dampierre 1, 2, 3, 4 Fessenheim 1, 2	Flamanville 1, 2 Golfech 1, 2 Gravelines 1, 2, 3, 4, 5, 6 Nogent 1, 2 Paluel 1, 2, 3, 4 Penly 1, 2 Saint-Alban 1, 2 Saint Laurent B1, B2 Tricastin 1, 2, 3, 4
Germany	E.ON Kernkraft GmbH	Brokdorf Grafenrheinfeld Grohnde	Isar 1, 2 Unterweser
	EnBW Kernfraft AG	Philippsburg 1, 2	Gemeinschaftskraftwerk-Neckar 1, 2
	RWE Power AG	Biblis A, B Emsland	Gundremmingen B, C
	Vattenfall Europe Nuclear Energy GmbH	Brunsbüttel	Krümmel
	(Where multiple owners and/or operators are involved, only Leading Undertakings are listed)		

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 1,2	
	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, 6
Lithuania	Ignalina Nuclear Power Plant	Ignalina 2	
Mexico	Comisiòn Federal de Electricidad	Laguna Verde 1, 2	
Pakistan	Pakistan Atomic Energy Commission	Chasnupp 1	Kanupp
Romania	Societatea Nationala Nuclearelectrica	Cernavoda 1	
Russian Federation	Rosenergoatom	Balakovo 1, 2, 3, 4 Kalinin 1, 2, 3 Kola 1, 2, 3, 4	Novovoronezh 3, 4, 5 Volgodonsk 1
Slovak Republic	JAVYS	JAVYS 1, 2 (Bohunice 1, 2)	
	Slovenske Electrarne	Bohunice 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
Sweden	Forsmarks Kraftgrupp AB	Forsmark 1, 2, 3	
	OKG AB	Oskarshamn 1, 2, 3	
	Vatenfall AB	Ringhals 1, 2, 3, 4	
Switzerland	Forces Motrices Bernoises (FMB)	Mühleberg	
	Kernkraftwerk Gosgen-Daniken (KGD)	Gosgen	
	Kernkraftwerk Leibstadt AG (KKL)	Leibstadt	
	Nordostschweizerische Kraftwerke AG (NOK)	Beznau 1, 2	
The Netherlands	N.V. EPZ	Borssele	
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	British Energy	Sizewell B	
United States	American Electric Power	D.C. Cook 1, 2	South Texas 1, 2
	Arizona Public Service Co.	Palo Verde 1, 2, 3	
	Constellation Energy	Calvert Cliffs 1, 2 Ginna	Nine Mile Point 1, 2
	Progress Energy	H. B. Robinson 2	
	Entergy Nuclear NE	Indian Point 2, 3	Pilgrim 1
	Exelon	Braidwood 1, 2 Byron 1, 2 Clinton 1 Dresden 2, 3 LaSalle County 1, 2	Limerick 1, 2 Oyster Creek 1 Peach Bottom 2, 3 Quad Cities 1, 2 TMI 1
	First Energy Corporation	Beaver Valley 1,2 Davis Besse 1	Perry 1
	Florida Power and Light	Duane Arnold 1 Seabrook	St. Lucie 1, 2 Turkey Point 3, 4
	Nuclear Management Company	Kewaunee 1 Monticello 1 Palisades 1	Point Beach 1, 2 Prairie Island 1,2
	Pacific Gas and Electric Co.	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	
	Southern Nuclear Company	Vogtle 1, 2	
	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	NPD	
	Hydro Quebec	Gentilly 1	
France	Électricité de France (EDF)	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	Mülheim-Kärlich	
	(Where multiple owners and/or operators are involved, only Leading Undertakings are listed)		
Italy	SOGIN	Caorso Garigliano	Latina Trino
Japan	Japan Atomic Power Co.	Tokai 1	
	Japan Atomic Energy Agency	Fugen (LWCHWR)	
Lithuania	Ignalina Nuclear Power Plant	Ignalina 1	
Russian Federation	Rosenergoatom	Novovoronezh 1, 2	
Spain	UNESA	Jose Cabrera	Vandellos 1
Sweden	Barsebäck Kraft AB	Barsebäck 1, 2	
The Netherlands	NCGKN	Dodewaard	

Ukraine	Ministry of Energy of Ukraine	Chernobyl 1, 2, 3
United States	Amergen Energy Company	TMI 2
	Entergy Nuclear NE	Indian Point 1
	Exelon	Dresden 1 Zion 1, 2 Peach Bottom 1
	Nuclear Management Company	Big Rock Point 1
	Pacific Gas and Electric Company	Humboldt Bay 3
	Southern California Edison Co.	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	Direction Générale du Travail (DGT) du Ministère de l'emploi, de la cohésion sociale et du logement, represented by l'Institut de Radioprotection et de Sûreté Nucléaire (IRSN)
Germany	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, represented by GRS
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 (HSK, Swiss Federal Nuclear Safety Inspectorate)
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'Energie 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 co-operation

- 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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