Radiological Protection

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Occupational Exposures at Nuclear Power Plants

Eighteenth Annual Report of the ISOE Programme, 2008

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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 steadily decreased since the early 1990s. Regulatory pressures, technological advances, improved plant designs and operational procedures, “as low as reasonably achievable” (ALARA) culture and experience exchange have contributed to this downward trend. However, with the continued ageing and possible life extensions of nuclear power plants worldwide, ongoing economic pressures, regulatory, social and political evolutions, and the potential of new nuclear build, the task of ensuring that occupational exposures are as low as reasonably achievable taking into account operational costs and social factors, continues to present challenges to radiological protection professionals.

Since 1992, the Information System on Occupational Exposure (ISOE), jointly sponsored by the OECD Nuclear Energy Agency (NEA) and the International Atomic Energy Agency (IAEA), has provided a forum for radiological protection professionals from nuclear power utilities and national regulatory authorities worldwide to discuss, promote and co-ordinate international co-operative undertakings for the radiological protection of workers at nuclear power plants. The objective of ISOE is to improve the management of occupational exposures at nuclear power plants by exchanging broad and regularly updated information, data and experience on methods to optimise occupational radiological protection.

As a technical exchange initiative, ISOE 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, and cost-benefit and other analyses promoting the application of the ALARA principle in local radiological protection programmes.

This Eighteenth Annual Report of the ISOE Programme (2008) presents the status of the ISOE programme for the year 2008.

"... the exchange and analysis of information and data on ALARA experience, dose-reduction techniques, and individual and collective radiation doses to the personnel of nuclear installations and to the employees of contractors are essential to implement effective dose management programmes and to apply the ALARA principle." (ISOE Terms and Conditions, 2008-2011).

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

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EXECUTIVE SUMMARY

Since 1992, the Information System on Occupational Exposure (ISOE) has supported the optimisation of worker radiological protection in nuclear power plants through a worldwide information and experience exchange network for radiation protection professionals at nuclear power plants and national regulatory authorities, and through the publication of relevant technical resources for ALARA management. This 18th Annual Report of the ISOE Programme (2008) presents the status of the ISOE programme for the calendar year 2008.

ISOE is jointly sponsored by the OECD/NEA and IAEA, and its membership is open to nuclear electricity utilities and radiation protection regulatory authorities worldwide who accept the programme's Terms and Conditions. The current ISOE Terms and Conditions for the period 2008-2011 came into force on 1st January 2008. At the end of 2008, the ISOE programme included 59 participating utilities in 26 countries (278 operating units and 32 shutdown units), as well as the regulatory authorities of 22 countries. The ISOE occupational exposure database itself included information on occupational exposure levels and trends at 397 operating reactors in 29 countries, covering about 90% of the world's operating commercial power reactors. Four ISOE Technical Centres (Europe, North America, Asia and the IAEA) manage the programme's day-to-day technical operations.

Based on the occupational exposure data supplied by ISOE members for operating power reactors, the 2008 average annual collective doses per reactor and 3-year rolling averages per reactor (2006-2008) were:

	2008 average annual collective dose (man·Sv/reactor)	**3-year rolling average for 2006-2008 (man·Sv/reactor)**
Pressurised water reactors (PWR/VVER)	0.69	0.72
Boiling water reactors (BWR)	1.35	1.38
Pressurised heavy water reactors (PHWR/CANDU)	1.27	1.07
All reactors, including gas cooled (GCR) and light water graphite reactors (LWGR)	0.86	0.86

In addition to information from operating reactors, the ISOE database contains dose data from 75 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. However, work continued in 2008 to improve the data collection for such 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 2008, the ISOE network website (www.isoe-network.net) continued to provide the ISOE membership with a comprehensive web-based information and experience exchange portal on dose reduction and ISOE ALARA resources. The development of data input modules for the on-line submission of members' occupational exposure data continued during 2008, for final testing and implementation in 2009.

The annual ISOE international ALARA symposia on occupational exposure management at nuclear power plants continued to provide an important forum for ISOE participants and for vendors to exchange practical information and experience on occupational exposure issues. The 2008 ISOE International ALARA Symposium, organised by the Asian Technical Centre, was held in Tsuruga, Japan. The technical centres also continued to host regional symposia, which – in 2008 – included the ISOE European Regional ALARA Symposium, organised by the European Technical Centre in Turku, Finland, and the ISOE North American Regional ALARA Symposium in Fort Lauderdale, United States, organised by the North American Technical Centre in co-operation with EPRI. These symposia provide a global forum to promote the exchange of ideas and management approaches for maintaining occupational radiation exposures as low as reasonably achievable.

Of importance is the support that the technical centres supply in response to special requests for rapid technical feedback and in 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 occupational exposure management.

The ISOE Working Group on data analysis (WGDA) continued its activities in support of the technical analysis of the ISOE data and experience, focusing largely on the integrity and consistency of the ISOE database. Under the WGDA, the Expert Group on work management completed its report on *Work Management to Optimise Occupational Radiological Protection at Nuclear Power Plants*.

Principal events in ISOE participating countries are summarised in Section 6 of this report. Details of ISOE participation and programme of work for 2009 are provided in the appendices.

SYNTHÈSE DU RAPPORT

Depuis 1992, le programme ISOE (système d'information sur les expositions professionnelles) 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 la publication de dossiers techniques spécifiques pour la mise en œuvre d'ALARA. Ce dix-huitième rapport annuel du système ISOE (2008) fait le point sur le programme ISOE à la fin de l'année 2008.

ISOE est conjointement sponsorisé par l'Agence de l'OCDE pour l'énergie nucléaire et l'AIEA, et est ouvert à l'adhésion d'exploitants des centrales nucléaires de production d'électricité et des autorités réglementaires de radioprotection qui acceptent les conditions de mise en œuvre du programme. Les conditions de mise en œuvre actuelles pour la période 2008-2011 sont entrées en vigueur le 1er janvier 2008. À la fin de 2008, 59 exploitants de 26 pays participaient au programme ISOE (278 réacteurs nucléaires en fonctionnement et 32 réacteurs arrêtés) ainsi que les autorités réglementaires de 22 pays. La base de données ISOE quant à elle contient des informations sur les expositions professionnelles et leurs tendances pour 397 réacteurs en exploitation dans 29 pays, représentant ainsi près de 90 % de l'ensemble des réacteurs de puissance en fonctionnement dans le monde. Quatre centres techniques ISOE (Europe, Amérique du Nord, Asie et AIEA) gèrent au jour le jour les opérations techniques du programme.

Sur la base des données sur les expositions professionnelles fournies par les membres ISOE, la dose collective moyenne par réacteur annuelle pour 2008 et la dose collective par réacteur moyennée sur trois ans (2006-2008) des réacteurs en fonctionnement étaient de :

	Dose collective moyenne annuelle 2008 (Homme·Sv/réacteur)	**Dose collective moyennée trois ans pour 2006-2008 (Homme·Sv/réacteur)**
Réacteurs à eau pressurisée (REP/VVER)	0,69	0,72
Réacteurs à eau bouillante (REB)	1,35	1,38
Réacteurs à eau lourde pressurisée (PHWR/CANDU)	1,27	1,07
Tous les réacteurs, y compris les graphite gaz (GCR) et les réacteurs à eau graphite (RBMK)	0,86	0,86

La base de données ISOE contient également des données concernant les doses collectives de 75 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. Toutefois, un travail a été poursuivi en 2008 pour améliorer la collecte de données pour ces réacteurs en vue de faciliter les comparaisons. 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 2008, le site internet du Réseau ISOE (www.isoe-network.net) a continué de fournir aux membres ISOE une information complète ainsi qu'un portail d'échange d'expérience sur la réduction des doses et sur les documents ALARA. Le développement du module de saisie des données pour la soumission sur le Web des données d'exposition professionnelle des participants a continué en 2008, afin d'effectuer les tests finaux et la mise en œuvre du module en 2009.

Les symposiums ISOE ALARA annuels internationaux sur la gestion des expositions professionnelles dans les centrales nucléaires constituent des rendez-vous importants permettant aux participants ISOE et aux entreprises exposantes d'échanger des informations et des bonnes pratiques sur les expositions professionnelles dans les centrales nucléaires. Le symposium international ISOE ALARA de 2008, organisé par le centre technique ISOE asiatique, s'est tenu à Tsuruga, au Japon. Les centres techniques continuent également d'organiser des symposiums régionaux : en 2008, un symposium a été organisé par le centre technique ISOE européen à Turku, en Finlande et un symposium a été organisé à Fort Lauderdale, aux États-Unis par le centre technique ISOE d'Amérique du Nord en coopération avec l'EPRI. Ces symposiums perpétuent la tradition de fournir un large forum pour promouvoir les échanges d'idées et d'expériences 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.

Le groupe de travail ISOE sur l'analyse des données (WGDA) a poursuivi ses activités d'appui pour l'analyse technique des données, en se focalisant principalement sur l'intégrité et la cohérence de la base de données ISOE. Dans le cadre du WGDA, le groupe d'experts sur la gestion du travail a finalisé son rapport sur « L'organisation du travail pour optimiser les expositions professionnelles dans les centrales nucléaires ».

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 la participation et le programme de travail d'ISOE pour 2009 sont fournis dans les appendices.

ZUSAMMENFASSUNG

Seit 1992 fördert ISOE die Optimierung des Strahlenschutzes in Kernkraftwerken durch weltweiten Informations- und Erfahrungsaustausch für beruflich strahlenexponierte Personen und nationale Aufsichtsbehörden und die Veröffentlichung von wichtigen technischen Erkenntnissen das ALARA – Management. Dieser 18. Jahresbericht (2008) stellt den Status des ISOE-Progamms für das Kalenderjahr 2008 vor.

ISOE wird gemeinsam durch OECD/NEA und IAEA unterstützt, eine Mitgliedschaft ist für alle Kernkraftwerksbetreiber und Strahlenschutzaufsichtsbehörden unter Beachtung und Anerkennung der ISOE- Geschäftsordnung weltweit offen. Die geltenden Geschäftsbedingungen für die Zeit von 2008 bis 2011 traten am 01. Januar 2008 in Kraft. Am Ende des Jahres 2008 waren 59 Betreiber aus 26 Ländern (278 in Betrieb befindliche KKW, 32 im Rückbau befindliche Anlagen) sowie Aufsichtsbehörden aus 22 Ländern im ISOE Programm eingebunden. Die ISOE-Datenbank zur beruflichen Strahlenexposition enthält Informationen zu Dosisdaten und Dosistrends von 397 in Betrieb befindlichen Reaktoren in 29 Ländern, die etwa 90% der weltweit kommerziell genutzten Leistungsreaktoren darstellen. Vier ISOE Zentren (Europa, Nordamerika, Asien und IAEA) sind für die technisch-organisatorische Umsetzung des ISOE Programms zuständig.

Basierend auf den von den ISOE- Mitgliedern gelieferten Daten zeigt die nachfolgende Tabelle die durchschnittliche jährliche Kollektivdosis und die gleitenden 3-Jahres Mittelwerte für in Betrieb befindliche Leistungsreaktoren pro Block:

	2008 mittlere Jahreskollektivdosis (man·Sv/Block)	**3-Jahresmittelwerte 2006-2008 (man·Sv/Block)**
Druckwasserreaktoren (DWR/WWER)	0.69	0.72
Siedewasserreaktoren (SWR)	1.35	1.38
Schwerwasserreaktoren (PHWR/CANDU)	1.27	1.07
Alle Reaktoren, inkl. gasgekühlte (GCR) und Leichtwasser Graphitreaktoren (LWGR)	0.86	0.86

In Ergänzung zu Informationen über in Betrieb befindliche Reaktoren enthält die Datenbank auch Dosisangaben von 75 endgültig abgeschalteten oder im Rückbau befindlichen Anlagen. Da diese Reaktoren sich weitestgehend in Typ und Größe unterscheiden und sich in unterschiedlichen Stadien der Stilllegung befinden, ist es schwierig, eindeutige Dosistrends zu bestimmen. Allerdings wurden in 2008 Arbeiten fortgeführt, um die Datenbasis für solche Anlagen zu verbessern, mit dem Ziel, ein besseres Benchmarking zu ermöglichen. Einzelheiten zu Dosistrends für in Betrieb befindliche und im Rückbau befindliche Anlagen werden in Sektion 2 dieses Berichts dokumentiert.

Neben den ISOE- Daten zur beruflichen Strahlenexposition und zugehörigen Datenanalysen, liegt die Stärke des ISOE- Programms im breit angelegten Informationsaustausch unter den Mitgliedern. Auf der ISOE Netzwerk – Webseite (www.isoe-network.net) wurde in 2008 die Unterstützung der ISOE Mitglieder weiter mit einer umfangreichen internetgestützten Information und einem Portal für Erfahrungsaustausch zur Strahlenschutzoptimierung und Nutzung von ALARA- Methoden fortgeführt. Die Module zur Online-Datenerfassung von Strahlenexpositionsdaten wurden in 2008 hinsichtlich der finalen Testphase und Implementierung in 2009 weiterentwickelt.

Das jährliche internationale ALARA Symposium zum Management der beruflichen Strahlenexposition in Kernkraftwerken stellte erneut ein wichtiges Forum für die ISOE Teilnehmer und für Hersteller dar, um Informationen und Erfahrungen aus der Strahlenschutzpraxis auszutauschen. Das durch das Asiatische Technische Zentrum organisierte internationale ISOE ALARA Symposium 2008 fand in Tsuruga, Japan, statt. Die technischen Zentren haben auch weiter regionale Symposien begleitet, so das europäische regionale ISOE ALARA Symposium in 2008, organisiert vom Europäischen Technischen Zentrum in Turku, Finnland, und das regionale Nordamerikanische ALARA Symposium in Fort Lauterdale, USA, organisiert vom Nordamerikanischem Technischen Zentrum in Zusammenarbeit mit EPRI. Diese Symposien bilden ein globales Forum, um den Austausch von Ideen und Methoden des Managements im Sinne von ALARA zu fördern.

Von besonderer Bedeutung ist die Unterstützung durch die Technischen Zentren, wenn es um spezielle Fragestellungen von Mitgliedern und deren schnelle Beantwortung geht. Außerdem organisieren und unterstützen die Zentren Anlagenbesuche zu Benchmarkzwecken auf freiwilliger Basis. Die Kombination von ISOE Symposien und technischen Besuchen stellt für Strahlenschutzexperten ein gutes Hilfsmittel zur überregionalen Zusammenarbeit dar.

Die ISOE -Arbeitsgruppe, die sich mit Datenanalysen (WGDA) befasst, führte ihre Aktivitäten bei der Unterstützung der technischen Analyse von ISOE- Daten und Erfahrungen fort, mit dem Focus auf Integrität und Konsistenz der ISOE Datenbank. Unter der WGDA hat die Expertengruppe für “Work Management” ihren ISOE-Bericht “Work Management in der Kernkraftwerksindustrie” beendet.

Wesentliche Informationen aus den in ISOE beteiligten Ländern sind in Sektion 6 dieses Berichtes zusammengefasst. Einzelheiten zur ISOE- Teilnahme und zum Arbeitsprogramm 2009 sind in den Anhängen dokumentiert.

执行摘要

自 1992 年以来，“职业照射信息系统”一直通过世界各地核电厂和国家监管当局辐射防护专业人员信息和经验交流网络以及通过发表关于“合理可行尽量低原则”管理的相关技术资源，支持开展核电厂工作人员放射性防护优化工作。《职业照射信息系统计划第 18 期年度报告》（2008 年）介绍了该计划在 2008 年的状况。

“职业照射信息系统”由经济合作与发展组织核能机构和国际原子能机构联合主办，全世界接受该计划“条款和条件”的核电公司和辐射防护监管当局均可申请参加。现行 2008－2011 年期间“职业照射信息系统”的“条款和条件”系于 2008 年 1 月 1 日生效。截至 2008 年底，“职业照射信息系统”计划包括 26 个国家的 59 个参加电力公司（278 台在运机组；32 台关闭机组）以及 22 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 397 座在运反应堆职业照射水平和趋势的资料，涵盖世界上约 90%的在运商业动力堆。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。

根据“职业照射信息系统”成员提供的在运动力堆的职业照射数据，每座反应堆的 2008 年平均集体剂量和每座反应堆的三年（2006－2008 年）滚动平均数据如下：

	2008 年平均集体剂量（人·希/堆）	**2006－2008 年三年滚动平均数据（人·希/堆）**
压水堆（压水堆/水水堆）	0.69	0.72
沸水堆	1.35	1.38
加压重水堆（加压重水堆/坎杜堆）	1.27	1.07
包括气冷和轻水石墨反应堆在内的所有反应堆	0.86	0.86

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 75 座已关闭或处于某一退役阶段的反应堆的剂量数据。由于这些反应堆机组通常类型不同，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。但 2008 年继续开展了旨在改进此类反应堆数据收集的工作，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。2008 年，“职业照射信息系统”网站（www.isoe-network.net）继续为该系统成员提供有关剂量降低情况和该系统“合理可行尽量低”资源的全面网基信息和经验交流门户。2008 年继续开发了供成员在线提交职业照射数据的数据输入模块，以便在 2009 年进行最后的测试和实施。

核电厂职业照射管理问题年度“职业照射信息系统”的“合理可行尽量低原则”国际专题讨论会继续为该系统的参加者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。由亚洲技术中心组织的 2008 年度“职业照射信息系统”的“合理可行尽量低原则”国际专题讨论会在日本敦贺举行。各技术中心还继续主办了几次地区专题讨论会，包括欧洲技术中心在芬兰图尔库组织的 2008 年度“职业照射信息系统”的“合理可行尽量低原则”欧洲地区专题讨论会和北美洲技术中心与美国电力研究所合作在美国劳德代尔堡组织的北美洲地区专题讨论会。这些专题讨论会为促进交流思想和管理方案提供了全球论坛，目的是实现保持职业辐射照射符合“合理可行尽量低”的原则。

各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”各地区之间交流有关剂量降低信息而自愿组织的现场基准访问所提供的支助颇为重要。“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职业照射管理方案提供了一种手段。

“职业照射信息系统”数据分析工作组继续开展支持该系统数据和经验技术分析的活动，并主要侧重于“职业照射信息系统”数据库的完整性和一致性。在数据分析工作组下设立的工作管理专家组编写完成了关于“实行工作管理以优化核电厂职业性放射防护”的报告。

本报告第六部分概述在“职业照射信息系统”参加国开展的主要活动。附件提供有关“职业照射信息系统”的参加情况和 2009 年工作计划的详细资料。

概 略

1992 年以来、ISOE（職業被ばく情報システム）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 ALARA 管理の技術的な資源の公表を通じて、原子力発電所作業員の放射線防護の最適化を支援している。この ISOE プログラムの第 18 年次報告書（2008）は、2008 年の ISOE プログラムの状況を示したものである。

ISOE は OECD/NEA と IAEA が共同出資をしており、ISOE メンバーの資格はプログラムの規約を承認した電気事業者と規制当局に開かれている。2008-2011 年に適用される新規約は 2008 年 1 月 1 日に発効した。2008 年末では、ISOE プログラムには 26 ヵ国の 59 加盟電気事業者（278 基は運転中； 32 基は操業停止）並びに 22 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 397 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原子炉の約 90%が扱われている。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。

ISOE メンバーから提供された職業被ばくデータによれば、運転中原子炉における 2008 年の一炉あたりの平均集団線量及び一炉あたりの 3 年平均年間集団線量(2006-2008 年)は以下の通りである。

	2008 年 平均集団線量 (man·Sv/炉)	**2006-2008 年 3 年平均 (man·Sv/炉)**
加圧水型原子炉 (PWR/VVER)	0.69	0.72
沸騰水型原子炉 (BWR)	1.35	1.38
加圧重水型原子炉 (PHWR/CANDU)	1.27	1.07
ガス冷却炉 (GCR)と軽水黒鉛炉(LWGR)を含む全ての原子炉	0.86	0.86

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 75 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。しかし効果的なベンチマーキングの促進のための操業停止と廃止措置の原子炉のデータ収集改善を 2008 年も継続した。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。2008 年においてISOE ネットワーク・ウェブサイト（www.isoe-network.net）は、線量低減と ALARA 資源に関する包括的な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ことが継続されている。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は、2009 年の最終テスト及び完成に向け、2008 年も引き続き行なわれた。

原子力発電所での職業被ばく管理に関する年次 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続けている。 アジア技術センターによる 2008 年 ISOE 国際 ALARA シンポジウムは、日本の敦賀で開催された。 また、技術センターは、地域シンポジウム開催を継続しており、2008 年にはフィンランドのツルクにおいて欧州技術センターによる ISOE 欧州地域 ALARA シンポジウム、米国のフォート・ローダーデールにおいて EPRI 共催北米技術センターによる ISOE 北米地域 ALARA シンポジウムが開催された。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している。

迅速な技術的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において、技術センターが提供する支援は重要である。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、情報を共有し、ISOE 地域間の連結を築くことができ、作業管理のための世界的規模のアプローチの開発手段が提供されている。

ISOE データ分析ワーキンググループ（WGDA）は、ISOE データベースの完全性及び一貫性に主に焦点を合わせ、ISOE データ及び経験の技術分析のサポート活動を継続した。WGDA の下、「原子力発電所における作業管理」報告書が完成した。

本報告書の第 6 章で ISOE 加盟国の主な出来事について要約する。ISOE の参加者の詳細、及び 2009 年の作業計画を附属書に提示する。

РЕЗЮМЕ

С 1992 года Информационная система контроля профессионального облучения персонала АЭС (ISOE) направлена на оптимизацию радиационной защиты работников АЭС посредством использования всемирной сети по обмену информацией и опытом между специалистами по радиационной защите на АЭС и в национальных регулирующих органах, а также путем публикации соответствующих технических материалов по управлению работами на основе принципа ALARA. Настоящий 18-й ежегодный доклад о результатах работы по программе ISOE отражает положение дел с осуществлением программы ISOE в 2008 календарном году.

Финансирование программы ISOE осуществляется совместно АЯЭ ОЭСР и МАГАТЭ. Вступление в программу ISOE открыто для всех атомных электростанций, а также национальных регулирующих органов, отвечающих за вопросы радиационной защиты персонала АЭС. Единственным необходимым условием членства является ратификация Положения и Условий этой программы. Нынешние Положение и Условия ISOE на период 2008-2011 годов вступили в силу 1 января 2008 года. В конце 2008 года программа ISOE включала в себя 59 энергопредприятий в 26 странах (278 эксплуатируемых энергоблоков; 32 остановленных энергоблока), а также национальные регулирующие органы 22 стран. База данных по профессиональному облучению ISOE содержала информацию об уровнях и тенденциях профессионального облучения на 397 находящихся в эксплуатации реакторах в 29 странах, охватывая приблизительно 90% находящихся в эксплуатации промышленных энергетических реакторов мира. Управление повседневной технической деятельностью по программе ISOE обеспечивается четырьмя техническими центрами (Европа, Северная Америка, Азия и МАГАТЭ). На основе данных о профессиональном облучении, полученных от членов ISOE в 2008 году, значения средней годовой коллективной дозы, нормированные на один энергоблок, а также средние за трехлетний период (2006-2008 годы) значения коллективных доз, нормированных на один энергоблок, в отношении находящихся в эксплуатации энергетических реакторов составляли:

	Средняя годовая коллективная доза за 2008 г. (чел.·Зв/энергоблок)	**Средняя коллективная доза за трехлетний период 2006-2008 г. (чел.·Зв/энергоблок)**
Реакторы с водой под давлением (PWR/ВВЭР)	0,69	0,72
Кипящие водяные реакторы (BWR)	1,35	1,38
Корпусные тяжеловодные реакторы (PHWR/CANDU)	1,27	1,07
Все реакторы, включая газоохлаждаемые (GCR) и легководные реакторы с графитовым замедлителем (LWGR)	0,86	0,86

В дополнение к информации по находящимся в эксплуатации энергоблокам, база данных ISOE содержит также данные о дозах по 75 реакторам, находящимся в стадии останова или снятия с эксплуатации. Поскольку эти энергоблоки, как правило, относятся к различным типам, имеют различные мощности и находятся на различных стадиях снятия с эксплуатации, четкие тенденции изменения дозы определить трудно. Однако в 2008 году продолжилась работа по улучшению сбора данных по таким реакторам с целью содействия усовершенствованию оценок

контрольных показателей. Подробная информация о тенденциях дозы профессионального облучения применительно к реакторам, находящимся в эксплуатации, и реакторам, находящимся в процессе снятия с эксплуатации, содержится в разделе 2 этого доклада.

Целью программы ISOE является максимально широкое распространение среди всех участников данных и аналитической информации о профессиональном облучении. В 2008 году на интернет веб-сайте ISOE (www.isoe-network.net) было продолжено размещение всеобъемлющей информации, а также обеспечена работа специализированного форума для обмена опытом по различным аспектам снижения доз и применения принципа ALARA. В течение 2008 года продолжилась разработка модулей ввода данных о профессиональном облучении в он-лайновом режиме, окончательное испытание и внедрение которых запланировано на 2009 год.

Ежегодно проводимые в рамках программы ISOE международные симпозиумы ALARA по оптимизации профессионального облучения персонала АЭС продолжали обеспечивать важный форум как для участников ISOE, так и для работающих в данной отрасли компаний-поставщиков продукции с тем, чтобы они могли обмениться практической информацией и опытом по вопросам профессионального облучения. В 2008 году в Цуруге, Япония, был проведен Международный ISOE ALARA Симпозиум, организованный Азиатским техническим центром. В технических центрах ISOE также продолжалось проведение региональных симпозиумов: в 2008 году был организован Европейский региональный симпозиум ISOE ALARA, организованный Европейским техническим центром в Турку, Финляндия, а также Североамериканский региональный ISOE ALARA в Форт-Лоудердейл, США, организованный Североамериканским техническим центром в сотрудничестве с EPRI. Эти симпозиумы обеспечивают глобальный форум для содействия обмену идеями и управленческими подходами в отношении поддержания профессионального радиационного облучения "на разумно достижимом низком уровне".

Важное значение имеет поддержка, которую технические центры ISOE предоставляют в ответ на специальные запросы, требующие оперативной обратной связи по вопросам технического характера, а также в плане организации технических визитов объектов с целью проведения контрольных сравнений для обмена информацией между регионами ISOE по вопросам снижения доз облучения персонала АЭС. Сочетание симпозиумов и технических визитов ISOE предоставляет специалистам по радиационной защите возможность встретиться, обменяться информацией и установить связи между регионами ISOE для выработки глобального подхода к управлению профессиональным облучением.

Международная рабочая группа по анализу данных ISOE (WGDA) продолжала свою деятельность в поддержку технического анализа данных и опыта ISOE, уделяя основное внимание обеспечению целостности и согласованности базы данных ISOE. В рамках работы WGDA, группой международных экспертов была подготовлена техническая публикация АЯЭ ОЭСР/МАГАТЭ “Оптимизация радиационной защиты персонала АЭС на основе методологии управления работами”.

Важнейшие события, произошедшие в участвующих в ISOE странах, кратко излагаются в разделе 6 настоящего доклада. Подробные сведения об участниках ISOE и программа работы на 2009 год содержатся в приложениях.

RESUMEN EJECUTIVO

Desde 1992, el Sistema de Información sobre Exposición Ocupacional (Information System on Occupational Exposure, ISOE), ha apoyado la optimización de la protección radiológica de los trabajadores de las centrales nucleares a través de una red de intercambio de experiencia e información a escala mundial para los profesionales de protección radiológica de centrales y las autoridades reguladoras, y mediante la publicación de informes técnicos relevantes sobre gestión ALARA. Este 18º Informe Anual del Programa ISOE (2008) presenta el estado del programa para el año 2008.

La participación en el programa ISOE, co-patrocinado conjuntamente por la OCDE/NEA y el OIEA, está abierta a compañías eléctricas y autoridades reguladoras de todo el mundo que acepten los Términos y Condiciones del Programa. Los actuales términos y condiciones para el periodo 2008-2011 entraron en vigor el 1 de enero de 2008. A finales de 2008, el programa ISOE contaba con la participación de 59 compañías eléctricas de 26 países (278 unidades en operación y 32 paradas), así como de las autoridades reguladoras de 22 países. La base de datos de exposición ocupacional del ISOE incluía información sobre niveles de exposición ocupacional y tendencias en 397 reactores en operación en 29 países, cubriendo aproximadamente el 90% del total de reactores comerciales de potencia en el mundo. Cuatro Centros Técnicos del ISOE (Europa, Norteamérica, Asia y el OIEA) gestionan día a día las funciones técnicas del programa.

En base a los datos de exposición ocupacional aportados por los miembros del programa ISOE y referidos a reactores de potencia en operación, la dosis colectiva media anual por reactor en 2008 y la media trienal (2006-2008) por reactor fueron:

	Dosis colectiva anual media en 2008 (Sv.p/reactor)	**Media de dosis trienal 2006-2008 (Sv.p/reactor)**
Reactores de agua a presión (PWR/VVER)	0.69	0.72
Reactores de agua en ebullición (BWR)	1.35	1.38
Reactores de agua pesada a presión (PHWR/CANDU)	1.27	1.07
Todos los reactores, incluyendo los refrigerados por gas (GCR) y los de agua ligera y grafito (LWGR)	0.86	0.86

Además de la información relativa a los reactores en operación, la base de datos del ISOE contiene datos de dosis de 75 reactores parados o en alguna etapa del proceso de clausura. Dado que estos reactores son de diferentes tipos y tamaños y se encuentran en diferentes fases de sus respectivos programas de clausura, es difícil identificar tendencias dosimétricas claras. No obstante, durante el 2008 han continuado los trabajos de recopilación de datos de estos reactores con el fin de proporcionar un mejor análisis comparativo. La sección 2 de este documento presenta información detallada sobre las tendencias de dosis ocupacionales para reactores en operación y reactores en fase de clausura.

Aunque el programa ISOE es bien conocido por sus datos y análisis de exposición ocupacional, su fuerza radica en el objetivo de compartir ampliamente esta información entre sus participantes. En 2008, la página WEB de la red de ISOE (www.isoe-network.net) continuó poniendo a disposición de los miembros del programa un portal de información amplia y de intercambio de experiencias sobre reducción de dosis y recursos ALARA. El desarrollo de módulos de entrada de datos para la aportación on-line por parte de los miembros continuó durante el año 2008, para la comprobación final y puesta en funcionamiento en el año 2009.

Los Simposios anuales internacionales ALARA del ISOE sobre la gestión de la exposición ocupacional en centrales nucleares, continúan siendo foros importantes para participantes del programa ISOE y suministradores para intercambiar información práctica y experiencia en asuntos de exposición ocupacional. El Simposio ALARA Internacional de 2008 del ISOE, organizado por el Centro Técnico Asiático, se celebró en Tsuruga, Japón. Los centros técnicos siguieron albergando Simposios regionales, que en 2008 incluyeron el Simposio Regional Europeo organizado por el Centro Técnico Europeo en Turku, Finlandia, y el Simposio Regional Norteamericano en Fort Lauderdale, USA, organizado por el Centro Técnico Norteamericano en cooperación con EPRI. Estos simposios proporcionan un foro global para la promoción del intercambio de ideas y planteamientos de gestión para mantener los niveles de exposición ocupacional tan bajos como sea razonablemente alcanzable.

Es importante el apoyo que brindan los centros técnicos en respuesta a los requerimientos específicos de rápida realimentación técnica, así como la organización de visitas voluntarias para el intercambio de información sobre reducción de dosis entre regiones del programa ISOE. La combinación de Simposios del ISOE y visitas técnicas proporciona un valioso foro de encuentro, intercambio de información y establecimiento de relaciones entre las regiones ISOE para los profesionales de la protección radiológica, con el fin de desarrollar un planteamiento global a la gestión de la exposición ocupacional.

El Grupo de Trabajo para el Análisis de Datos (Working Group on Data Analisis, WGDA) del ISOE continuó sus actividades de apoyo al análisis técnico de los datos y experiencias operativas del ISOE, centrándose en gran medida en la integridad y consistencia de la base de datos de ISOE. Bajo dicho Grupo, el Grupo de Expertos en Gestión de Trabajos (Expert Group on Work Management) completó su informe sobre "Gestión de Trabajos para optimizar la proteccion radiologica ocupacional en Centrales nucleares" (Work Management to Optimise Occupational Radiological Protection at Nuclear Power Plants).

Los principales sucesos ocurridos en los países participantes en el programa ISOE se resumen en la Sección 6 del presente informe. En los Anexos se ofrecen detalles de las participaciones en ISOE y el programa de trabajo para 2009.

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

Since 1992, ISOE has supported the optimisation of worker radiological protection in nuclear power plants through a worldwide information and experience exchange network for radiation protection professionals from utilities and national regulatory authorities, and through the publication of relevant technical resources for ALARA management. The ISOE programme includes a global occupational exposure data collection and analysis programme, culminating in the world's largest database on occupational exposures at nuclear power plants and an communications network for sharing dose reduction information and experience. Since the launch of ISOE, participants have used these resources 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.

ISOE Participants include nuclear electricity utilities (public and private), national regulatory authorities (or institutions representing them) and ISOE Technical Centres who have agreed to participate in the operation of ISOE under its Terms and Conditions (2008-2011). Four ISOE Technical Centres (Asia, Europe, North America and the IAEA) manage the day-to-day technical operations in support of the membership in the four ISOE regions (see Appendix 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.
- 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 2008, the ISOE programme included 59[1] Participating Utilities in 26 countries (278 operating units; 32 shut-down units), as well as the regulatory authorities of 22 countries. The decrease in participation in comparison with the previous year is due to parties that had not yet formally renewed their participation under the current Terms and Conditions by the end of 2008. Table 1 summarises total participation by country, type of reactor and reactor status at the end of 2008. A complete list of reactors, utilities and authorities officially participating in ISOE at the time of publication of this report (February 2010) is provided in Appendix 3.

In addition to exposure data provided annually by Participating Utilities, Participating Authorities may also contribute official national data in cases where some of their licensees are not ISOE members. The ISOE database thus includes occupational exposure data and information at 472 reactor units in 29 countries (396 operating, 75 in cold-shutdown or some stage of decommissioning and 1 pre-operational), covering about 90% of the world's operating commercial power reactors.[2] The ISOE database is made available to all ISOE members, according to their status as a participating utility or authority, through the ISOE Network website and on CD-ROM.

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

Table 1. **ISOE official participants and ISOE database (as of December 2008)**

Note: The list of reactors, utilities and authorities officially participating in ISOE at the time of publication of this report (February 2010) is provided in Appendix 3.

Operating reactors: ISOE participants						
Country	**PWR/VVER**	**BWR**	**PHWR**	**GCR**	**LWGR**	**Total**
Armenia	1	–	–	–	–	1
Belgium	7	–	–	–	–	7
Brazil	2	–	–	–	–	2
Bulgaria	2	–	–	–	–	2
Canada	–	–	21	–	–	21
China	4	–	–	–	–	4
Czech Republic	6	–	–	–	–	6
Finland	2	2	–	–	–	4
France	58	–	–	–	–	58
Germany	11	6	–	–	–	17
Hungary	4	–	–	–	–	4
Japan	24 [3]	32	–	–	–	56
Korea, Republic of	16	–	4	–	–	20
Mexico	–	2	–	–	–	2
The Netherlands	1	–	–	–	–	1
Romania	–	–	2	–	–	2
Russian Federation	15	–	–	–	–	15
Slovak Republic	6	–	–	–	–	6
Slovenia	1	–	–	–	–	1
South Africa, Rep. of	2	–	–	–	–	2
Spain	6	2	–	–	–	8
Sweden	3	7	–	–	–	10
Switzerland	3	2	–	–	–	5
United Kingdom	1	–	–	–	–	1
United States	14	9	–	–	–	23
Total	**189**	**62**	**27**	–	–	**278**
Operating reactors: Not participating in ISOE, but included in the ISOE database[4]						
Country	**PWR/VVER**	**BWR**	**PHWR**	**GCR**	**LWGR**	**Total**
Canada	–	–	1	–	–	1
China	1	–	–	–	–	1
Lithuania	–	–	–	–	1	1
Pakistan	1	–	1	–	–	2
Ukraine	15	–	–	–	–	15
United Kingdom	–	–	–	18	–	18
United States	55	26	–	–	–	81
Total	**72**	**26**	**2**	**18**	**1**	**119**
Total number of operating reactors included in the ISOE database						
	PWR/VVER	**BWR**	**PHWR**	**GCR**	**LWGR**	**Total**
Total	**261**	**88**	**29**	**18**	**1**	**397**

3. Includes one unit at pre-operational status.
4. Includes utilities that had not renewed participation as of December 2008 under current ISOE Terms and Conditions (see Appendix 3 for status as of Febuary 2010).

Table 1. **ISOE official participants and ISOE database (as of December 2008)** (Cont'd)

Definitively shutdown reactors: ISOE participants							
Country	**PWR/ VVER**	**BWR**	**PHWR**	**GCR**	**LWGR**	**Other**	**Total**
Bulgaria	4	–	–	–	–	–	4
Canada	–	–	2	–	–	–	2
France	1	–	–	6	–	–	7
Germany	3	1	–	1	–	–	5
Italy	1	2	–	1	–	–	4
Japan	–	–	–	1	–	1	2
The Netherlands	–	1	–	–	–	–	1
Russian Federation	2	–	–	–	–	–	2
Spain	1	–	–	1	–	–	2
Sweden	–	2	–	–	–	–	2
United States	–	–	–	1	–	–	1
Total	**12**	**6**	**2**	**11**	–	**1**	**32**
Definitively shutdown reactors: Not participating in ISOE but included in the ISOE database							
Country	**PWR/ VVER**	**BWR**	**PHWR**	**GCR**	**LWGR**	**Other**	**Total**
Lithuania	–	–	–	–	1	–	1
Ukraine	–	–	–	–	3	–	3
United Kingdom	–	–	–	22	–	–	22
United States	10	6	–	1	–	–	17
Total	**10**	**6**	–	**23**	**4**	–	**43**
Total number of definitively shutdown reactors included in the ISOE database							
	PWR/ VVER	**BWR**	**PHWR**	**GCR**	**LWGR**	**Other**	**Total**
Total	**22**	**12**	**2**	**34**	**4**	**1**	**75**
Total number of reactors included in the ISOE database							
	PWR/ VVER	**BWR**	**PHWR**	**GCR**	**LWGR**	**Other**	**Total**
Total	**283**	**100**	**31**	**52**	**5**	**1**	**472**
Number of **Participating Countries**							**26**
Number of **Participating Utilities**[5]							**59**
Number of **Participating Authorities**[6]							**25**

5. Represents the number of lead utilities; in some cases, plants are owned/operated by multiple enterprises.
6. Three countries participate with two authorities.

2. OCCUPATIONAL DOSE STUDIES, TRENDS AND FEEDBACK

A key element of ISOE is the tracking of occupational exposure trends from nuclear power facilities worldwide for benchmarking, comparative analysis and experience exchange amongst ISOE members. This information is maintained in the ISOE Occupational Exposure Database (ISOEDAT) which contains annual occupational exposure data supplied by Participating Utilities (generally based on operational dosimetry systems). The ISOE database includes the following data types:

- Dosimetric information from commercial NPPs in operation, shutdown or in some stage of decommissioning, including:
  - Annual collective dose for normal operation.
  - Maintenance/refuelling outage.
  - Unplanned outage periods.
  - Annual collective dose for certain tasks and worker categories.
- Plant-specific information relevant to dose reduction, such as materials, water chemistry, start-up/shutdown procedures, cobalt reduction programme, etc.
- Radiation protection related information for specific operations, jobs, procedures, equipment or tasks (radiological lessons learned):
  - Effective dose reduction.
  - Effective decontamination.
  - Implementation of work management principles.

Using the ISOE database, 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

Figures 1 and 2 show the trends in annual average and 3-year rolling average collective dose per reactor, by reactor type, for 1992-2008. In general, the average collective dose per operating reactor unit has consistently decreased over the time period covered in the ISOE database, with the 2008 averages maintaining the levels reached in last few years. In spite of some yearly variations, the clear downward dose trend in most reactors has continued, with the exception of PHWRs, which have shown a slight increasing trend since the lows achieved in the 1996-1998 time period.

With respect to 2008, a summary of average annual collective doses 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 per reactor are shown in Tables 3 and 4 respectively. These results are based primarily on data reported and recorded in the ISOE database during 2008, supplemented by the individual country reports (Section 6) as required. Figures 3 to 6 provide a detailed breakdown of the 2008 data in bar-chart format, ranked from highest to lowest average dose. In all figures, the “number of units” refers to the number of reactor units for which data has been reported for the year in question.

Figure 1. **Average collective dose per reactor for all operating reactors included in ISOE by reactor type, 1992-2008 (man·Sv/reactor)**

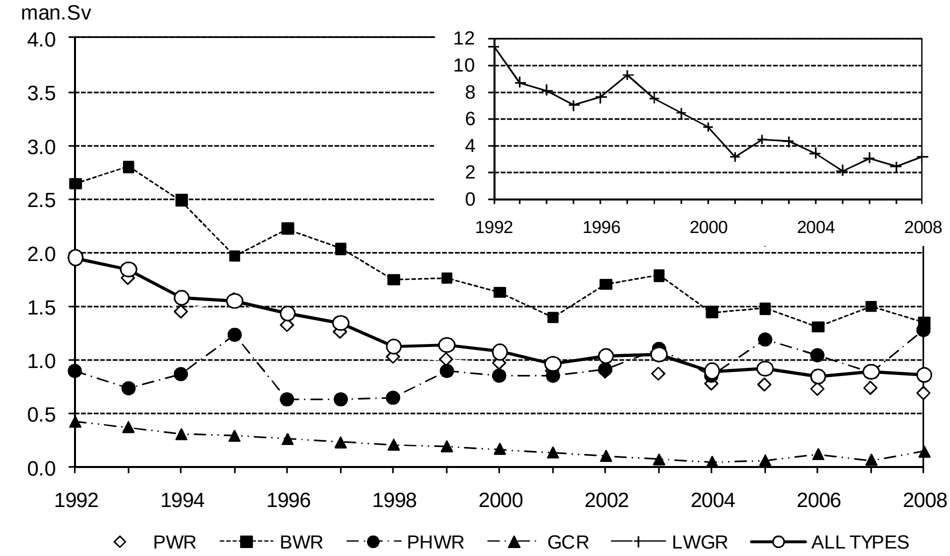
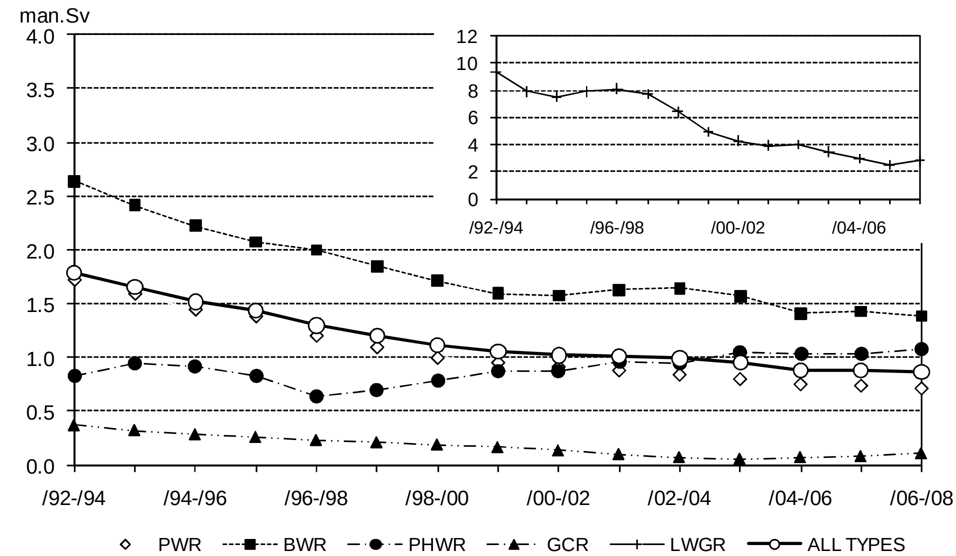


Figure 2. **3-year rolling average per reactor for all operating reactors included in ISOE by reactor type, 1992-2008 (man·Sv/reactor)**



Note: Inset charts shows average collective dose for LWGRs.

Table 2. **Summary of average collective doses for operating reactors (2008)**

	2008 average annual collective dose (man·Sv/reactor)	**3-year rolling average for 2006-2008 (man·Sv/reactor)**
Pressurised water reactors (PWR/VVER)	0.69	0.72
Boiling water reactors (BWR)	1.35	1.38
Pressurised heavy water reactors (PHWR/CANDU)	1.27	1.07
All reactors, including gas cooled (GCR) and light-water graphite reactors (LWGR)	0.86	0.86

Table 3. **Average annual collective dose per reactor, by country and reactor type, 2006-2008 (man·Sv/reactor)**

	PWR, VVER			BWR			PHWR		
	2006	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
Armenia	0.86	0.78	1.24						
Belgium	0.39	0.29	0.39						
Brazil	0.56	1.05	0.74						
Bulgaria	0.40	0.41	0.27						
Canada							0.98	0.92	1.38
China	0.49	0.66	0.54						
Czech Republic	0.15	0.17	0.13						
Finland	0.83	0.36	0.78	1.10	0.59	0.46			
France	0.69	0.63	0.66						
Germany	0.84	1.04	0.62	1.14	0.99	1.19			
Hungary	0.35	0.45	0.33						
Japan	1.09	1.35	1.57	1.33	1.47	1.45			
Korea, Republic of	0.54	0.67	0.49				0.58	0.80	0.59
Mexico				1.48	2.74	4.69			
The Netherlands	0.62	0.23	0.28						
Pakistan	0.02	n/a	0.59				4.48	n/a	3.70
Romania							0.56	0.27	0.34
Russian Federation	0.70	0.91	0.69						
Slovak Republic	0.28	0.24	0.16						
Slovenia	0.86	0.89	0.15						
South Africa, Rep. of	0.80	0.74	0.75						
Spain	0.38	0.50	0.29	0.41	4.15	0.50			
Sweden	0.51	0.41	0.56	1.09	1.10	0.85			
Switzerland	0.35	0.37	0.46	0.97	1.10	1.16			
Ukraine	0.95	1.17	n/a						
United Kingdom	0.52	0.05	0.26						
United States	0.87	0.69	0.68	1.43	1.54	1.29			
Average	**0.73**	**0.73**	**0.69**	**1.31**	**1.50**	**1.35**	**1.04**	**0.87**	**1.27**
By region[1]									
Europe	0.59	0.56	0.54	1.02	1.33	0.91			
Asia	0.86	1.07	1.14	1.33	1.47	1.45	0.58	0.80	0.59
North America	0.87	0.69	0.68	1.43	1.60	1.48	0.98	0.92	1.38
IAEA	0.72	0.94	0.64				2.52	0.27	1.46

	GCR			LWGR		
Lithuania				3.06	2.37	3.10
United Kingdom	0.12	0.06	0.14			

	2006	**2007**	**2008**
Global Average	**0.84**	**0.89**	**0.86**

Notes: Data provided directly from country, rather than calculated from the ISOE database, include: Belgium (2008); Japan (PWR: 2008, includes one reactor in pre-operational status; BWR: 2006-2008); United States (2006-2008); Canada (2008).
Doses for Canada are calculated for 18 reactors (2006, 2007); 20 reactors (2008).

1. See Appendix 3 for country composition of the four ISOE regions.

Table 4. **3-year rolling average annual collective dose per reactor, by country and reactor type, 2004-2006 to 2006-2008 (man·Sv/reactor)**

	PWR, VVER			**BWR**			**PHWR**		
	04-06	**05-07**	**06-08**	**04-06**	**05-07**	**06-08**	**04-06**	**05-07**	**06-08**
Armenia	0.96	0.83	0.96						
Belgium	0.40	0.36	0.35						
Brazil	0.55	0.74	0.78						
Bulgaria	0.74	0.56	0.37						
Canada							1.03	1.07	1.10
China	0.57	0.60	0.56						
Czech Republic	0.17	0.17	0.15						
Finland	0.82	0.53	0.66	0.99	0.94	0.72			
France	0.75	0.70	0.66						
Germany	1.02	1.06	0.83	1.07	1.05	1.11			
Hungary	0.40	0.43	0.38						
Japan	1.10	1.13	1.34	1.43	1.40	1.42			
Korea, Republic of	0.58	0.59	0.56				0.72	0.71	0.66
Mexico				2.23	1.97	2.97			
The Netherlands	0.54	0.35	0.38						
Pakistan	0.34	n/a	n/a				2.50	n/a	n/a
Romania							0.65	0.52	0.38
Russian Federation	0.90	0.87	0.77						
Slovak Republic	0.32	0.32	0.23						
Slovenia	0.54	0.61	0.63						
South Africa, Rep. of	0.79	0.89	0.76						
Spain	0.37	0.42	0.39	1.06	2.29	1.69			
Sweden	0.57	0.52	0.49	0.91	1.08	1.02			
Switzerland	0.50	0.46	0.40	1.14	1.02	1.08			
Ukraine	1.04	1.04	n/a						
United Kingdom	0.31	0.31	0.28						
United States	0.79	0.78	0.75	1.56	1.56	1.42			
Average	**0.75**	**0.74**	**0.72**	**1.41**	**1.43**	**1.38**	**1.03**	**1.04**	**1.07**
By region									
Europe	0.65	0.61	0.56	1.01	1.18	1.09			
Asia	0.89	0.91	1.02	1.43	1.40	1.42	0.72	0.71	0.66
North America	0.79	0.78	0.75	1.60	1.58	1.50	0.98	1.07	1.10
IAEA	0.85	0.85	0.78				1.58	1.49	1.62

	GCR			**LWGR**		
Lithuania				3.00	2.51	2.84
United Kingdom	0.07	0.08	0.11			

	04-06	**05-07**	**06-08**
Global Average	**0.88**	**0.88**	**0.86**

Notes: Calculated from the ISOE database, supplemented by data provided directly be country (see Notes, Table 3)

Figure 3. **2008 PWR/VVER average collective dose per reactor by country (man·Sv/reactor)**

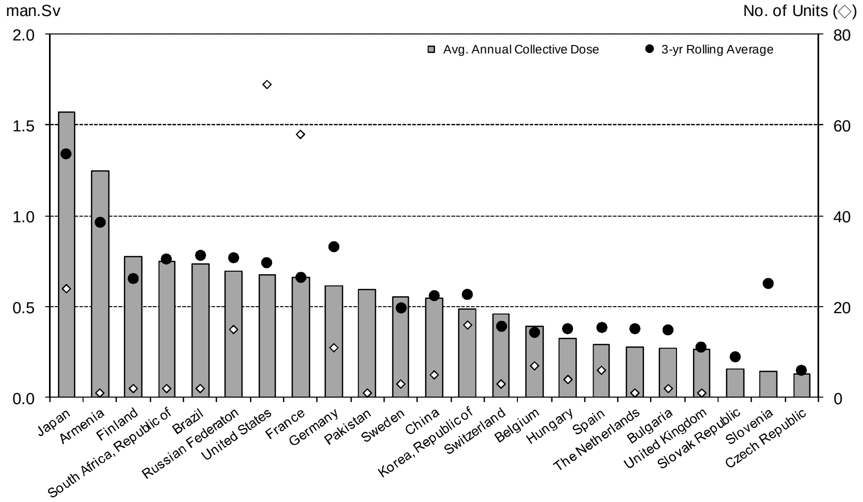


Figure 4. **2008 BWR average collective dose per reactor by country (man·Sv/reactor)**

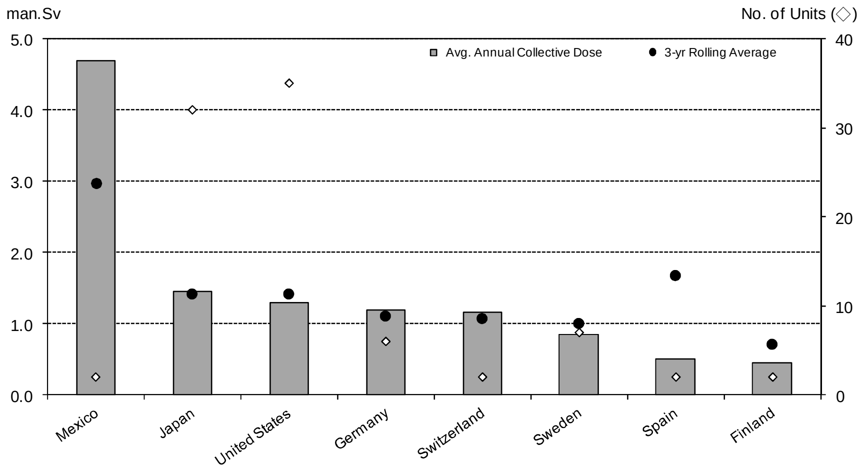


Figure 5. **2008 PHWR average collective dose per reactor by country (man·Sv/reactor)**

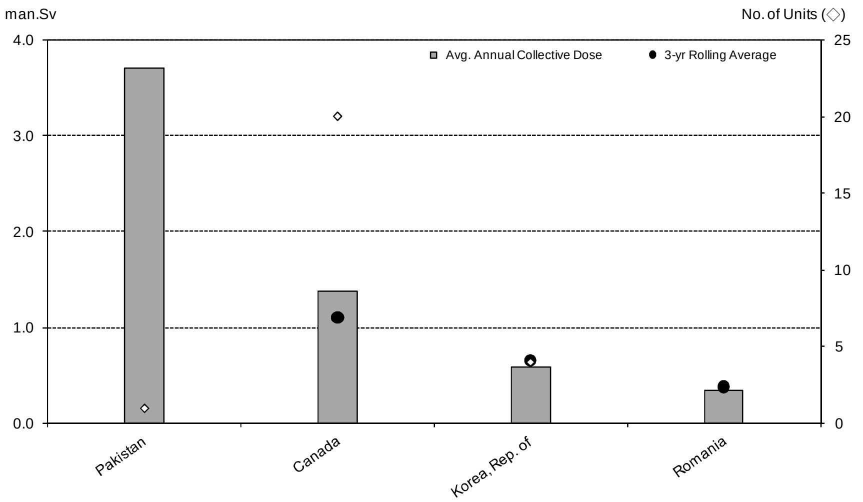
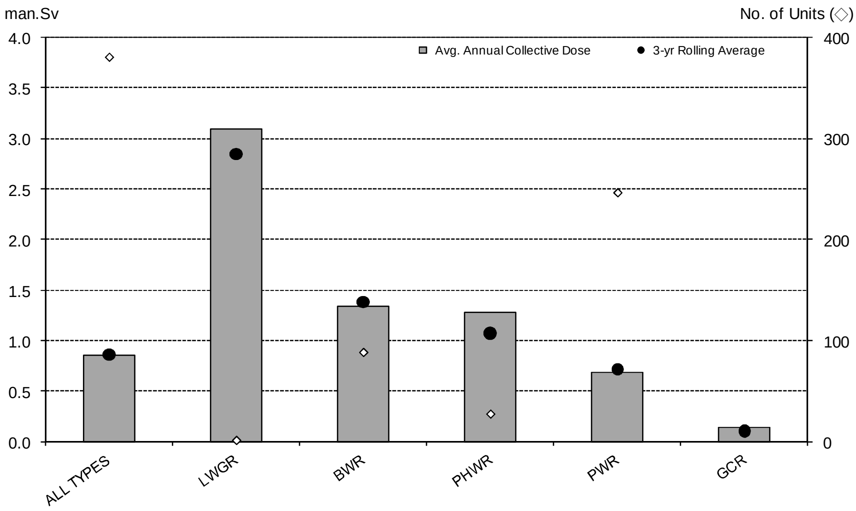


Figure 6. **2008 average collective dose per reactor by reactor type (man·Sv/reactor)**



The following discussion provides a brief overview of the results and trends observed in the four ISOE regions. However, it is noted that due to the various power plant designs and the complex parameters influencing collective doses, these analyses and figures do not support any conclusions with regard to the quality of radiation protection performance in the countries addressed. More detailed discussion and analyses of dose trends in individual countries are provided in Section 6.

European region

In the European region, the 2008 average collective dose for PWRs and VVERs was around 0.54 man·Sv/reactor, with half of the countries showing a slight decreasing trend over the last three years, and the other half showing a small increase. The average collective dose for European BWRs was around 0.91 man·Sv/reactor, which is the lowest values since three years.

The trends over time of the 3-year rolling average annual collective dose per reactor, which provides a better representation of the general trend in dose, shows a continuity of the decrease for PWRs and VVERs, going from 0.65 man·Sv/reactor for 2004-2006 to 0.56 man·Sv/reactor for 2006-2008 (13% decrease). After the increase of 2005-2007, the BWR trend is again decreasing, the 2006-2008 value (1.09 man·Sv) staying, however, higher than that for 2004-2006 (1.01 man·Sv).

For European BWRs, the data from individual countries shows that with respect to the 3-year rolling average annual collective dose for 2006-2008, three main groups can be distinguished:

Finland .... 0.72 man·Sv/reactor.
Germany, Sweden and Switzerland .... 1.02-1.11 man·Sv/reactor.
Spain .... 1.69 man·Sv/reactor.

As far as European PWRs are concerned, it is also possible identify three country groupings with respect to the 3-year rolling average annual collective dose for 2006-2008:

United Kingdom .... 0.3 man·Sv/reactor.
Belgium, Spain, Sweden, Switzerland and the Netherlands........~0.4-0.5 man·Sv/reactor.
France and Germany:...~0.7-0.8 man·Sv/reactor.

Regarding VVERs, the Czech Republic showed the lowest 3-year rolling average annual collective dose per reactor in 2006-2008 at 0.15 man·Sv/reactor, followed by the Slovak Republic (0.23 man·Sv/reactor), Hungary (0.38 man·Sv/reactor) and Finland (0.66 man·Sv/reactor).

Asian region

In the Asian region, the 2008 average collective dose per reactor decreased for all reactor types except Japanese PWRs. The 3-year rolling average annual collective dose shows a decreasing trend for Korean PHWRs, and a stable trend for Japanese BWRs and Korean PWRs.

The average collective dose per reactor for Japanese PWRs, 1.57 man·Sv, has increased from the previous year, influenced mainly by the increase of inspection and modification works during periodic inspections. In many PWRs, detailed inspections of materials using Nickel-based alloy at the primary loop boundary, as well as repair works were performed as needed. The average outage duration for PWRs of 144 days represented an increase of 42 days from the previous year.

For Korean PWRs, the average collective dose per reactor was 0.49 man·Sv, which was less than ⅓ of the value for Japanese PWRs. For Korean PHWRs, the average collective dose per reactor was 0.59 man·Sv and the 3-year rolling average annual collective dose was 0.66 man·Sv, the latter showing a decreasing trend. Regarding Japanese BWRs, the 2008 average collective dose per reactor decreased slightly to 1.45 man·Sv from 1.47 man·Sv in 2007. The 3-year rolling average annual collective dose shows a steady tendency since 2005 about 1.4 man·Sv.

North American region

In the North American region, participating ISOE countries include the United States, Canada, and Mexico. In 2008, there were a total of 46 reactors participating in ISOE, including 14 PWRs, 11 BWRs, and 21 PHWRs (Table 1). The information below is broken down by country and includes information for average collective dose, 3-year rolling average annual collective dose, and electricity generation.

In the United States, there are 104 commercial operating nuclear power plants, for which the net electricity generated was 806 670 gigawatt-hours (91 834 megawatt-years). Some data is collected for all 104 commercial operating nuclear power reactors regardless of participation in ISOE, on which the following statistics are based. In 2008, the average collective dose per reactor for PWRs was 0.68 man·Sv/reactor, which represents a 1% decrease from the 2007 value of 0.69 man·Sv/reactor. The average collective dose per reactor for BWRs was 1.29 man·Sv/reactor, which represents a 16% decrease from the 2007 value of 1.54 man·Sv/reactor. The overall decreasing trend in the average collective dose per reactor indicates that utilities are continuing to successfully implement ALARA dose reduction features at their facilities. The 3-year rolling average annual collective dose per reactor for PWRs was 0.75 man·Sv/reactor for 2006-2008, which represents a 4% decrease from 2005-2007 3-year rolling average annual collective dose of 0.78 man·Sv/reactor. In 2006-2008, the 3-year rolling average annual collective dose per reactor for BWRs was 1.42 man·Sv/reactor, representing a 9% decrease from the 2005-2007 3-year rolling average annual collective dose of 1.56 man·Sv/reactor.

In Canada, 22 CANDU units are licensed to operate. The average collective dose for 2008 for the fleet of 20 operating reactors (including 3 units in refurbishment) was 1.38 man·Sv/reactor. The average collective dose for the 3 units in refurbishment was 3.07 man·Sv/reactor; the average dose for 2 units in safe storage was 0.039 man·Sv/reactor. In 2006-2008, the 3-year rolling average annual collective dose for operating reactors was 1.10 person·Sv per reactor, which represents a 3% increase from the 2005-2007 3-year rolling average annual collective dose of 1.07 person·Sv per reactor.

In Mexico, two BWR units are in commercial operation at the Laguna Verde Nuclear Power Station. The Mexican country dose for 2008 was 4.69 man·Sv/reactor, resulting in a reversal of the downward trend in annual dose since 2000. The crud (^{60}Co) burst observed since 2007 continued to have an impact on occupational exposures. More details are provided in Section 6.

Non-OECD countries (participating through the IAEA)

The information provided by the non-OECD countries lead to the following conclusions. The 2008 average annual collective dose reported for PWRs and VVERs showed a wide variation from 0.15 to 1.24 man·Sv/reactor, with an average of 0.64 man·Sv/reactor. For PHWRs, the 2008 average annual collective doses also showed a wide variation from 0.34 to 3.701 man·Sv/reactor, with an average of 1.46 man·Sv/reactor.

The trends over time of the 3-year rolling average annual collective dose per reactor for PWRs and VVERs show an annual average of 0.78 man·Sv/reactor, which represents a decrease when considering the 2005-2007 rolling average. For PHWRs, the 3-year rolling average annual collective dose per reactor of 1.6 man·Sv/reactor shows a stable situation with respect to the previous 3-year rolling averages. In the case of LWGRs (Lithuania), the 3-year rolling average for 2006-2008 shows a rather high but stable annual collective dose per reactor.

As expected, the outages for maintenance and refuelling in 2008 caused the highest collective doses which contributed to increase overall average collective doses. From the country reports in Section 6, it can be seen that efforts are being made to improve the optimisation of the annual collective dose per reactor. From Tables 3 and 4, it can be seen that the countries affiliated to the IAEA Technical Centre have, for PWRs and VVERs, a performance similar to that of the other ISOE regions. However, for specific PHWR and LWGR installations, further optimisation will bring substantial reductions in the collective dose per reactor.

2.2 Occupational exposure trends: Definitely shutdown reactors

In addition to information from operating reactors, the ISOE database contains dose data from 75 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 2006-2008 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, definitive conclusions cannot be drawn. Under the ISOE Working Group on Data Analysis, work continued in 2008 aimed at improving data collection for shut-down and decommissioned reactors in order to facilitate better benchmarking.

Table 5 provides average annual collective doses per unit for definitely shutdown reactors by country and reactor type for 2006-2008, based on data recorded in the ISOE database, supplemented by the individual country reports (Section 6) as required. Figures 7-10 present the average collective dose per reactor for shutdown reactors for 1992-2008 by reactor 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 units and average annual dose per reactor by country and reactor type for definitely shutdown reactors, 2006-2008 (man·mSv/reactor)**

		2006		**2007**		**2008**	
		No.	**Dose**	**No.**	**Dose**		
PWR	France	1	5.5	1	10.4	1	23.2
	Germany	3	174.2	3	322.9	5	160.0
	Italy	1	10.0	1	0.5	1	1.1
	Spain			1	292.9	1	134.7
	United States	8	93.7	6	26.5	10	7.1

Table 5. **Number of units and average annual dose per reactor by country and reactor type for definitely shutdown reactors, 2006-2008 (man·mSv/reactor)** (Cont'd)

		2006		2007		2008	
		No.	**Dose**	**No.**	**Dose**		
VVER	Bulgaria	2	23.5	4	60.4	4	31.0
	Germany			5	28.6	5	27.0
	Russian Federation	2	126.1	2	100.6	2	78.0
BWR	Germany	1	483.1	1	405.1	3	179.0
	Italy	2	12.4	2	6.5	2	29.1
	The Netherlands	1	0.3	1	0.4	1	0.3
	Sweden	2	51.8	2	70.5	2	39.1
	United States	5	70.2	3	137.5	3	13.4
GCR	France	6	6.3	6	2.2	6	2.8
	Germany					2	13
	Italy	1	0.4	1	0.5	1	2.9
	Japan	1	30	1	30	1	20
	United Kingdom	14	60	18	44.1	16	48
LWGR	Lithuania	1	352.3	1	215.8	1	188.4
LWCHWR	Japan	1	195.6	1	85.7	1	431.3

Figure 7. **Average collective dose per shutdown reactor: PWR/VVERs (man·mSv/reactor)**

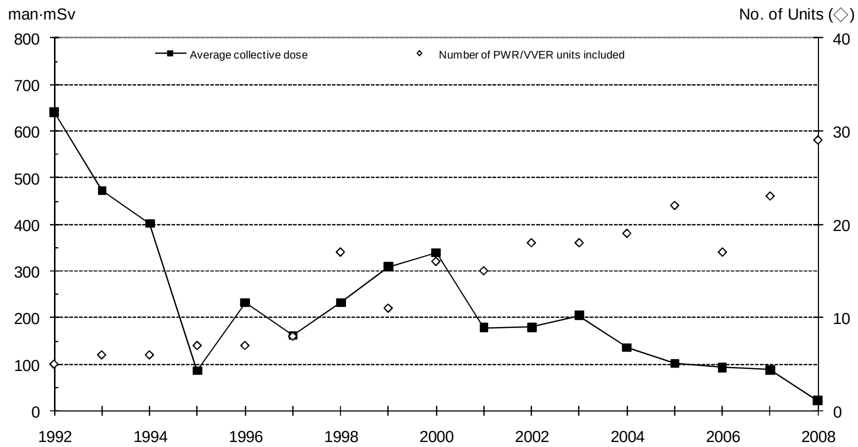


Figure 8. **Average collective dose per shutdown reactor: BWRs (man·mSv/reactor)**

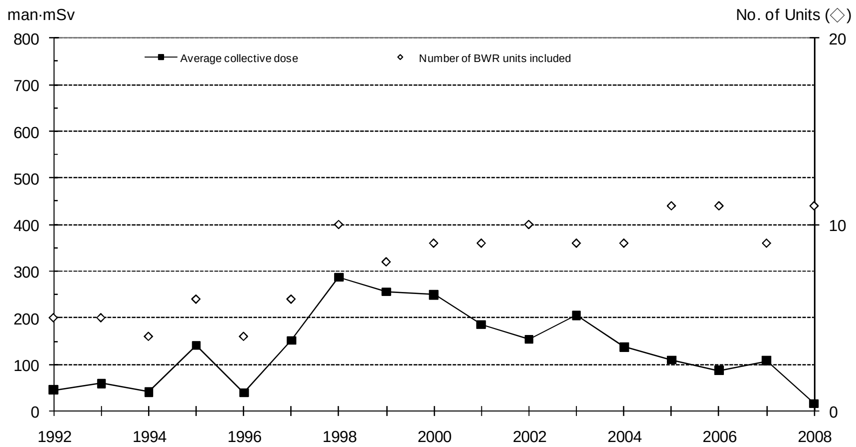


Figure 9. **Average collective dose per shutdown reactor: GCRs (man·mSv/reactor)**

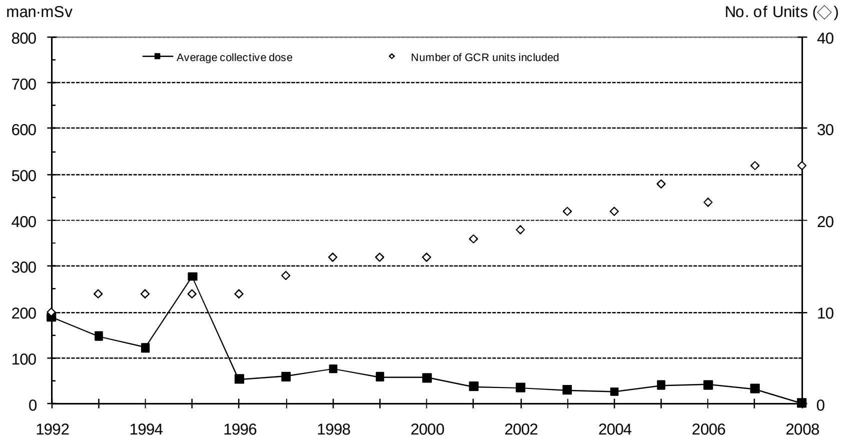
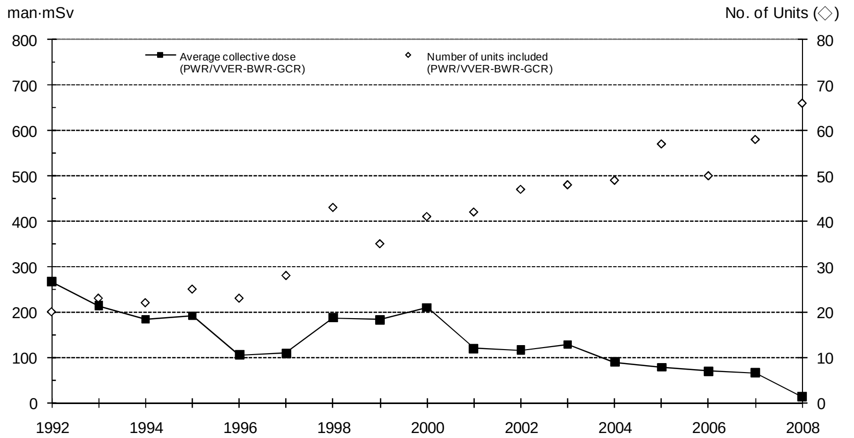


Figure 10. **Average collective dose per shutdown reactor: PWR/VVER, BWR, GCR (man·mSv/reactor)**



2.3 Trends in 3-year rolling average outage dose by sister group

This section provides an analysis of trends in 3-year rolling average collective doses for the last generation of PWR and BWR sister unit groups (reactor units of comparable type and design), in order to give an indication of NPP performance in terms of outage collective dose.

Note: The 3-year average outage collective dose for one sister group is the mean of the 3-year average outage collective dose of each reactor belonging to the group. For BWRs, the analysis takes into account only the reactor design and not the gross power, as this can vary within a sister group.

PWRs: 3-loop reactors

In the analysis, only 3-loop and 4-loop reactors are considered. With respect to the first category, the following PWR 3-loop sister group are considered:

- F32: Framatome, 3 loops, second generation. Two reactors in China, 28 in France, 2 in Korea and 2 South-Africa.
- W32: Westinghouse, 3 loops, second generation. Two reactors in Belgium, 4 in Korea, 5 in Spain, 2 in Sweden and 2 in the United States.
- M32: Mitsubishi designer, 3 loops, second generation. Five reactors in Japan.
- S32: Siemens, 3 loops, second generation. Two reactors in Germany and 1 in Spain.

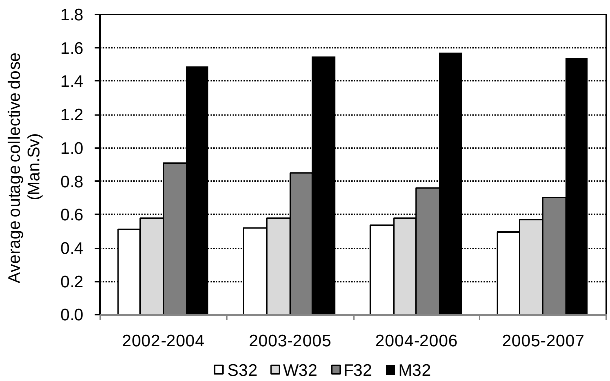
The specific reactors in each of these groups are shown in the following table.

PWR 3-loop reactors

Sister group	Country	Reactor		
F32	China	Daya Bay 1, 2		
	France	Blayais 1, 2, 3, 4 Chinon B1, B2, B3, B4 Cruas 1, 2, 3, 4	Dampierre 1, 2, 3, 4 Gravelines 1, 2, 3, 4, 5, 6 Saint Laurent B1, B2	Tricastin 1, 2, 3, 4
	Korea	Ulchin 1, 2		
	South Africa	Koeberg 1, 2		
W32	Belgium	Doel 4	Tihange 3	
	Korea	Kori 3, 4	Yonggwang 1, 2	
	Spain	Almaraz 1, 2	Asco 1, 2	Vandellos 2
	Sweden	Ringhals 3, 4		
	United States	Harris 1	Summer 1	
M32	Japan	Ikata 3	Sendai 1, 2	Takahama 3, 4
S32	Germany	Neckar 1		
	Spain	Trillo 1		
	Switzerland	Gosgen 1		

As shown in Figure 11, with the exception of F32, the sister unit groups maintain a constant trend over the period considered: groups S32 and W32 present a 3-year rolling average for outage collective dose around 0.5 man·Sv; the value for M32 is around 1.5 man·Sv. The higher value of the later group of reactors, which are located in Japan, may be due to the national inspection system which requires comprehensive inspections between operating cycles, resulting in extended outage duration. With respect to F32, a significant decrease in the outage dose over the considered period can be observed: from 0.9 man·Sv in 2002-2004 to 0.7 man·Sv in 2005-2007 (22% decrease). The results of this group for the final 3-year period considered (2005-2007) are now closer to the S32 and W32 sister unit groups.

Figure 11. **3-year rolling average outage collective dose for the PWR 3-loop reactors**



The minimum values recorded for the final 3-year period (2005-2007), as well as the number of outages per year by sister unit groups are shown in the following table.

Minimum average outage collective dose (man·Sv), 2005-2007

Sister group	Reactor name	Country	Minimum average outage collective dose (man·Sv)
F32	Tricastin 2	France	0.33 (1)
W32	Doel 4	Belgium	0.24 (2)
M32	Takahama 3	Japan	1.30
S32	Trillo 1	Spain	0.31 (2)

(1) Minimum value also for the period 2003-2005. (2) Minimum value also for the 3 other periods.

Number of outages per year by sister unit groups

Sister group (No. of reactors)		2002	2003	2004	2005	2006	2007
F32	*(34)*	29	34	31	32	31	32
W32	*(15)*	9	13	12	9	12	12
M32	*(5)*	3	4	4	4	3	4
S32	*(3)*	3	3	3	3	3	3

PWRs: 4-loop reactors

In the analysis, the following PWR 4-loop sister group are considered:

- F43: Framatome, 4 loops, third generation. Four reactors in France.
- W42: Westinghouse, 4 loops, second generation. Fourteen reactors in the United States, 1 in the United Kingdom.
- M42: Mitsubishi, 4 loops, second generation. Four reactors in Japan.
- S43: Siemens, 4 loops, third generation (Konvoi). Three reactors in Germany.

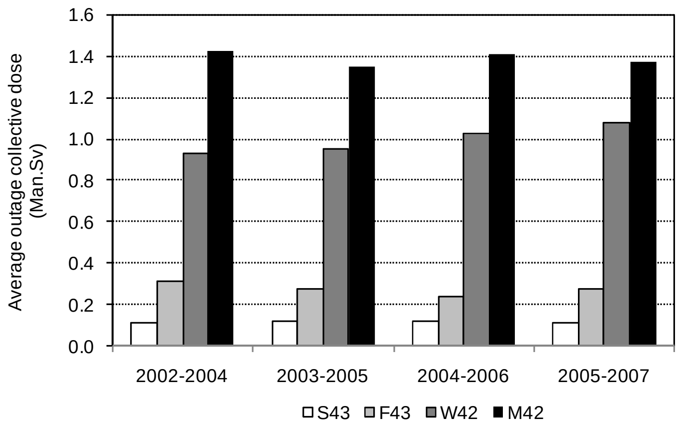
The reactors in each of these groups are shown in the following table.

PWR 4-loop reactors

Sister group	Country	Reactor		
F43	France	Chooz B1, B2	Civaux 1, 2	
W42	United Kingdom	Sizewell B 1		
	United States	Braidwood 1, 2 Byron 1, 2 Callaway 1	Comanche Peak 1, 2 Millstone 3 Seabrook 1	South Texas 1, 2 Vogtle 1, 2 Wolf Creek 1
M42	Japan	Genkai 3, 4	Ohi 3, 4	
S43	Germany	Emsland 1	Isar 2	Neckar 2

For all sister unit groups, the trend is quite constant over the period considered (Figure 12). A large disparity can be seen between the S43/F43 and the W42/M42 sister unit groups: the S43/F43 groups presents the lowest outage collective dose (around 0.1 man·Sv and 0.25 man·Sv, respectively), whereas W42 and M42 present values of around 1 man·Sv and 1.4 man·Sv respectively.

Figure 12. **3-year rolling average outage collective dose for the PWR 4-loop reactors**



The minimum values recorded for the final 3-year period (2005-2007) as well as number of outages per year by sister unit groups are shown in the following table.

Minimum average outage collective dose (man·Sv), 2005-2007

Sister group	Reactor name	Country	Minimum average outage collective dose (man·Sv)
F43	Chooz B1	France	0.24
W42	Sizewell B1	United Kingdom	0.40 (1)
M42	Genkai 4	Japan	1.13
S43	Neckar 2	Germany	0.09

(1) Minimum value also for the 3 other periods.

Number of outages per year by sister unit groups

Sister group *(No. of reactors)*	2002	2003	2004	2005	2006	2007
F43 *(4)*	2	4	4	4	4	4
W42 *(15)*	12	7	8	13	9	7
M42 *(4)*	4	2	3	3	3	2
S43 *(3)*	3	3	3	3	3	3

BWRs

With respect to BWRs, the sister unit groups taken into account in the analysis are:

- ABB4: ABB Atom, last generation. Two reactors in Sweden.
- ABWR: General Electric-Toshiba-Hitachi Advanced BWR reactors. Three reactors in Japan.
- GE5: General Electric, last generation. One reactor in Spain, 1 in Switzerland, 4 in the United States.
- TOS2: Toshiba, last generation. Sixteen reactors in Japan.

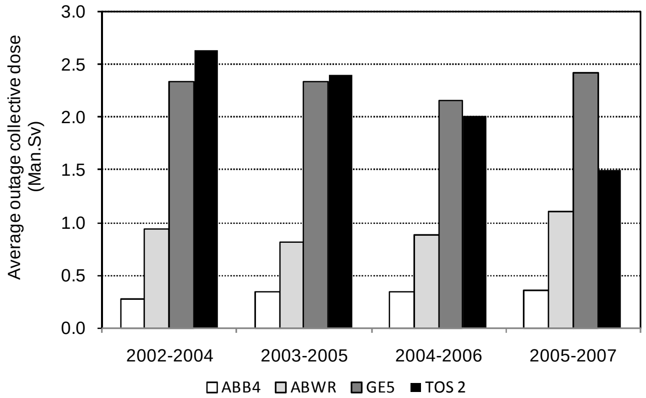
The reactors in each of these groups are shown in the following table.

BWR

Sister group	Country	Reactor	Gross power
ABWR	Japan	Hamaoka 5 Kashiwaza 6, 7	1 350 MWe
GE5	Spain	Cofrentes 1	990 MWe
	Switzerland	Leibstadt 1	1 045 MWe
	USA	Clinton 1 Grand Gulf 1 Perry 1 River Bend 1	980 to 1 300 MWe
TOS2	Japan	Fukushima Daini 1, 2, 3, 4 Hamaoka 3, 4 Higashidori 1 Kashiwaza 1, 2, 3, 4, 5 Onagawa 2, 3 Shika 1 Shimane 2	540 to 1 100 MWe
ABB4	Sweden	Forsmark 3 Oskarshamn 3	1 200 MWe

As seen in Figure 13, there is a large disparity between the 3-year average outage collective dose of the BWR sister unit groups considered. The best performances can be noticed for ABB4 and ABWR (around 0.25 man·Sv and 1 man·Sv, respectively); outage doses for the other two groups are significantly higher – around 2.4 man·Sv for GE5, although it is noted that the outage dose for TOS2 has decreased significantly over the period considered (from 2.6 man·Sv to 1.5 man·Sv). It is also noted that some BWRs present outage collective doses similar to the best PWR values (e.g., ABB4 trend is quite similar to the F43 trend).

Figure 13. **3-year rolling average outage collective dose for the BWR reactors**



The minimum values recorded for the final 3-year period (2005-2007) as well as number of outages per year by sister unit groups are shown in the following two tables, respectively:

Minimum average outage collective dose (man·Sv), 2005-2007

Sister group	Reactor name	Country	Minimum average outage collective dose (man·Sv)
ABB4	Forsmark 3	Sweden	0.34 (1)
ABWR	Hamaoka 5	Japan	0.25
GE5	Leibstadt 1	Switzerland	0.53 (2)
TOS2	Higashidori 1	Japan	0.14

(1) Minimum value also for the periods 2003-2005, and 2004-2006.
(2) Minimum value also for the 3 other periods.

Number of outages per year by sister unit groups

Sister group *(No. of reactors)*	2002	2003	2004	2005	2006	2007
ABWR *(3)*	1	2	1	1	3	1
ABB4 *(2)*	2	2	2	2	2	2
GE5 *(6)*	4	4	4	3	3	5
TOS2 *(16)*	4	9	10	9	12	9

2.4 Analysis of the 3-year average annual collective dose (2005-2007) by age category

This section provides an analysis of the 3-year average annual collective dose for the period 2005-2007 for different reactor age categories, as follows:

- PWRs: last generation of 3- and 4-loop reactors – F32, W32, M32, S32, F43, W42, M42, S43 sister unit groups.
- BWRs: last generation reactors – ABB4, ABWR, TOS2, GE5 sister unit groups.

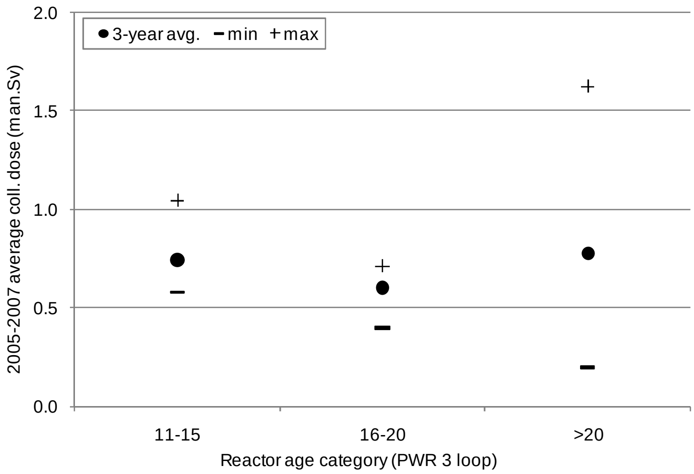
The analyses provided include the following:

- *"2005-2007" average collective dose (man·Sv)*: the average annual collective doses for each age category for the period 2005-2007, calculated by averaging the 3-year annual collective doses for all reactors in the relevant category.
- *Standard deviation (σ):* provides a measure of the dispersion of the 3-year average annual collective doses among the reactors of each category.
- *Min/Max 3-year average collective dose (man·Sv):* The minimum and maximum 3-year average annual collective doses for a single reactor in each category.
- *No. of reactors:* The total number of reactors per category.

PWRs: 3-loop reactors

In the analysis of 3-loop PWRs, there are no reactors younger than 10 years old. Of a total of 57 reactors, 54 (i.e. 95%) are older than 15 years. The summary of results is shown below.

Figure 14. **PWR 3 loops, 3-year average annual collective dose (man·Sv) by age category**



	Reactor age category (years)				
	1-5	6-10	11-15	16-20	>20
2005-2007 average coll. dose (man·Sv)	–	–	0.7	0.6	0.8
Standard deviation σ	–	–	0.2	0.1	0.3
Min 3-year average coll. dose (man·Sv)	–	–	0.6	0.4	0.2
Max 3-year average coll. dose (man·Sv)	–	–	1.05	0.7	1.6
No. of reactors	–	–	3	8	46

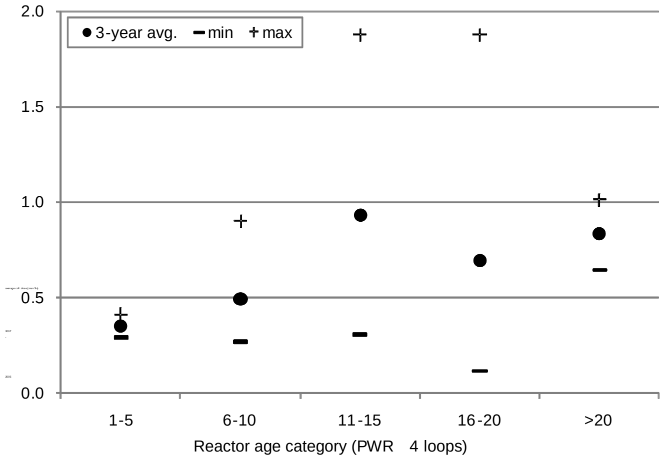
For these reactors, the 2005-2007 average annual collective dose by reactor age category is around 0.6 man·Sv. The maximum and minimum average annual collective doses are observed for reactors in the “>20 years” group (1.6 man·Sv and 0.2 man·Sv, respectively), with a factor of 8 between these values. This group also presents the highest data dispersion with a standard deviation of 0.3. The difference between maximum and minimum values is much lower for the youngest reactors of “11-15 years” (around 2 times).

PWRs: 4-loop reactors

It is observed that the age distribution for 4-loop PWRs is wider than for the 3-loop reactors. Of 26 reactors, a majority (17) are older than 15 years. Only a few (5) are less than 10 years.

While the lowest 2005-2007 average annual collective dose is observed for the youngest reactors (0.4 man·Sv for “1-5 years”), the highest value (0.9 man·Sv) is observed for the “11-15 years” category. An opposite trend is observed for reactors in the “11-15 years” and “16-20 years” groups (0.9 man Sv and 0.7 man·Sv, respectively). The youngest reactors also present the smallest data dispersion within the group (σ = 0.06). The greatest difference between the minimum and maximum average annual collective dose within a reactor age category is observed in the “11-15 years” group, where the highest average collective dose (1.9 man·Sv) is around 20 times higher than the minimum (0.1 man·Sv).

Figure 15. **PWR 4 loops, 3-year average annual collective dose (man·Sv) by age category**

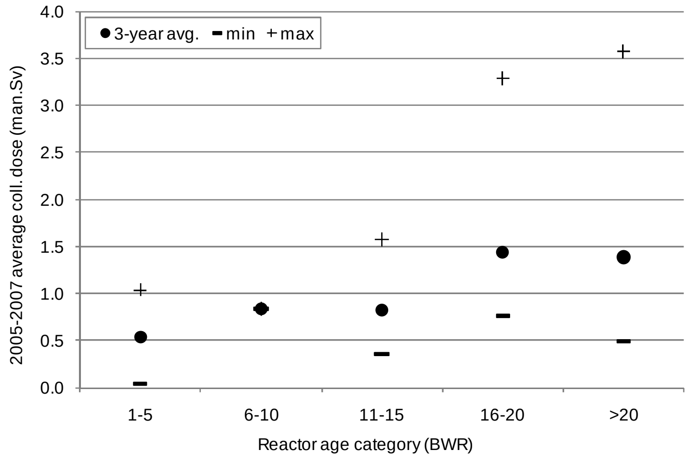


	Reactor age category (years)				
		6-10	**11-15**	**16-20**	**>20**
2005-2007 average coll. dose (man·Sv)	0.4	0.5	0.9	0.7	0.8
Standard deviation σ	0.06	0.3	0.6	0.45	0.2
Min 3-year average coll. dose (man·Sv)	0.3	0.3	0.3	0.1	0.65
Max 3-year average coll. dose (man·Sv)	0.4	0.9	1.9	1.9	1.0
No. of reactors	2	3	4	13	4

BWRs

With respect to the BWRs considered in the analysis, of the total number of reactors (28), approximately half are less than 15 years old. The reactor age category ">20 years" contains the greatest number of reactors (10 reactors). The summary of results is shown below:

Figure 16. **BWR, 3-year average annual collective dose (man·Sv) by age category**



	Reactor age category (years)				
	1-5	**6-10**	**11-15**	**16-20**	**>20**
2005-2007 average coll. dose (man·Sv)	0.5	0.8	0.8	1.4	1.4
Standard deviation σ	0.4	0	0.4	0.8	0.9
Min 3-year average coll. dose (man·Sv)	0.04	0.8	0.4	0.8	0.5
Max 3-year average coll. dose (man·Sv)	1.04	0.8	1.6	3.3	3.6
No. of reactors	4	1	6	7	10

The youngest reactors ("1-5 years") present the lowest 2005-2007 average annual collective dose (0.5 man·Sv). Similar trends are observed for the categories "6-10 years" and "11-15 years" with 3-year average annual collective doses of 0.8 man·Sv, and for the categories "16-20 years" and "> 20 years" (1.4 man·Sv). It is noticed that the dispersion of data is highest within the "> 20 years" group ($\sigma = 0.9$). This group also contains the reactor with the maximum average annual collective dose (3.6 man·Sv). The minimum value (0.04 man·Sv) is associated with a reactor in the "1-5 years" group.

3. MAJOR EQUIPMENT EXPERIENCE: STEAM GENERATOR REPLACEMENT OUTAGE AT ANGRA 1 (BRAZIL)[1]

3.1 Introduction

The Angra 1 Nuclear Power Plant is a Westinghouse 2-loop PWR (net output of 632 MWe prior to steam generator replacement), located in Angra dos Reis (Brazil). Angra 1 started commercial operation in 1985. Since 2003, the process for collective radiation exposure reduction was slowed due to increased outage frequency to address degradations in the model D3 steam generators. Primary water stress corrosion cracking (PWSCC) was, in most of the cases, responsible for tube corrosion in the old steam generators (OSG), leading to tube thinning and an increased probability of tube rupture events. Mid-cycle outages required to perform tests and maintenance for the defective OSG, including work to plug failed tubes and those with a high probability of failure, contributed to increases in the collective radiation exposure, skilled workers doses and personnel contamination events.

Eletronuclear decide to correct the problem by replacing the OSG in 2009 with two new steam generators with a feed water-ring system. The Electronuclear radiological protection organisation was committed to ensuring that this endeavour was performed without accident or significant incident. Radiological protection management was also concerned with minimising the collective dose for the project and keeping individual doses ALARA.

3.2 Chronology of events

In August 2003, a sudden increase in the OSG primary-to-secondary leak rate caused a plant shutdown according to operating procedures. At that time, the Angra 1 1P12 outage was also initiated. A full-scope eddy current test was performed, in which 100% of the SG tubes were examined, and the retainer ring for the nozzle dams inside the SG primary bowl was installed. Between July 2004 – June 2007, an additional 6 outages were performed to undertake a variety of tasks. In February 2008, the last outage (1P15A) before the steam generator replacement (SGR) was performed, involving many tasks related to the upcoming SGR operations planned for the 1P16 outage. Several improvements in shielding were implemented, showing highly favourable results in reducing the outage collective dose.

On 24 January 2009, the 1P16 refuelling outage started, for which the main task was the SGR and its subtasks. The results of this outage are discussed below. The conclusions outline the expectations for the upcoming operating cycles for Angra 1 NPP and the consequent challenges for the Eletronuclear Radiological Protection Division: less outage duration, lower collective dose, lower individual doses – how to achieve this and still maintain a reasonable cost effectiveness for saving doses?

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1. This section is based on a paper originally presented at the 2009 ISOE International ALARA Symposium (*Magno Jose de Oliveira, Marcos Antonio do Amaral, Edson Minelli and William Alves Ferreira (2009), Radiological Protection for the Angra 1 Steam Generator Replacement Outage*), available from the ISOE Network (www.isoe-network.net).

3.3 Steam generator replacement

SGR radiological protection plan and ALARA plans

While the “Technical Specifications for Angra 1 Steam Generator Replacement” first addressed radiological issues, the most important document with a radiological focus was the “Angra 1 Steam Generator Replacement Radiological Protection Plan”, developed by Eletronuclear Radiological Protection Division and submitted to the Brazilian Nuclear Regulatory Commission (CNEN) for comment and approval. During the planning phase, an EPRI expert assessment mission was contracted by Eletronuclear RP Division to evaluate the plan. The EPRI report proved to be very useful and the main recommendations, emphasising dose reduction methods, dose control technologies, highly visible signs, effective communication and coverage for field tasks, were implemented. Additionally, some facilities were built to support the work, such as the containment access facility to provide secondary access to the reactor building, the Decon Area (tent) to permit low level and dry decontamination outside the plant buildings and the extended controlled area (connected to the containment equipment hatch in a posted contaminated controlled area) to facilitate handling of insulation and pipes before their installation.

The SGR ALARA Plan was initiated by carrying out the dosimetric phase during the 1P15A outage, involving radiation surveys, source term characterisation, job scope and working areas definition, designation of dose reduction methods, doses estimates and specific ALARA planning for the main activities. Immediately before the 1P16 outage, all the tasks and subtasks for each ALARA Plan were defined, including the respective Radiological Work Permits (RWP) with instructions, precautions and alarm settings. A comprehensive training structure was established for the radiation workers, RP technicians and special training.

Nineteen ALARA Plans were produced, followed-up and finished according to the plant ALARA procedure. With respect to the final collective dose, 81% originated from tasks covered by specific ALARA plans and the remaining 19% from non-ALARA tasks, i.e., below the threshold to start an ALARA specific job plan. The accomplishment of the ALARA Plans and the measures to reduce and control workers doses were critical to achieving the collective dose of 1 310 man·mSv, 8% below the initial estimate of 1 417 man·mSv, and below the contractually defined target of <1 500 man·mSv.

Dose reduction methods

The main methods to reduce collective and individual doses were source term reduction, lead shielding, water shielding and mock-up training. The control of workers entering the Controlled Area, visible signage and lights contributed to the favourable results.

Source term reduction through the removal of activated corrosion products was one of the most important contributors to dose reduction for the SGR. Since 2004, Angra 1 performed zinc injection to the reactor coolant system (RCS) during operation. In addition, chemical decontamination using hydrogen peroxide was carried out to remove corrosion products, with a target for ^{58}Co of 1.85 Bq/kg immediately after each refuelling shutdown. In the 1P16 outage, the H_2O_2 process was shown to be effective and the target was achieved in less time than was initially estimated. This operation removed a total of 23 TBq, reducing worker doses.

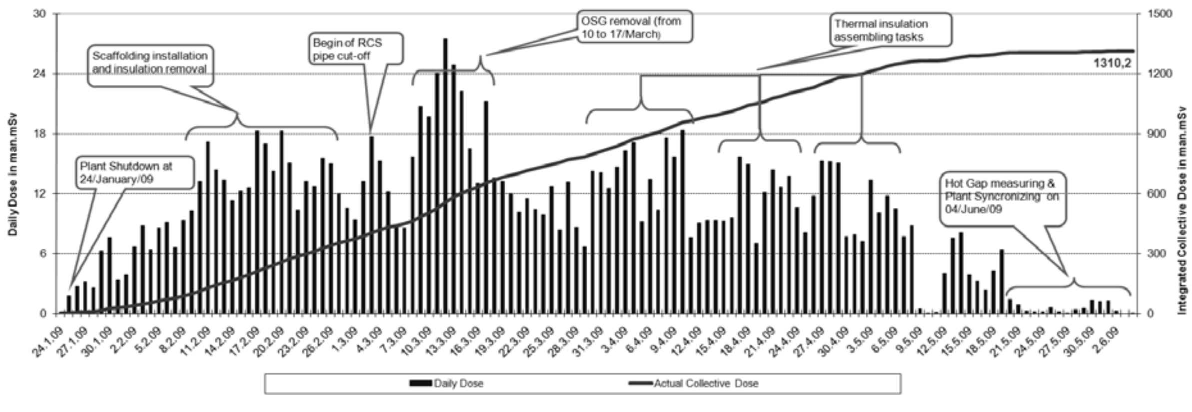
Intensive use of lead blankets of several sizes aimed to reduce ambient dose rates and hot spots. Two approaches to shielding installation were adopted: first, to protect individuals working in high radiation areas against unplanned doses; second, to reduce low dose rates in the working environments (for example, in transit areas) leading to significant reductions in collective dose over the work duration. Approximately 40 000 kg of lead shielding were installed inside the controlled area, particularly in the reactor building, RCS pipes, OSG platforms etc. The reduction in dose rate after installation ranged from 25%-50% in the hot, cold and intermediate legs and the safety injection lines, and from 25%-30% in the resistance temperature detectors manifold. Shield blankets were installed over the grid floor of the SG platforms, assuring minimum values of dose rates in the staying areas.

Water management inside the systems to provide additional shielding was considered by the RP team and the EPRI Mission as a key factor for dose reduction during the SGR planning phase. Most of the tasks were planned to be performed, as much as possible, with the secondary side of the OSG and the RCS filled with water. After the final OSG secondary side drainage to allow cutting of the main feed water piping, OSG purge lines and drain systems lines, an increase in dose rate of about 100% in the vicinity of the OSG was observed. Therefore, only required tasks were authorised to proceed.

Finally, a detailed and life-size mock-up with associated piping was planned to test tools and to train work crews in the tasks of shielding installation, cutting pipes, installing tripod and shielding supports for cutting primary lines, welding pipes and foreign object search and retrieval (FOSAR) operations. Unfortunately, this mock-up was not released in a timely manner for use before the SGR. Therefore, the old Angra 1 mock-up, a partial reproduction of primary internal chamber of the steam generators but without the connections with the primary pipe legs and out of the desired conditions, was decontaminated and used for training. Despite the success obtained with the broad project, the mock-up issue should be treated carefully, because its inadequacy meant much more improvisation, sometimes wasting time and doses, and increasing the risk of incident and injury.

For better illustration of the dose evolution, Figure 17 shows the daily and integrated doses associated with the major tasks during the SGR.

Figure 17. **Evolution of the collective dose during Angra 1 SGR**

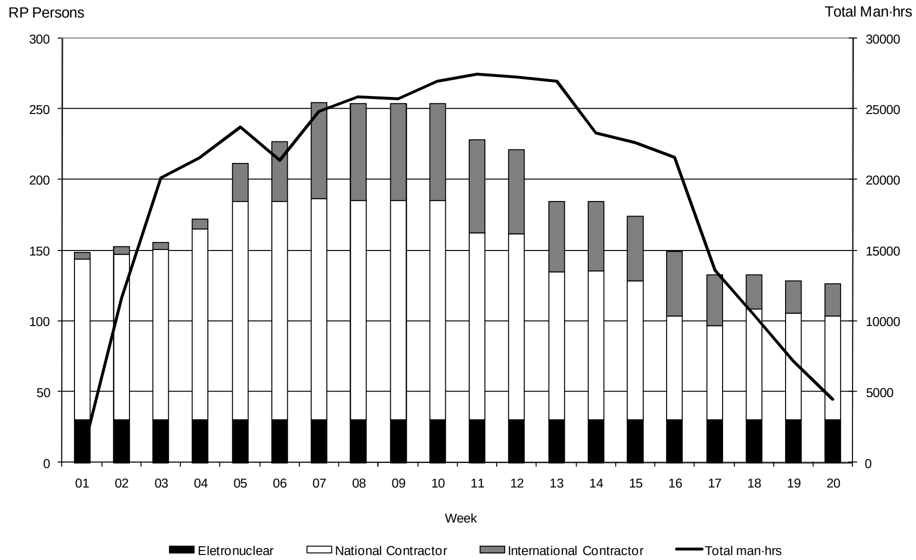


Radiological protection organisation

The organisation of the Eletronuclear RP Division encompasses a range of operational and organisational functions (RP, monitoring, ALARA planning, training, dosimetry, etc). The Division had 253 persons assigned for the SGR (Eletronuclear employees and contract workers), distributed between helpers, auxiliary technicians, decontamination technicians, junior and senior RP technicians, supervisors and RP Supervisors. All radiological safety efforts were managed by this organisation and the contracted field technicians were directly co-ordinated by the Angra 1 RP Supervision. All supervisors and technicians received specific instructions for the 1P16 Outage Programme, especially for tasks related to the SGR and ALARA Planning. Additionally, international technicians received training on the radiation instruments used by Angra 1 RP technicians and on the specific RP criteria applicable to Angra 1.

Figure 18 shows the mobilisation of human resources, which were organised using two daily schedules: some working with two teams of twelve hours a day and some working with three teams of eight hours a day.

Figure 18. **Mobilisation and demobilisation of RP workers**



Dose control, job coverage and communication

The worker's dose control was performed using the Electronic Access Control System (EACS), designed especially for the Angra site. With this system, the requirements for radiation workers are verified online; if necessary, the system can block access in case of any missing requirement or alarm, and can inform the RP Control Point in case of an in-field dosimeter alarm. The system also detects any attempt of battery removal or bad contact with the battery terminals. Job coverage was performed using a single Control Point (the Containment Access Facility – CAF) with the establishment of Advanced Control Points inside the area. The CAF was designed to store 2 000 TLDs and 750 electronic dosimeters. Inside the meeting room, two TV monitors were linked to 14 cameras, with a senior technician permanently covering the job details and directing RP efforts as required.

The communication process among supervisors was defined by the RP Manager to immediately occur between the daily meeting Plan of the Day (POD) and the daily Plant Outage Meeting. The use of radios with a specific ALARA channel enabled online communication among the team leaders. To ensure success, the use of 3-way communication and phonetic alphabet was reinforced and extensively practiced.

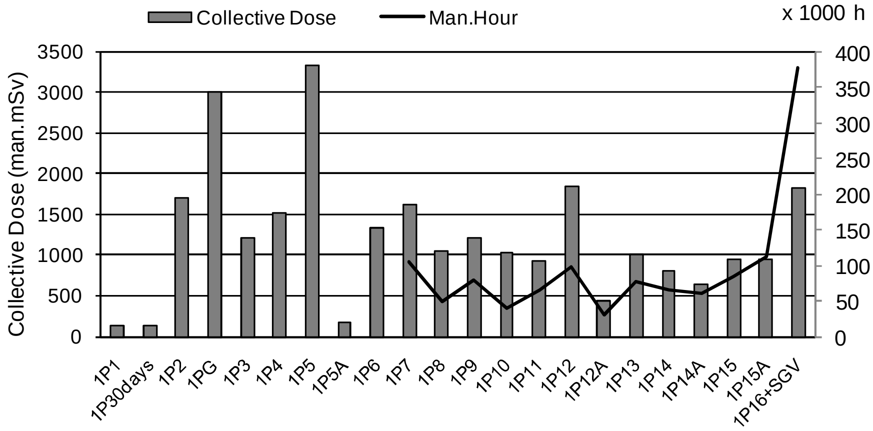
Techniques and technologies

The technologies and techniques employed as part of RP efforts included emergency warning lights to indicate high risk activities, such as radiography, primary leg cutting and removal, etc, teledosimetry to permit the real time monitoring of the workers executing jobs inside Controlled Area, and CCTV/radio systems to enable communications during tasks and give opportunity to coach workers in terms of RP and maintenance practices, etc. Coloured postings and warning messages to indicate "waiting" or "do not stay" areas were distributed inside the Controlled Area, allowing workers to identify rest/wait areas, and allowing RP Techs to act promptly to remove unneeded workers from identified areas. RP Personnel Identification (red jackets with reflective letters indicating "Radiological Protection") were used by RP personnel both in contaminated and non-contaminated areas, allowing the workers to promptly identify the RP and Auxiliary Technicians in field, accelerating job execution and reducing the risk of bad practices. Finally, a special RP team was created during the SGR to release materials from the Controlled Areas of the Plant buildings to the Decon Area for subsequent monitoring, segregation, and clearance of clean materials.

3.4 Results

The results for the Angra 1 SGR are below presented. In summary, the OSG were removed and new ones installed, bringing opportunities for Angra 1 to start to be within the best plant indicators in its category, worldwide. Figure 19 shows the historical collective dose and man-hours (after the 7th Outage, 1P7) for Angra 1, in order to compare the magnitude of the SGR work. Figure 20 shows the evolution of the average collective dose index (μSv/h), demonstrating the effect of the large increase in the hours worked inside Controlled Area and the improvements made to reduce this ALARA index despite the fact that some years had an increase in the collective dose.

Figure 19. **Angra 1 outage collective doses**



Note: "A": mid-cycle outage, "30 Days": post- commissioning; "G": electrical generator failure

Figure 20. **Angra 1 outage dose rate index**

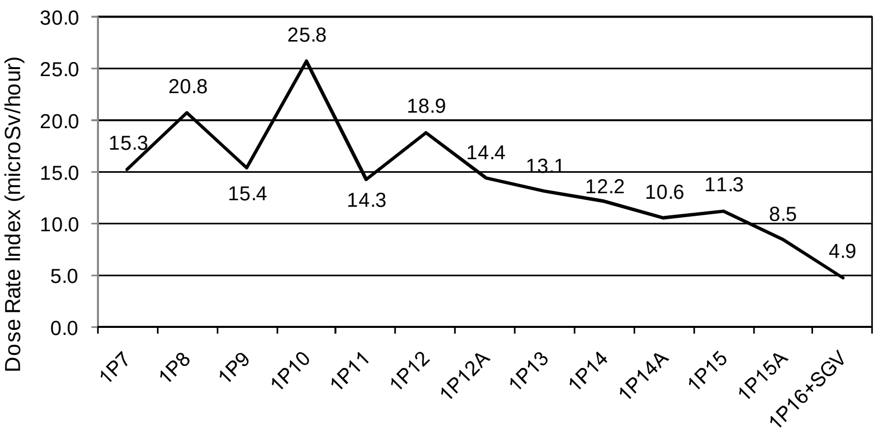


Figure 21 presents the daily values for workers inside, and entries into, the Controlled Area during the SGR, and illustrates the radiological protection concern, as the majority of the workforce was Brazilian contractors, who were not as skilled as some international contractors in working in radiological controlled areas. The peak was 1 401 persons inside Controlled Area and 3 060 entries in a single day, and the average values over the entire outage were, respectively, 767 persons and

1 697 entries/day. Figure 22 shows the reduction achieved in the collective dose index as the shielding was installed and the controls put in place and, lastly, after the removal of the OSG. Finally, Figure 23 shows the average dose per person and per entry. Again, the effect of source term reduction due the removal of the OSG it is visible at the end of outage.

Figure 21. **Angra 1 SGR – trend for people and entries in the radiological controlled areas**

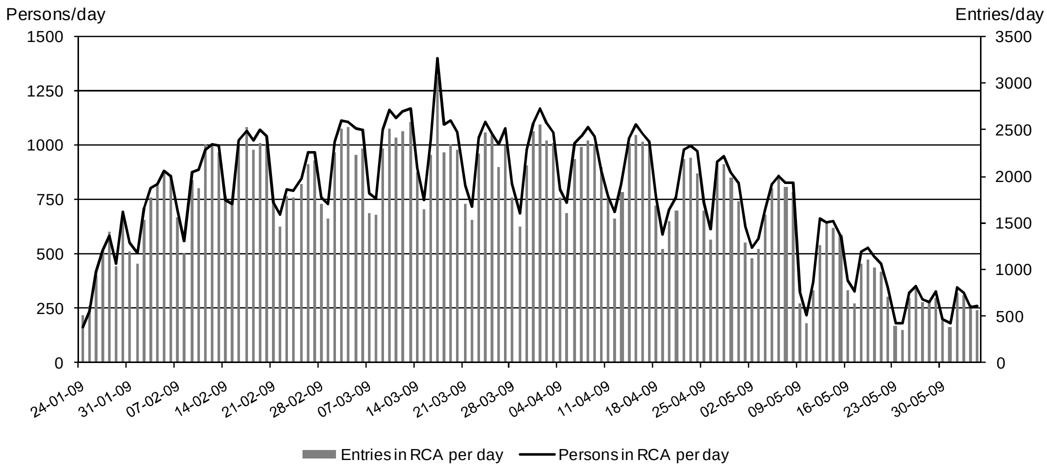


Figure 22. **Angra 1 SGR – Dose rate index**

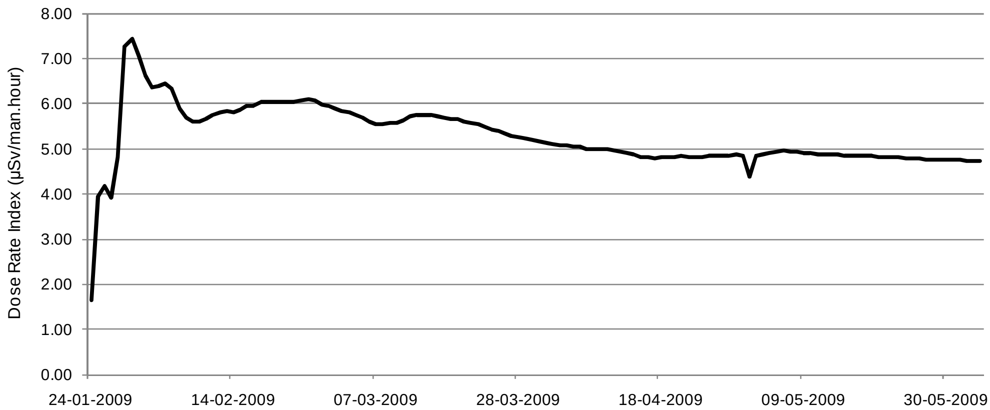
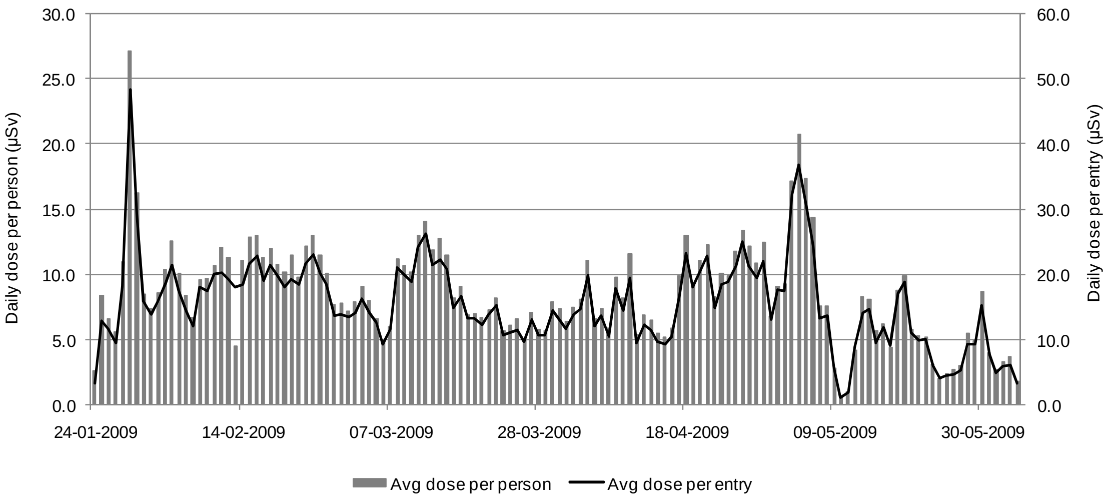


Figure 23. **Angra 1 SGR – Average dose per person and per entry in the SGR**



3.5 Conclusion

The Angra 1 steam generator replacement represented an enormous challenge for the Eletronuclear RP organisation, not only because of the size of the job, but also because of some changes in managerial posts. However, this was successfully managed, and almost all the provisions in the RP Plan were implemented before or during the SGR.

The SGR completion has brought new challenges to the Angra 1 organisation. First, the Plant Superintendent has established a target duration of no more than 30 days for new outages. Second, the Eletronuclear Operations Directorate established a 3-year target to achieve the median value for the WANO collective radiation exposure indicator.

For the Eletronuclear RP organisation, the two targets mentioned above means that a greater number of workers will be involved in simultaneous tasks inside the Controlled Area during future outages. Anticipating this situation, the RP Manager has started a process to install remote monitoring technology, which was partially used during the SGR with success. Another powerful tool is the use of temporary shielding, not only to shield the high dose rates, but aiming to reduce low dose rates fields in areas with high occupation rate and worker transit. The post-SGR primary chemistry is also a matter of attention, considering that some plants faced an increase in source term related to the ^{58}Co after their SGR. Those experiences are being considered for the present cycle and the next plant outage shutdown. Lastly, new RP Technicians will need to be appropriately trained, particularly after construction resumes at Angra 3. The RP Training Group will play a fundamental role in the quality of RP Technicians in the coming years.

4. ISOE EXPERIENCE EXCHANGE ACTIVITIES

While ISOE is well known for its occupational exposure data and analyses, the programme's strength comes from its efforts to share such information broadly amongst its participants. The combination of ISOE symposia, ISOE Network 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 occupational exposure management. This section provides information on the main information and experience exchange activities within ISOE during 2008.

4.1 ISOE ALARA symposia

ISOE International ALARA Symposium

The ATC organised the 2008 ISOE International Symposium, held 13-14 November 2008 in Tsuruga, Japan and sponsored by the OECD/NEA and IAEA. The symposium was attended by about 90 participants from 14 countries. Distinguished papers selected by the participating technical centres for presentation at the 2009 ISOE International ALARA Symposium in Vienna included:

- *Reduction of Radiation Exposure at Higashidori Nuclear Power Station*, Mr. Shigeru Ito (Tohoku Electric Power Company, Japan).
- *Braidwood Station Alternate Post Peroxide Cleanup Methodology*, Mr. Patrick Daly (Braidwood PWR, United States).

The 2009 and 2010 ISOE International ALARA Symposia will be organised by the IAEA and ETC respectively.

ISOE Regional ALARA Symposia

NATC, in cooperation with the Electric Power Research Institute (EPRI), organised and conducted the 2008 ISOE North American ALARA Symposium & EPRI Radiation Protection Conference from 14-16 January 2008 in Fort Lauderdale, United States. Participation included: over 160 participants from 7 countries; over 30 vendors; and over 35 technical ALARA papers. Darlington nuclear station was presented with the World Class ALARA Performance Award based on accomplishments in the area of airborne tritium reduction. ATC participated in the symposium and presented its activities.

ETC organised and conducted the 2008 ISOE European ALARA Symposium from 25-27 June in Turku, Finland. The Symposium was preceded by meetings of the radiation protection managers and the senior regulatory body representatives. The Symposium gave the opportunity to 160 participants from 27 European, North American and Asian countries to meet and receive information from 36 podium presentations and 21 posters presentations. A visit to the TVO site was also organised.

Proceedings and conclusions of the various Symposia are available on the ISOE Network.

4.2 The ISOE Network (www.isoe-network.net)

The ISOE Network is a comprehensive information exchange website on dose reduction and ALARA resources for ISOE participants, providing rapid and integrated access to ISOE resources through a simple web browser interface. The network, containing both public and members-only resources, provides participants 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. In 2008, the ISOE Management Board approved an initiative, lead by ETC, to reformat the layout and organisation to enhance usability and better meet user needs.

ISOE occupational exposure database

In order to increase user access to the data within ISOE, the ISOE occupational exposure database is accessible to ISOE participants through the ISOE Network. Since 2005, the database statistical analysis module, known as MADRAS, has been available on the Network. 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.
- Trends in the number of reactor units.
- 3-year rolling average for collective dose per reactor.
- 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. Modules for on-line data entry for the ISOE 1 questionnaire will be implemented in 2009.

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 ISOE publications, reports, presentations and proceedings.

Radiological protection forum

In addition to the ALARA Library, registered ISOE users can access the RP Forum to submit a question, comment or other information relating to occupational radiation protection to other users of the Network. 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.

4.3 ISOE benchmarking visits

To facilitate the direct exchange of radiation protection practice and experience, the ISOE programme supports voluntary site benchmarking visits amongst the Participating Utilities in the four technical centre regions. These visits are organised at the request of a utility with technical centre assistance and included in the 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, post-visit reports are 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 within ISOE. Highlights of visits conducted during 2008 are summarised below.

Benchmarking visits organised by ATC

The Japan Nuclear Energy Safety Organization (JNES) manages the ISOE-ATC and organised a benchmark visit to the United States on 10-17 February 2008. This was performed as part of a project for exposure reduction entrusted to JNES by the Ministry of Economy, Trade and Industry. The visiting group was composed of people such as JNES and university staff related to radiation protection. The purpose of the visit was to investigate advanced technologies for dose reduction and to exchange information about ALARA activities. The group visited the Vogtle, Arkansas Nuclear One and Quad Cities nuclear power plants. Through this visit, advanced technologies such as the online monitoring system and various aspects of aggressive ALARA activities at each plant were identified.

Benchmarking visits organised by the IAEA

Preliminary contacts were established in order to organise a benchmarking exercise for the CANDU reactor in Cernavoda

Benchmarking visits organised by NATC

After the 2008 ISOE North American ALARA Symposium, 3 EDF utility managers participated in a tour of St. Lucie and Crystal River NPPs to evaluate RP software programs (17-18 January 2008). The NATC Regional Director hosted 3 EDF senior managers at the Calvert Cliffs Nuclear Station on 26-27 February 2008. The group visited the site during a refuelling outage to observe the use of remote monitoring technologies in radiation protection. The group discussed equipment reliability monitoring programs with Calvert Cliff experts. EDF has formed a joint venture with Calvert Cliffs to build Calvert Cliffs, Unit 3.

5. ISOE PROGRAMME MANAGEMENT ACTIVITIES DURING 2008

In 2008, 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, including enhanced inter-regional co-operation and co-ordination. This was facilitated through the ISOE ALARA Symposia, ISOE Network website and ISOE-organised benchmarking visits (see Section 4 for details). These initiatives have continued to 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 Renewal of ISOE Terms and Conditions for 2008-2011

At its 17th annual meeting in November 2007, the ISOE Steering Group approved the new ISOE Terms and Conditions for the period 2008-2011, effective 1 January 2008. The Terms and Conditions where updated to better reflect operational and organisational practices within ISOE. All current participants were requested to confirm their continued participation under the ISOE Terms and Conditions for 2008-2011. Under the new Terms, the ISOE Steering group was renamed the ISOE Management Board.

5.2 Management of the official ISOE databases

Official database release

ETC continued to manage the official ISOE database, preparing the CD-ROM version under ACCESS with 2006 data and distributing it in January 2008 directly to European Participating Utilities, and to the other technical centres for distribution to their regional members. Specific databases for each Participating Authority were also created and distributed in January 2008. The first release of the ISOEDAT database with data from 1969 to 2007 (partial) was made available in July 2008 through the ISOE Network, followed by regular updates on the Network. The end-of-year release of the database and ISOE Software on CD-ROM was provided to all participants following the annual ISOE Management Board meeting.

Development of ISOEDAT online

The NEA and ETC continued development of the web-enabled data input modules as part of the ISOEDAT web migration project Phase 2, including WGDA testing periods in May and October 2008, with a view towards on-line implementation on the ISOE Network in 2009.

5.3 Management of the ISOE Network

The ISOE Network continued to serve as the central portal for ISOE-related information and resources, including the ISOE database. The ISOE Network was developed by ETC and NEA and is managed by ETC. At the end of 2008, about 430 utility and 70 regulatory member accounts had been created. Following direction of the Management Board in 2007, the ETC prepared a proposed revised website layout with a view towards improving its operational usefulness for ISOE members. At its 2008 annual meeting, the Management Board approved its implementation when completed.

5.4 ISOE management and programme activities

As part of the overall operations of the ISOE programme, ongoing technical and management meetings were held throughout 2008, including:

ISOE Meetings	Date
Working Group on Data Analysis	September 2008.
Expert Group on Work Management	February 2008; May 2008.
Task Team on Decommissioning	February 2008, June 2008.
ISOEDAT-web Working Group	Ongoing ad-hoc meetings between NEA and ETC.
Ad-hoc Expert Group for the International Basic Safety Standards	February 2008; September 2008.
ISOE Bureau	May 2008; November 2008.
Technical Centres	September 2008.
18th ISOE Management Board Meeting	November 2008.
Joint NEA/CRPPH-ISOE Activities	
Expert Group on Occupational Exposure	April 2008; October 2008.

ISOE Management Board

The ISOE Management Board continued to focus on the management of the ISOE programme, reviewing the progress of the programme at its annual meeting 2007 and approving the programme of work for 2008, including the new ISOE Terms and Conditions (2008-2011), which came into effect 1 January 2008. The 2008 mid-year meeting of the ISOE Bureau focused on the status of ISOE activities, the status of renewal of the new ISOE Terms and Conditions by participants, planning for the ISOE Annual Session 2008, and discussion of a common format for the ISOE International ALARA Symposia.

ISOE Working Group on Data Analysis

The Working Group on Data Analysis (WGDA) met once in September 2008, continuing its focus on the integrity and consistency of the ISOE database, timely data collection and the development of the on-line data input modules. The WGDA also discussed a new proposal to improve data collection and experience exchange activities for reactors undergoing decommissioning, and the possible development of a new data analysis feature to allow simplified, user-defined "free" queries of the database, in addition to the pre-defined MADRAS queries.

Task Team on Decommissioning

This WGDA task team met twice in 2008 to develop and finalise its proposal for improving the data collection, analysis and experience exchange aspects of participating reactors undergoing decommissioning. As part of this, it was suggested that options for linkages with the OECD/NEA International Co-operative Programme on Decommissioning be investigated.

ISOEDAT Web Migration Working Group

The ISOEDAT-web working group continued work on the ISOEDAT web migration project, Phase 2, focusing on the development of on-line data input modules. At its 2008 annual meeting, the Management Board approved their implementation in 2009, following final testing.

Expert Group on Work Management

Under the auspices of the WGDA, the EGWM meet two times during 2008 to complete its report on "Work Management to Optimise Occupational Radiological Protection at Nuclear Power Plants", which takes into account new experience and technology in occupational radiation dose reduction and 15 years of ISOE experience exchange. At its 2008 annual meeting, the Management Board approved the report for publication.

Ad-hoc Expert Group on the Revision of the BSS

This ad-hoc expert group was launched by the ISOE Management Board during its annual meeting in 2007, in order to review, with respect to good practice in occupational exposure, drafts of a revised International Basic Safety Standards as they were made available through the ISOE Joint Secretariat (as BSS co-sponsoring organisations). The group met twice in 2008 to provide consolidated comments, through the ISOE Secretariat, into the BSS drafting and comment process, including a formal review meeting within the NEA.

Meeting of Technical Centres

The ATC and ETC met in September 2008 to discuss coordination and data collection issues, and finalise the EGWM report.

Joint NEA/CRPPH-ISOE Activities: Expert Group on Occupational Exposure

The EGOE was created by the NEA Committee on Radiation Protection and Public Health (CRPPH), with an invitation to ISOE to participate in its activities. The EGOE met twice in 2008, with significant participation by ISOE members, including all ISOE technical centres. The group's work focused on the development of radiological protection criteria for designing new nuclear power plants, intended for vendors, authorities and utilities. The group also began work addressing implementation aspects of the new ICRP recommendations for occupational exposure.

6. PRINCIPAL EVENTS OF 2008 IN ISOE PARTICIPATING COUNTRIES

As with any summary data, the information presented in Section 2: Occupational Dose Studies, Trends and Feedback, provides only a general overview of average numerical results from the year 2008. Such information serves to identify broad trends and helps to highlight specific areas where further study might reveal relevant experiences or lessons. However, to help to enhance this numerical data, this section provides a short list of important events which took place in ISOE participating countries during 2008 and which may have influenced the occupational exposure trends. These are presented as reported by the individual countries.[1] It is noted that the national reports contained in this section may include dose data arising from a mix of operational and/or official dosimetry systems.

ARMENIA

The Armenian Nuclear Power Plant (ANPP), the only nuclear power plant in the region, consists of two VVER/440/270 units (a modified, seismic design VVER/440/230). Unit 1 started commercial operations in 1976 and Unit 2 in 1980. Both units were shut down shortly after the 1988 Spitak earthquake. Re-commissioning works were performed from 1993-1995; in November 1995 Unit 2 restarted operation. Currently, the ANPP Unit N1 is in a conservation regime (long-term shut down).

Summary of national dosimetric trends

For the year 2008, the dosimetric trends at the Armenian NPP have slightly increased for collective and maximum individual dose. The maximum individual dose was 19.6 mSv. The contractors collective dose was 0.19 man·Sv.

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

Year	Collective dose	Year	Collective dose	Year	Collective dose
1995	4.18	2000	0.96	2005	0.82
1996	3.46	2001	0.66	2006	0.85
1997	3.41	2002	0.95	2007	0.78
1998	1.51	2003	0.86	2008	1.05
1999	1.57	2004	1.08		

Events influencing dosimetric trends

In 2008, general repair and maintenance activities were planned and performed, including works related to chemical cleaning and non-destructive testing of the reactor vessel, eddy current control of SG tubes and cutting of damaged tubes, which have influenced the dosimetric trends at ANPP.

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

New plants on line/plants shut down

The new plant construction is on line at the organisational stage.

Safety-related issues

Some elements of the radiation control system are obsolete and need to be replaced.

Organisational evolutions

Dose planning is still the main tool for the reduction of individual doses of staff.

Technical plans for major work in 2009

Modernisation plan of the Radiation Control System, including the individual dose monitoring and contamination spraying monitoring equipment.

Major evolutions

ALARA principles implementation is progressing slowly because of lack of financing support.

2009 Issues of Concern

In 2009, radioactive waste drums replacement and conditioning works are expected. Administrative and technical measures must be scheduled by the plant and approved by the Armenian Nuclear Regulatory Authority.

Regulatory plans

Review of the safety assessment report (SAR) in terms of radiation protection and safety, and radioactive waste management.

BELGIUM

Dose information

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

Collective doses for the year 2008 (in man·mSv)				
Tihange NPP	**Tihange 1**	**Tihange 2**	**Tihange 3**	**Total**
Plant Personnel	94.474	119.911	23.664	236.049
Contractor's Personnel	419.560	624.547	58.897	1 103.004
Total	512.034	744.458	82.561	1 339.053
Doel NPP	**Doel 1, 2**	**Doel 3**	**Doel 4**	**Total**
Plant Personnel	119.66	121.40	53.04	294.10
Contractor's Personnel	450.40	456.96	199.66	1 107.02
Total	570.06	578.36	252.70	1 401.12

Events influencing dosimetric trends

- Tihange 3: unforeseen stop for checking nuclear fuel integrity (suspicion of fuel leakage) in December 2007 – January 2008.
- Doel 3: unforeseen stop for mechanical seal problems on primary and residual heat removal pumps, August – September 2008.

Number and duration of outages

Unit	Collective dose (man·mSv)	Unit	Collective dose (man·mSv)
Tihange 1	445.799	Doel 1	235
Tihange 2	682.411	Doel 2	263
Tihange 3	*No outage in 2008*	Doel 3	481
		Doel 4	213

Safety-related issues

High temperature of the mechanical seals of the residual heat removal pumps at Doel 3 NPP was evaluated as a level 1 incident on the international nuclear event scale (INES). Unexpected events included: Tihange 3: unforeseen stop for checking nuclear fuel integrity (suspicion of fuel leakage) in December 2007 – January 2008; Doel 3: unforeseen stop for mechanical seal problems on primary and residual heat removal pumps, August – September 2008.

Technical plans for major work in 2009

- Outage for Tihange 2 and 3 in 2009.
- Outage for all Doel units in 2009. Steam generators are being replaced at Doel 1, together with a slight power increase.

Regulatory plans for major work in 2009.

- Power increase of Doel 1 unit with steam generator replacement in 2009.

BRAZIL

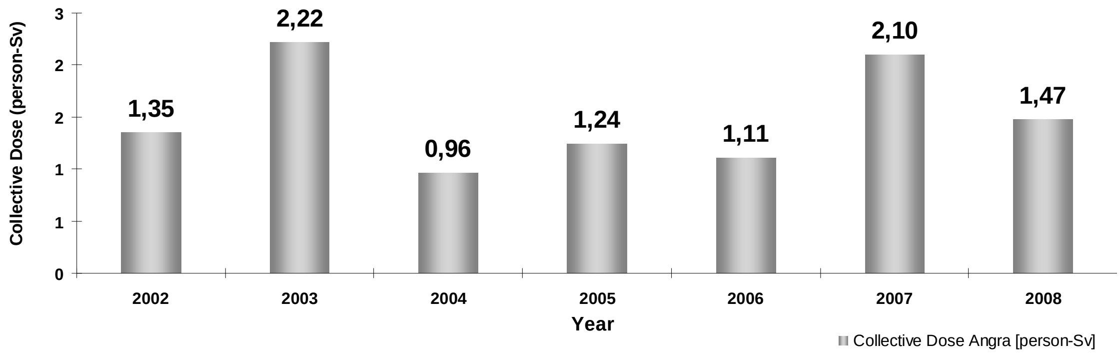
Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
PWR	2	0.74

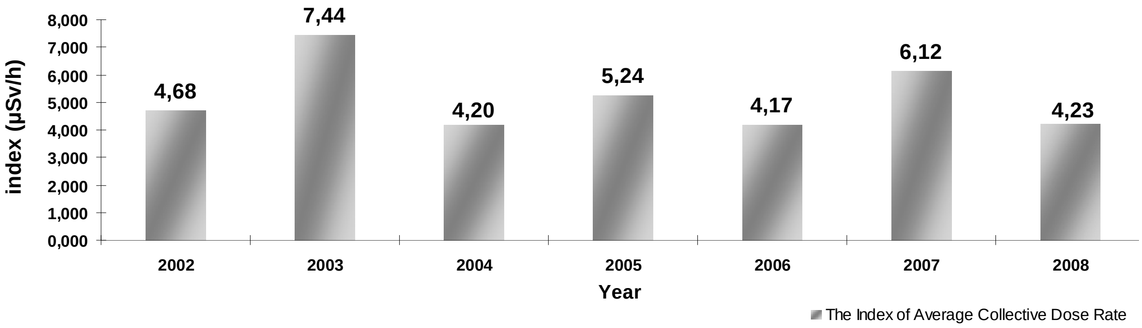
Summary of national dosimetric trends

The total collective dose (CD) at Angra in 2008 was 1.47 person·Sv (Unit 1: 1.11 person·Sv; Unit 2: 0.36 person·mSv). The total number of exposed radiation workers was 3 683 (Unit 1: 1 991 utility workers; Unit 2: 1 692 utility workers).

Collective dose at Angra (2002-2008)



The index of average collective dose rate at Angra (2002-2008)



Events influencing dosimetric trends

The main contributions to the Angra CD were planned refuelling outages, with the preparations for the steam generator replacement (SGR) carrying a significant fraction of the dose in Angra 1. 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

- 1P15A: 61 days (standard maintenance outage with refuelling and SGR preparations).
- 2P6: 35 days (standard maintenance outage with refuelling).

Issues of concern in 2009

- Refuelling outage 16th cycle (unit 1).
- Steam generator replacement for Angra 1.
- Refuelling outage 7^{th} cycle (unit 2).

Technical plans for major work in 2009

- Setup of teledosimetry (1^{st} phase).
- Install new vehicles portal monitor.
- Steam generator replacement at Angra 1.

BULGARIA

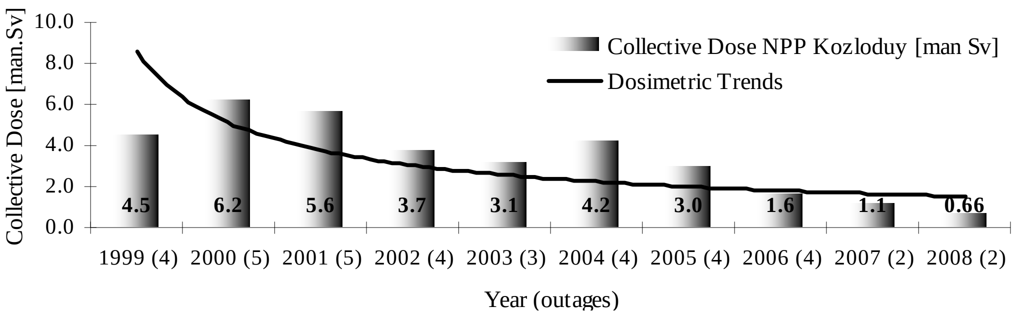
Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
VVER-1 000	2	0.27
Reactors in cold shutdown or in decommissioning		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
VVER-440	4	0.03

Summary of national dosimetric trends

The total collective dose (CD) at NPP Kozloduy in 2008 was 0.66 man·Sv (utility employees: 0.58 man·Sv; contractors' employees: 0.08 man·Sv). The average individual effective dose was 0.21 mSv and the maximum individual effective dose was 9.29 mSv.

Collective Dose (CD) at NPP Kozloduy, 1999-2008



Number and duration of outages

Unit No	Outage duration (days)	Number of outages
Unit 5	40	For refuelling and maintenance.
Unit 6	42	For refuelling and maintenance.

Organisational evolutions

Reduction of the plant personnel ≈ 15%

Issues of concern in 2009

Complete new organisational structure for Units 1, 2, economically independent from Units 3, 4.

Technical plans for major work in 2009

Some dismantling works on Units 1, 2.

CANADA

Summary of national dosimetric trends

The collective dose in 2008 for the CANDU fleet of 20 operating reactors was 27 636 person mSv, or 1.38 person·Sv/reactor.

Selected units are undergoing a major, multi-year plant refurbishment to achieve more decades of safe and efficient operations. The scope of the major refurbishments is reflected in the increase in occupational dose for these units. Collective dose for units in refurbishment in 2008 (Bruce A Units 1, 2; Point Lepreau) was 9 202 person·mSv, with an average collective dose of 3.07 person·Sv (307 person-rem) per reactor. Unit refurbishment dose is included in the Canadian annual collective dose. In 2006-2008, the 3-year rolling average annual collective dose for operating reactors was 1.10 person·Sv (110 person-rem) per reactor, which represents a 3% increase from the 2005-2007 3-year rolling average annual collective dose of 1.07 person·Sv (107 person-rem) per reactor. Collective dose for units in safe storage (Pickering-A units 2, 3) was 78 person·mSv, with an average of 0.039 person·Sv (3.9 person-rem) per reactor. There was no radiation exposure in excess of regulatory dose limits.

Ontario Power Generation/Darlington Nuclear Generating Station

Darlington Nuclear Generating Station (DNGS) has four operating units (1 to 4). The station total collective dose for 2008 was 1 736 person·mSv or 434 person·mSv/unit (less than the established target of 750 person·mSv /unit). The internal dose was 139 person·mSv or 34.75 person·mSv/unit (also less than the established target of 75 person·mSv/unit).

The station had one planned outage (D811) and one forced short outage (D821) during 2008. The total outage dose was 1 516 person·mSv, significantly better than the established target of 2 460 person·mSv. The reductions in collective dose were achieved through implementation of several ALARA initiatives such as minimisation of gravity-filled state (GFS) to reduce D2O leakage, installation of high capacity Munters to reduce reactor vault tritium, and use of specialised soft tungsten during HFD cable replacement work to improve shielding effectiveness. Darlington continues to strive for improvements in radiation protection through a strategic source term reduction plan scheduled to continue through 2013. Improvements in human performance have resulted in no internal or external unplanned exposures in 2008.

Ontario Power Generation/Pickering Nuclear Generating Station-A

Pickering Nuclear Generating Station-A (PNGS-A) has two operating Units (1, 4) and two units in safe storage (2, 3).

Operating Units (1, 4): The total collective dose for these two units was 702 person·mSv or 351 person·mSv/unit (close to the revised target of 340 person·mSv/unit). The external dose was 386 person·mSv and internal dose was 316 person·mSv. The established target was revised to account for deferral of the planned outage P841 to 2009. The “Collective Dose-Outages” resulting from forced outages in units 1 and 4 was 166 person·mSv. The relatively higher internal dose to collective effective dose ratio was due to higher tritium levels in U1 and U4 due to poor drier performance and removal for replacement of F/M rooms’ vapour barriers due to aluminum reduction issues.

Units in safe storage (2, 3): The units’ total collective effective dose was 77.9 person·mSv (the external dose was equal to 45.2 person·mSv and internal dose was 32.7 person·mSv).

Ontario Power Generation/Pickering Nuclear Generating Station-B

Pickering B has four operating units (5 to 8). The total collective effective dose was 3 952 person·mSv (988 person·mSv/unit). This dose is slightly higher than in 2007 due to increased outage work. The external dose was 3 288 person·mSv and the internal dose was 666 person·mSv. The performance for the internal dose component of 166 person·mSv/unit is slightly below the dose target of 170 person·mSv/unit. This has been the lowest collective internal at Pickering-B to date and can be attributed to improved drier performance, decreased tritium curie content in moderator and heat transport D2O, and easier access to trends and current tritium levels in the units.Total collective dose for outages in 2008 was 3 292 person·mSv. Two forced outages (Units 5 and 7) and two planned outages (Units 7 and 8) contributed to the total. Unexpected outage scope additions included moderator heat exchanger maintenance and calandria tube replacement on Unit 7, adding approximately 90 and 120 person·mSv external, respectively.

Hydro-Quebec/Gentilly-2 Nuclear Generating station

Hydro-Quebec has one operating unit at Gentilly. The total collective effective dose for 2008 was 1 152 person·mSv (external dose: 1 014 person·mSv; internal dose: 140 person·mSv). The collective dose is higher than in 2007 due to increased outage work, with a total collective outage dose of 1 001 person·mSv. Some of the ALARA initiatives implemented in 2008 at Gentilly-2 included:

- Daily verification of previous day doses with investigations if unusual/above a set threshold doses are seen.
- Daily brief RP meeting (RP manager/advisers/technicians) on the day’s highlights and jobs.
- Introduction of reusable covers shoes and transport bags.
- Meetings with workers and hierarchy together with RP advisers if unplanned doses happen.
- Increased and efficient ALARA group involvement dose planning for unplanned situation (e.g., contact between the fuel machine, with spent fuel bundles, with an elevating platform).

New Brunswick Power/Point Lepreau Generating Station

New Brunswick Power has one operating unit at Point Lepreau. The station shut down on 28 March 2008 for a planned 18 month refurbishment. The dose estimate for the entire project is 8.2 Sv. The 2008 total collective effective dose was 5 998 person·mSv (external dose: 5 624 person·mSv; internal dose: 374 person·mSv).

By the end of July, the fuel had been removed from the reactor core and the primary heat transport and moderator heavy water systems had been drained to storage tanks and dried. The dismantling of the reactor components began in August with removal of the 760 feeder tubes from the reactor face to the headers. By the end of the year, the removal of the pressure tubes was in progress. The Feeder removal was the most dose extensive work at 2 440 mSv, about 15% less than the estimated total. At the end of the year the actual dose was approximately the same as estimated dose for the work completed, although a negative trend was in progress. The main reason for external doses exceeding estimates for some work was failure of specialised tooling to perform as designed. During defuelling, several fuel channels weeping heavy water resulted in increased airborne tritium concentrations. The improvements in ventilation and drying of the insulation blankets eventually reduced the tritium concentration to expected levels.

Bruce Power/Bruce Nuclear Generating Station-A

Bruce Nuclear Generating Station-A (Bruce-A) has two operating Units (3, 4) and two units in refurbishments (1, 2). Bruce A operating units (3, 4): The total collective effective dose was 4 240 person·mSv with an internal component of 578 person·mSv (2 120 person·mSv/unit). In 2008, there were several major planned outages. The "Collective Dose-Outages" was 3 662 person·mSv. The total collective dose has been increasing due to increased outage work associated with human performance and equipment problems.

Bruce A Units 1 and 2 Restart Project: Units 1 and 2 are shutdown, but have been under refurbishment since 2005. A significant portion of dose intensive work was carried out in 2007 and 2008. Units 1 and 2 total collective dose was 3 204 person·mSv (with an external dose 3 116 person·mSv and an internal dose of 88 person·mSv).

Bruce Power/Bruce Nuclear Generating Station-B

Bruce B has four operating units (5-8). The total collective effective dose was 6 652 person·mSv (1 565 person·mSv/unit) with an external dose of 6 064 person·mSv and an internal dose of 588 person·mSv. The total collective dose from the 2008 outages was 6 013 person·mSv. Contributing to the total collective dose in 2008 were two major planned outages. The increase in total collective dose is attributed to several factors including, but not limited to, human performance, increase in outage scope, equipment problems, and continually increasing source term.

CHINA

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
PWR	4	0.650

For Daya Bay NPP, the annual collective dose for 2008 is 825.96 man·mSv. For Lingao NPP, the annual collective dose for 2008 is 1 772.06 man·mSv.

Number and duration of outages

Unit	Duration	Collective dose (man·mSv)
Daya Bay unit 1	No outage.	
Daya Bay unit 2	13th refuelling outage: 2008/11/01 – 2008/11/30 (30 days)	636.81
Daya Bay unit 2	Forced outage: 2008/07/19 – 2008/07/31 (13 days)	66.08
Ling Ao unit 1	6th refuelling outage: 2008/03/10 – 2008/04/04 (26 days)	572.25
Ling Ao unit 2	5th refuelling outage: 2008/01/15 – 2008/02/11 (28 days)	528.44
Ling Ao unit 2	6th refuelling outage: 2008/12/09 – 2009/01/11 (34 days)	545.52 (Dose in 2008: 463.13)

CZECH REPUBLIC

Summary of dosimetric trends

Dukovany NPP

There are four units of PWR-440 type 213 in commercial operation since 1985. The collective effective dose (CED) during 2008 was 0.454 man·Sv. CED was 0.036 and 0.418 man·Sv for utility and contractors employees, respectively. The total number of exposed workers was 1 727 (558 utility employees, 1 169 contractors). The average annual collective dose per unit was 0.113 man·Sv. The maximal individual effective dose of 7.29 mSv was reached by a contract worker carrying out insulation works during outages.

Temelín NPP

There are two units of PWR 1 000 MWe type V320 in commercial operation since 2004. The collective effective dose (CED) during 2008 was 0.304 man·Sv. The CED was 0.039 and 0.245 man·Sv for utility and contractors employees, respectively. The total number of exposed workers was 1 535 (491 utility employees; 1 044 contractors). The average annual collective dose per unit was 0.152 man·Sv. The maximum individual effective dose of 5.39 mSv was received by a contract worker carrying out insulation works during outages.

Number and duration of outages

Dukovany	**Outage information**	**CED [man·Sv]**
Unit 1	25 days, standard maintenance outage with refuelling.	0.123
Unit 2	65 days, standard maintenance outage with refuelling.	0.157
Unit 3	22 days, standard maintenance outage with refuelling.	0.079
Unit 4	31 days, standard maintenance outage with refuelling.	0.097
Temelín	**Outage information**	**CED [man·Sv]**
Unit 1	165 days, (141 days standard maintenance outage with refuelling and 25 days forced maintenance outage).	0.156
Unit 2	52 days, standard maintenance outage with refuelling.	0.106

Major evolutions

Very low values of outage and total effective doses represent the results of good primary chemistry water regime, a well organised radiation protection structure and strict implementation of ALARA principles during activities related to works with high radiation risk.

Unexpected events

There were no unusual or extraordinary radiation events in 2008. At Temelín NPP, the standard maintenance outage was extended due to damaged rotor of the first unit’s turbine which was caused by the blade breaking off during the operation start. The forced outage was caused by the leak of the electrical heaters in pressuriser.

FINLAND

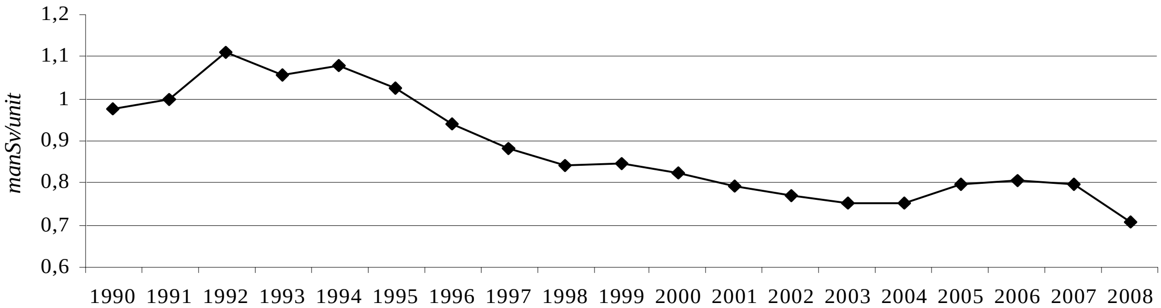
Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
BWR	2	0.468
VVER	2	0.778
Total: All types	4	0.623

Summary of national dosimetric trends

Annual collective dose strongly depends on length and type of annual outages. In 2008, the collective dose (2.5 man·Sv) of Finnish NPPs was somewhat higher than the previous year (1.9 man·Sv), mainly since an extensive 50 day 4-year inspection outage was completed at Loviisa 1. However, in the long run the 4-year rolling average of collective doses shows a slightly decreasing trend since the early 1990s.

Collective dose: 4-year rolling average in Finnish NPPs



Events influencing dosimetric trends

Olkiluoto

The service outage at OL1 lasted 20 days. It included replacement of a shut down cooling system valve (321 V3), refuelling, inspections, scheduled maintenance and annual tests and repairs. The refuelling outage at OL2 lasted eight days. In addition to refuelling, it involved inspections, maintenance work and cleaning of the turbine plant. In Olkiluoto, steam dryers of both units have been replaced during outages 2006 and 2007 resulting in a decreasing trend of dose rates during outages in turbine plants. In 2008, the old steam dryer of OL1 reactor was cut into pieces and transferred to the nuclear waste repository. The collective dose of the cutting work was 0.027 man·Sv.

Loviisa

At unit 1, the annual outage was a 4-year maintenance outage, and at unit 2, a short maintenance outage, with planned durations of 36.5 days and 20 days, respectively. Realised durations were 50.5 and 23 days. The main delays on unit 1 were caused by repair work of deformed RPVH lead-in (the defect was noticed at start-up phase) and unavailability of the polar crane during outage, and on unit 2, unplanned repair work of one safety water accumulator.

Despite delays and unplanned repair work, the collective outage doses were lower than anticipated (Unit 1: 1.08 man·Sv; Unit 2: 0.37 man·Sv). Major maintenance was performed on Unit 1 reactor components as two control rod drive mechanism nozzles of the RPV head 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.

Organisational evolutions

A major organisational change was completed in Loviisa NPP in June 2008, as decontamination and radioactive waste functions were separated from the radiation protection department to their own organisations in order to make the functions more effective.

Technical plans for major work in 2009

Olkiluoto 1: Refuelling outage, planned duration 8 days.

Olkiluoto 2: Service outage, planned duration 15 days, includes shut down cooling system valve replacement.

Olkiluoto 3: Under construction. The main component of the reactor island, the reactor pressure vessel, is at site area. A total of 520 tons of steel is in storage on site awaiting the construction work of the reactor building to proceed. The number of construction workers has reached its maximum. Manpower exceeded 4 000 in mid-February 2009.

Loviisa: both units: Short refuelling outages, planned durations 17 days on Lo1 and 19 days on Lo2. Renewal of plant I&C systems continue.

Regulatory plans for major work in 2009.

Work concerning the up-dating of regulatory guides (also in RP) will be one of major task during 2009. The process will take into account the experience achieved during the licensing of new NPPs. The target is also to create a new structure for the guides and to minimise their number by combining the existing ones. STUK continues to review documents concerning the detailed design of systems, structures and components of OL3. The review-process includes also RP aspects.

The existing NPP units in Finland are operated by TVO (OL1, OL2, OL3 (under construction) and Fortum Power and Heat (LO1 and LO2). Both licensees have expressed their interest to build new units. In addition, a new company, called Fennovoima Ltd, aims at constructing one or two NPP units.

TVO, Fennovoima and Fortum have filed applications for the Decision in Principle (DiP) to the Ministry of Employment and the Economy. The Ministry has announced that all applications will be processed in the Ministry simultaneously. All applicants have also submitted to STUK the required information for a preliminary safety assessment needed for the DiP. All companies have already initiated environmental impact assessment (EIA) procedures for the new NPPs. The first EIA procedures started during 2007.

FRANCE

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
PWR	58	0.66
Reactors in cold shutdown or in decommissioning		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
PWR	1	1.1×10^{-3}
CANDU	1	0.02×10^{-3}
GCR	5	3.8×10^{-3}
Fast Neutron	1	0.36×10^{-3}

Annual Collective Dose

The 2008 average collective dose was 0.66 man·Sv/reactor; the target was 0.65 man Sv/reactor. The average collective dose for the 3-loop reactors (34 reactors) was 0.71 man·Sv/reactor; the average collective dose for the 4-loop reactors (24 reactors) was 0.59 man·Sv/reactor.

In 2008, there were 23 short outages, 22 standard outages, and 5 ten-yearly outages, one steam generator replacement and two reactor vessel head replacements. The outage collective dose represents 83% of the total annual collective dose. The collective dose from the operating period represents 17% of the annual collective dose. The neutron total collective dose is about 0.37 man·Sv (0.32 man Sv from the spent fuel transport).

Individual doses

At the end of 2008, only 2 persons received a dose higher than 16 mSv on 12 rolling months. There were 8 workers (7 mechanics, 1 logistic) recorded with over 16 mSv on 12 rolling months. No worker received over 18 mSv on 12 rolling months.

Events influencing dosimetric trends, number of outages

EDF 3-loop reactors

In 2008, the 3-loop reactors outage programme was composed of 16 short outages, 16 standard outages (with 1 SGR and 2 RVHR) and no ten-yearly outage. The lowest collective doses for the various outages types were:

- Short outage: Gravelines 1 with 0.183 man·Sv.
- Standard outage: Blayais 1 with 0.491 man·Sv.

It can be noted that 2 reactors had no outage and that there were 2 forced outages (Cruas 1 and Fessenheim 2) giving a collective dose of 0.163 man·Sv.

EDF 4-loop reactors

In 2008, the 4-loop reactors outage programme was composed of 7 short outages, 6 standard outages and 5 ten-yearly outages. The lowest collective doses for the various outage types were:

- Short outage: Civaux 1 with 0.145 man·Sv.

- Standard outage: Chooz B2 with 0.220 man·Sv.
- Ten-yearly outage outage: Cattenom 2 with 0.938 man·Sv (the highest collective dose was for Flamanville 1 with 2.495 man·Sv).

It can be noted that 6 reactors had no outage and that there were 2 forced outages (Saint-Alban 1 and Penly 1) giving a collective dose of 0.042 man·Sv.

RP Incidents

All the RP events (ESR) reported to the French Authority were classified as INES 0. In 2008, there were 2 ESRs regarding internal contamination: one at Paluel 4 for 2 workers during waste handling and the other one at Tricastin 4 for 56 persons during the containment evacuation due to RP monitoring alarm.

New Targets

The new collective dose goal for 2009 is 0.65 man·Sv/reactor, and for 2010 to be lower than 0.70 man·Sv/reactor. For the individual dose, the objective is unchanged: nobody with an individual dose above 18 mSv on 12 rolling months and less than 30 persons receiving a dose exceeding 16 mSv on 12 rolling months.

Future activities in 2009

For the individual dose: At the end of the first quarter of 2009, the electronic neutron dosimeters will be used on all nuclear sites.

For the collective dose: Special attention will be paid to the first implementation of modifications and other maintenance activities during the third ten-yearly outage (VD3) on Tricastin 1 (outage scheduled in May 2009) and on Fessenheim 1 (outage scheduled in October 2009). The next VD3 will occur in 2010 on Bugey 2.

Autorité de sûreté nucléaire

In 2008, the French Nuclear Safety Authority, ASN, carried out 21 on-site radiation protection inspections on pressurised water reactors (PWRs) focusing on the organisation and management of radiation protection, as well as on the management of radioactive sources. ASN also assessed the action plan implemented by EDF, following the conclusions of the Advisory Committee of Experts for Reactors, consulted by ASN on radiation protection issues in PWRs. ASN considered it globally as satisfactory but asked EDF for complementary information concerning, notably, the self-assessment feedback and the optimisation methods and tools. In 2008, ASN identified the following main areas of improvement at a national level: control and containment of contamination in classified areas, staff training and effective management of operating experience feedback.

For 2009, ASN and its technical support organisation, the Institute of Radiation Protection and Nuclear Safety, IRSN, will focus on the management of source term reduction and ALARA tools. ASN will also continue to assess the implementation of radiation protection requirements on maintenance activities, this year focusing on the third ten-yearly outages over the 900 MWe park. Furthermore, ASN jointly with IRSN will perform an in-depth analysis and assessment of radiation monitoring systems in controlled areas. Finally, ASN and IRSN will lead further the reviewing process of the preliminary safety report of the EPR.

GERMANY

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
PWR	11	0.62
BWR	6	1.19
Reactors in cold shutdown or in decommissioning		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
PWR	5	0.160
BWR	3	0.179
GCR	2	0.013
VVER	5	0.027

Note: The contribution of each reactor under decommissioning to the annual collective dose strongly depends on the type of reactor and the decommissioning work performed. It should be noted that the reactors in cold shutdown or in decommissioning include i) some small prototype reactors which only contribute small annual doses to the average, and ii) two reactors in safe enclosure also with very small contributions to the related average. For the five reactors participating in ISOE, the average doses in 2008 are 0.252 man·Sv for 3 PWRs, 0.434 man·Sv for 1 BWR and 0 man·Sv for a GCR in safe enclosure.

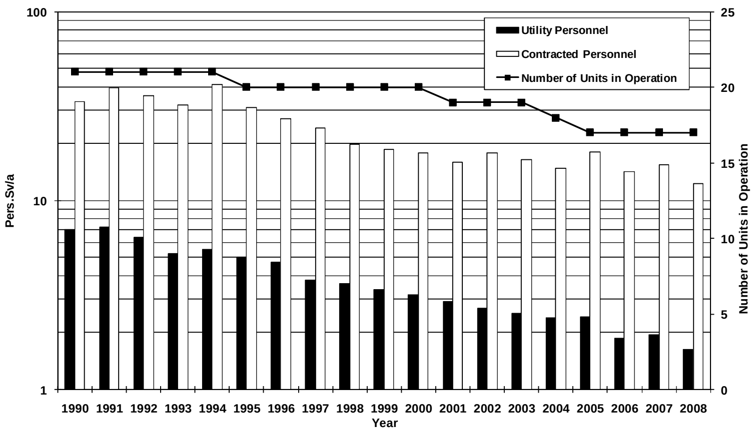
Political situation

The political situation was unchanged in 2008, but ongoing discussion was intensified in 2009 because of the campaign for the election of a new parliament and government in September 2009. In the federal state of Hessen, where NPP Biblis is situated, a minority of social democrats and greens tried to form a new government tolerated by the very left party. They intended to get a quick final shutdown of Biblis. On 3 November, the minority fraction performed a test voting and lost. On 8 January 2010, a new election will take place in Hessen. Because of maintenance and repair work in NPP Brunsbüttel and Biblis, the politically planned final shutdown will not be realised before the new parliament and government is elected. This has caused accusation by environmentalists that the utilities are use delaying tactics to avoid final shut down of the NPPs.

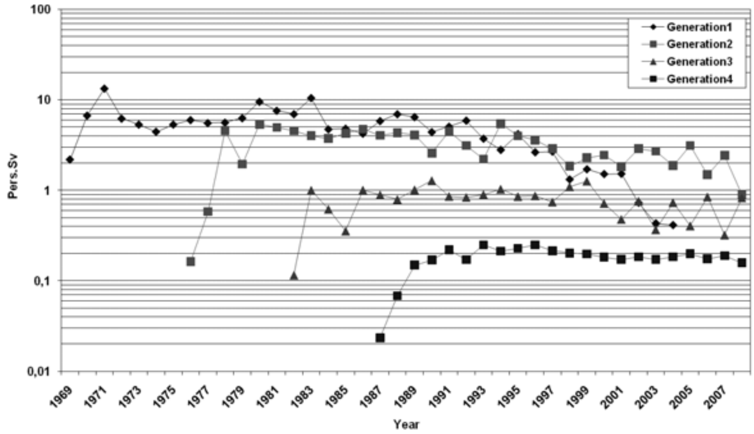
Summary of national dosimetric trends

NPPs in operation: 11 PWRs and 6 BWRs.

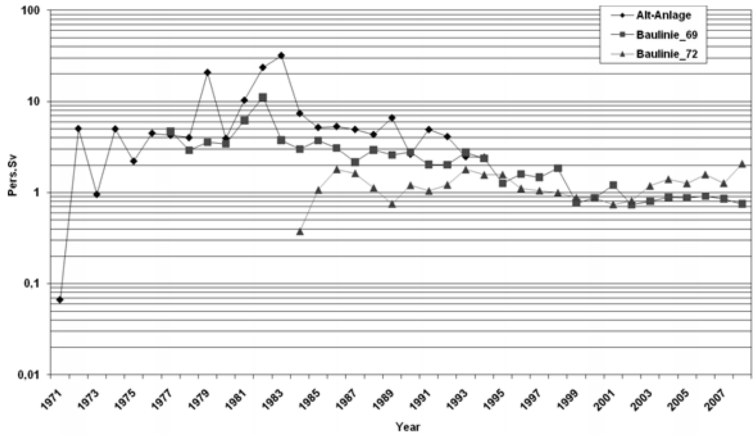
Annual collective dose 1990 – 2008 for all units in operation (Utility and Contractor Personnel, Number of Units in Operation)



Average annual collective dose 1990 – 2008 for PWR sister



Average annual collective dose 1990 – 2008 for BWR sister



Special developments and projects

A pilot project performed under the supervision of the authority for the realisation of legal dosimetry with EPDs was finished in April 2008. There are ongoing discussions between federal states, various official dose supervising institutes, equipment suppliers and utilities on how to ensure that the technical concept can be realised in envisaged field tests without unforeseen problems. The VGB Working Panel will try to clarify open questions until early 2009.

Increased attention is given to the question of keeping a high level of qualification of RP personnel. The VGB-Group is discussing a Swiss-German cooperation to create a qualification level between RP technician and RP engineer.

The VGB-Group has performed a survey about dose thresholds in our NPPs below the legal dose limits. This survey will serve to get a picture about differences and possible need to harmonise the threshold structure.

Since mid-2004, the VGB group is performing an investigation aimed at the following objectives:

- Early and safe detection of fuel element leakage with alpha nuclide releases and RP relevance (evaluation of experience with fuel element leakages).
- Development of a model for balancing the inventory of alpha nuclides and assessment of long-term consequences of alpha nuclide releases (relevance for dismantling after final shutdown).

- Development of measures for the reduction of fuel and alpha nuclide releases.
- Development of a strategy for the RP management in the decommissioning stage, based on plant specific experience and knowledge about inventory and behaviour of alpha nuclides.

Since the VGB concept for the supervision and avoidance of radioactive intakes is applied in the German NPPs, experience shows that the supervision of tritium intakes needs some attention. For instance in KKP unit 2, the last outage resulted in a collective dose from tritium of 22.8 mSv (10% of the total outage dose). The VGB Working Group will consider this item during their future meetings.

Special events

Safety culture

On 28 June 2007, a fire in a transformer of BWR Krümmel resulted in a reactor trip. The event did not create any safety risk for the plant or the environment. Nevertheless, this event caused increased public concern and was taken by the authorities and politicians in favour of phasing out the nuclear option to question the quality of safety culture. In a first step, some administrative structures and rules with respect to behaviour and communication of the shift personal and the control room staff have to be analysed and modified for NPP Krümmel. In addition, the Federal Ministry for Environment and Reactor Safety (BMU) asked the utilities to present the existing VGB safety culture concept and to optimise this concept as a standard, including performance indicators to enable judging of the quality of the safety culture in practice.

Wall plug replacement

In 2006 and 2007, Germany reported on the replacement of heavy load wall plugs which were not mounted according to specification. Corrective actions were performed in the NPPs Biblis, Brunsbüttel and Gundremmingen. Some other older NPPs have started investigations and corrective action, which will create an increase in outage durations dose accumulation.

Chloride induced corrosion and cracks at NPP Krümmel, Brunsbüttel

In the past, some German and other NPPs experienced chloride induced corrosion effects. During outage of NPP Krümmel and Brunsbüttel, chloride induced cracks were discovered in several safety relevant valve components. The chloride most probably originates from valve sealings (Bredtschneider). Repair actions (grinding, welding of layers) are in consideration and will cause increased dose collection. A special flushing procedure and an optimised concept for in-service inspections will be implemented. Investigations of valves in other NPPs did not show such corrosion effects.

HUNGARY

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
VVER	4	0.479 (with electronic dosimeters); 0.473 (with film badges)

Summary of national dosimetric trends

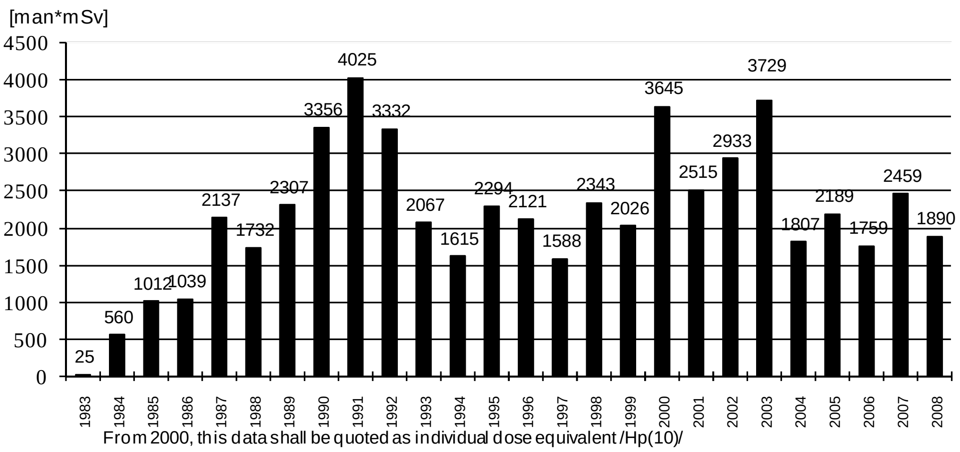
Based on operational dosimetry, the 2008 collective dose at Paks NPP was 1 916 man mSv (1 303 man mSv with dosimetry work permit + 613 man·mSv without dosimetry work permit). The highest individual radiation exposure was 17.0 mSv, which was well below the dose limit of 50 mSv/year and the dose constraint of 20 mSv/year. The collective dose decreased in comparison to the previous year.

Events influencing dosimetric trends

There was one general overhaul (long maintenance outage) in 2008. The collective dose for the outage was 532 man·mSv at Unit 2.

Outage durations – Unit 1: 32 days; Unit 2: 83 days; Unit 3: 30 days; Unit 4: 33 days.

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



Major evolutions

The four units at Paks NPP were put into operation between 1983 – 1987. Taking into account the designed lifetime (30 years), they should be shut down between 2013 – 2017. Based on present technical knowledge, it can be considered as a real long-term goal to extend the designed lifetime of the units by at least 10 years. An environmental license for lifetime extension has already been obtained.

Component or system replacements

Replacement of the radiation protection monitoring system in 2008 at Units 1 and 2 was finished. The replacement of the radiation protection monitoring system at Units 3 and 4 will start in 2009.

ITALY

Dose information

Reactors in cold shutdown or in decommissioning		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
PWR	1	0.0011
BWR	2	0.2907
GCR	1	0.0029

Events influencing dose trends included decommissioning activity at Caorso NPP, particularly the transfer of fuel elements to the reprocessing site in la Hague (France); and decommissioning activity at Garigliano NPP, particularly the removal of asbestos from the reactor building.

JAPAN

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
PWR	24 (*1)	1.57
BWR	32	1.45
Total: All types	56 (*1)	1.50
Reactors in cold shutdown or in decommissioning		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
GCR	1	0.02
LWCHWR	1	0.43

Note: (*1) Includes Tomari Unit 3, which is at pre-operational status; date of grid connection was 2009.3.20.

Summary of national dosimetric trends

The total collective dose for all operating reactors in fiscal year 2008 was 84.02 man·Sv, which was higher than the fiscal year 2007 value of 78.15 man·Sv. The average annual collective doses per unit for all operating BWRs and PWRs were 1.50 man·Sv, 1.45 man·Sv and 1.57 man·Sv, respectively. The BWR collective dose per unit for 2008 was nearly equal to the previous year. The PWR collective dose per unit for 2008 increased from the previous year by 0.22 man·Sv. The BWR average collective dose is stable after fiscal year 2004. On the other hand, the PWR average collective dose increased last year and this year, though it was stable for ten years or more at a value around 1.1 man·Sv.

Events influencing dosimetric trends

The increase in collective dose for PWRs was mainly due to the increase of inspection and modification works during the periodical inspections. In many PWR plants, detailed inspection of material using Nickel-based alloy at the primary loop boundary, as well as repair works were performed as needed. Also, improvement works of the seismic safety margin were performed in Japanese BWRs and PWRs. In addition, there were more periodical inspections for PWRs than the previous year.

Number and duration of outages

Periodic inspections were completed at 11 BWRs and 21 PWRs in the fiscal year 2008. The average outage duration for periodic inspection was 138 days for BWRs and 144 days for PWRs. The average duration for PWRs increased from the previous year by 42 days.

New plants on line/plants shut down

In the fiscal year 2008, Hamaoka Units 1 and 2 of Chubu Electric Power Company terminated their operation on 30 January 2009.

Major evolutions

Tomari NPP Unit 3, PWR (Hokkaido Electric Power Company), started trial operation in January 2009.

The new regulatory inspection system was implemented in January 2009. The new inspection system is for safety activities based on the maintenance program, aiming for safety assurance as an important action. In this system, the inspection is shifted from a uniform to a fine inspection according to the characteristics of each plant, allowing operating periods of up to18 or 24 months, which were previously limited to 13 months.

Component or system replacements

Replacements of steam generator and reactor vessel head were carried out at some PWR plants.

Issues of concern in 2009

Tomari NPP Unit 3, Hokkaido Electric Power Company, is scheduled to start commercial operation in December 2009.

REPUBLIC OF KOREA

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
PWR	16	0.49
CANDU	4	0.59
Total: All types	**20**	**0.51**

Summary of national dosimetric trends

For the year 2008, 20 NPPs were in operation: 16 PWR units and 4 CANDU units. The average collective dose per unit for the year 2008 was 0.51 man·Sv, lower than the 2007 value of 0.64 man·Sv. As in previous years, the reactor outages during 2008 contributed the major part to the collective dose;

79.3% of the collective dose was due to works carried out during the outages. There were in total 10 840 people involved in radiation works in 20 operating units and the total collective dose was 10.137 man·Sv.

Number and duration of outages

Periodical inspections were completed at 12 PWRs and 4 CANDUs. The total duration for periodical inspections was 368 days for PWRs and 93 days for CANDUs.

Major evolutions

The reactor was installed in Shin Kori Unit 1, being built near the Kori Nuclear Power Site. In total 6 PWR type nuclear power plants are under construction in Korea and 2 of them are advanced power reactors, APR 1400. There was tremendous improvement of facilities in Kori Unit 1, which received government approval to operate for an additional 10 years by replacing major equipment and reinforcing the safety facilities. The recording level for the control of radiation exposure was set up as 0.1 mSv. When the radiation exposure is below 0.1 mSv, the regulatory guideline recommends to write down ‘Less than recording level’ and calculate as ‘0 mSv’ in a database system.

Issues of concern in 2009

The pressure tubes of Wolsung Unit 1 (CANDU), which has operated 28 years, are being replaced due to sag, elongation, diametric expansion and wall reduction of pressure tubes and calandria tubes caused by increase of operational life. Low and intermediated-level radioactive waste disposal facilities, which include disposal silos and underground tunnels, are under construction. The radwaste reduction has been a top issue in Korea due to the lack of on-site temporary storage capacity.

LITHUANIA

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
LWGR	1	3.0988
Reactors in cold shutdown or in decommissioning		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
LWGR	1	0.1884

Summary of national dosimetric trends

In 2008, the occupational doses at the Ignalina NPP were similar to levels for 2005-2007, specifically 3.2872 man·Sv (3.0988 man·Sv for operating Unit 2 and 0.1884 man·Sv for Unit 1 at cold shutdown). In 2008, 2 320 INPP workers and 1 279 outside workers were working under the influence of ionising radiation in the controlled area of the INPP.

Planned annual collective doses were 3.327 man·Sv for INPP personnel, and 1.100 man·Sv for outside workers. However, there was no need to perform all planned repair works and therefore the collective doses were in fact 2.216 man·Sv for INPP personnel (67% of planned), and 1.071 man·Sv for outside workers (97% of planned). Overall collective dose for INPP personnel and outside workers was 3.287 man·Sv (74% of planned dose).The average effective individual dose for INPP staff was 0.96 mSv, and for INPP staff and outside workers, 0.91 mSv. The highest individual effective dose for INPP staff was 18.09 mSv, and for outside workers, 19.98 mSv.

Events caused the dosimetric trends

The main part of the overall collective dose was the collective dose received during the Unit 2 outage period. The collective dose was 2.432 man·Sv, equivalent to 74% of the INPP annual occupational collective effective dose. The main works that contributed to the collective dose during 2008 at the INPP are given in the Table below:

Main works	Collective dose (man·mSv)
Repairing of the main circulation circuit	403.17
Maintenance, repairing, replacement of the system of the reactor vessel and reactor equipment	496.56
Thermo – insulation works	501.11
Routine inspections	320.48
Decontamination of premises	138.42
Lighting, general electrical equipment	12.26
Radiological monitoring of workplaces	60.90
Repairing of reactor water clean-up system	27.18
Shielding and temporary shielding	34.92
Scaffolding	20.79
Preparing for the inspection of the main circulation circuit	111.43
Other works	67.86

Number and duration of outages

One planned outage at Unit 2 took place in 2008 (Unit 1 was shutdown on 31 December 2004). The outage duration was 50 days. The collective dose was distributed as follows: normal operation – 22% of the Unit 2 annual collective dose; outage – 78 % of the Unit 2 annual collective dose.

New plants on line/plants shut down

In 2008, territory was prepared for the project of construction of a new power plant. An environmental impact assessment report for the new NPP was prepared and reviewed in 2008 by the competent authorities. After a Government decision, INPP Unit 2 will be shutdown on 31 December 2009. INPP Unit 1 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. During 2008, cement solidification of ion exchange resins continued: 179 containers were filled up with waste, and each containers can hold eight 200 litres drums. During 2008, 134.7 m^3 of pulp was recycled. There are 409 containers in the storage facility. In 2009 the cement solidification work will continue.

During 2008, the transportation of spent nuclear fuel from Unit 2 to the interim spent fuel storage facility continued. Eight CONSTOR type containers were transported; in total, there are 102 containers in the facility. The storage facility will be extended and the loading of spent nuclear fuel will continue in 2009. The capacity of the existing Dry Spent Fuel Storage Facility was increased to 120 CONSTOR and CASTOR type containers.

In 2008, the Solid Waste Treatment and Storage Facility project was carried out. The technical project was provided the review and approved by the involved authorities. On December 2008, the technical project was provided for general expertise. The construction permit is expected in the beginning of 2009 after finalisation of expertise and approval of the project by the Government of the Republic of Lithuania.

The decommissioning project for the final shutdown and defueling phase of Unit 2 started on February 2008. The first version of the document for internal review was drafted on February 2009. Measures foreseen in the implementation plan for the UNIT 1 Decommissioning Programme at the INPP were further implemented.

Goals for 2009:

- Continuation of 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 2009:

- The collective dose shall not exceed 2.02 man·Sv.
- The collective dose during planned outage of Unit 2 shall not exceed 0.78 man·Sv.
- The collective dose during normal operation of Unit 2 shall not exceed 0.83 man·Sv.
- The collective dose during technical service of Unit 1 shall not exceed 0.41 man·Sv.

Component or system replacements

In 2008, the unloading of partially burnt nuclear fuel from Unit 1 and transportation to Unit 2 for re-use continued. There were 709 fuel assemblies unloaded from Unit 1, 672 fuel assemblies transported to Unit 2 and 594 loaded to the Unit 2 reactor core for re-use. These works will continue in 2009, allowing up to 50% reduction in nuclear fuel purchases. It is planned that in the middle of 2009, all fuel will be unloaded from Unit 1.

Unexpected events

In August 2008, Unit 2 had one unexpected shutdown.

Organisational evolutions

During preparation for decommissioning of INPP, the changes in INPP structural departments are continuing. A major part of the works conducted at INPP will fall to outside workers and to the INPP Decommissioning Project Management Unit.

Regulatory work in 2008 and plans in the coming year

In exercising the radiation protection state supervision and control at INPP, three inspections were carried out at Ignalina NPP in 2008. Eight inspections were also carried out at outside organisations (contractors). The following projects linked to the decommissioning of INPP were reviewed from the radiation protection point of view:

- Environmental impact assessment program report, technical project, safety analysis report for the landfill repository for short-lived very low level waste.
- Environmental impact assessment report for Ignalina NPP Building 117/1 equipment decontamination and dismantling.
- Technical project and safety analysis report for the new Solid Radioactive Waste Treatment and Storage Facilities for Ignalina NPP.
- Technical project and safety analysis report for the Interim Storage of Spent Nuclear Fuel from Ignalina NPP.
- Other technical projects, safety analysis reports.

In exercising the radiation protection state supervision and control in 2009, RPC is planning to carry out 4 inspections at Ignalina NPP, 12 inspections of outside organisations (contractors) and one inspection at the Maisiagala closed storage facility. The review of documents related to INPP decommissioning will continue.

MEXICO

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
BWR	2	4.69

Summary of national dosimetric trends

2008 was a year with high collective dose, affecting the downwards trend sustained between 2000 and 2007. The crud (^{60}Co) burst observed since 2007 continued affecting the plant exposure.

Events influencing dosimetric trends

Crud burst (previously reported in the 2007 ISOE report): This crud burst, which continued affecting dose rates, is a collateral effect of hydrogen plus noble metals addition start-up two cycles ago to prevent inter-granular stress corrosion cracking (IGSCC). The concentration of ^{60}Co in the reactor water increased by a factor of seven in Unit 1 and by a factor of three in Unit 2. The BRAC Index in Unit 1, 13th RFO increased from 82 mrem/h baseline to 400 mrem/h.

Crud migrations: as a consequence of a scram that occurred one week before the start-up of the U1RFO13, crud migrated into the primary coolant system as well as in the steam system, affecting in turn the exposure of the plant Power Uprate project activities.

Power Uprate activities: phase 1 of the Power Uprate activities consisted of four steam heaters substitution, two main steam reheaters substitution, and main condenser pipes substitution (Cu-Ni to Titanium). The dose rate increased one order of magnitude due to the crud migration described above.

Other special works/modifications included: substitution of Reactor Water Cleanup System pump and associated piping and valves; removal and repositioning of the recirculation pump motors from the drywell for a ten-year maintenance.

There was one outage in Unit 1 – 13th Refuelling Outage (U1RFO13): 101 days.

Major evolutions

Power Uprate Project: The objective of this project a 20% increase of the nominal power for each of the two Laguna Verde Units. The main points of the project are described below:

- First Phase: Unit 1 [U1RFO13, September-November 2008]; Unit 2 [U2RFO10, April-May 2008]:
  - Substitution of four steam heaters; two main steam reheaters (MSRs); main condenser pipes (Cu-Ni) to Titanium pipes.
  - Redesign of Turbine Building HVAC system.
- Second phase: Unit 1 [U1RFO14, April-May 2010]; Unit 2 [U2RFO11, August-October 2010]:
  - Substitution of turbine and generator.
  - Addition to two more steps to the condensate demineraliser system; condensate pump and booster condensate pump.
  - Reinforcement of Safety Relief Valves (SRVs).

New/experimental dose-reduction programmes

The new plant Dose Reduction Plan 2009-2013 is focusing on radioactive source term reduction considering: application of special resins for Cobalt removal; chemical decontamination (in 2010); physical removal of crud from reactor vessel (2010); stellited components substitution; increase of the efficiency of the Reactor Water Cleanup System filtration system; reduction of Fe concentration in feedwater. Other important aspects will also be enhanced, specially the refuelling outage planning will become more ALARA oriented.

Issues of concern in 2009

Collective dose reduction / source term reduction.

Technical plans for major work in 2009

Power Uprate project, Unit 2 first phase (see above), during the U2RFO10 [April-May 2009].

THE NETHERLANDS

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
PWR	1	0.268
Reactors in cold shutdown or in decommissioning		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
BWR	1	0.00027

Summary of national dosimetric trends

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 next years, some surveillance and maintenance activities will continue to be carried out every year. The collective annual dose (only for own staff) in 2007 was 0.27 man-mSv, mainly due to some extra inspections.

The Borssele plant (515 MWe), operated by NV EPZ, is a baseload unit. Up to this year it has enjoyed 34 years of commercial operation. Major backfittings were completed in the plant in 1997 and 2006. The plant electrical output has been raised in 2006 to 515 MWe. The annual outage in April lasted 26 days, 15 days longer than planned. It was a short outage with some maintenance and inspection works. At plant start-up, a small leakage was found on a drainpipe of a steam generator. In order to repair this leak, the core had to be unloaded again. The collective dose in the outage was 0.217 man·Sv. The annual collective dose amounted 0.268 man·Sv. In 2008, the average individual dose was 0.38 mSv for plant personnel and 0.62 mSv for contractor personnel. The highest annual individual dose was 2.77 mSv for plant personnel and 4.25 mSv for contractor personnel. In 2009, a short (13 days) outage is foreseen in April.

Related to the future of the plant: programs and plans for enabling long-term operation (LTO) until 2034 are being developed in the organisation.

PAKISTAN

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
PHWR (KANUPP)	1	3.701
PWR (CNPP)	1	0.592

ROMANIA

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
CANDU	2	0.344 (man Sv)

Summary of national dosimetric trends

Occupational exposure at Cernavoda NPP (2000 – 2008)

	Internal effective dose (man·mSv)	External effective dose (man·mSv)	Total effective dose (man·mSv)
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
2007 (U1+U2)	83.34	187.49	270.83
2008 (U1+U2)	209.3	479.34	688.64

Events influencing dosimetric trends

On 17 January 2008, a fuel-handling operator received an unplanned external gamma dose of 15.2 mSv because of inadequate personal radiation monitoring while cleaning up a spill of heavy water and repairing a level indicator in the on-line fuel machine maintenance room. The operator was unaware that radiological conditions had changed as a result of a highly activated component in the room. The highly activated component, an installed refuelling tool, had just been used in the reactor core during a refuelling sequence. This activity had not been done before, and the potential for a significant change to radiological conditions in the room was underestimated because of the short time that the tool resided in the core.

On 12 May 2008, during preliminary activities for fuel channels inspection, two fuel handling operators entered the fuelling machine maintenance room wearing contaminated areas suits and no respiratory protection, despite the fact that they were aware that a significant spill of tritiated water from primary heat transport system could occur. The result was the acute intake of tritiated water (through inhalation, absorption through the skin of liquid water and also tritiated water vapours): 9.5 mSv and 4.2 mSv committed doses.

Number and duration of outages

Planned Outage: A 55 days planned outage was done at Unit 1 between 10 May – 3 July 2008. Activities with major contribution to the collective dose were as follows:

- 10 fuel channels inspection.
- Reactor Building leak rate test.
- Feeders inspection / measuring.
- Preventive maintenance of fuelling machine bridge components.

The total collective dose at the end of the planned outage was 298 man·mSv (external dose: 187 man·mSv; internal dose: 111 man·mSv due to tritium intakes). Finally, this planned outage had a 48% contribution to the collective dose for the first ten months of the year.

Planned outage dose history

Year	Unit	Interval	Collective Dose Received (man·mSv)		
			External	Internal (^{3}H intakes)	Total
2003	1	15.05 - 30.06	345	161	506
2004	1	28.08 - 30.09	153	179	332
2005	1	20.08 - 12.09	127	129	256
2006	1	9.09 - 4.10	103	107	210
2007	2	20 - 29.10	16	0	16

Between 22-26 April 2008, both units experienced an unplanned shut down due to extreme weather conditions. There was no radiological impact of the activities performed in this time period.

At the end of the year 2008:

- There were 19 employees with individual doses exceeding 5 mSv; one with individual dose over 10 mSv and one with individual dose over 15 mSv (both unplanned exposure).
- The maximum individual dose was 15.32 mSv (unplanned exposure).
- The contribution of internal dose due to tritium intake was 30.4% for the year 2008.

Issues of concern in 2009

The main concerns for 2009 are activities with high radiological impact to be performed during Planned Outage of Unit 2, as “baseline” fuel channel inspection.

Technical plans for major work in 2009

Radiation protection-related issues

During the planned outage, modernisation of the “Tritium in Air Monitoring” system in Unit 1 continued with the installation of sampling lines in those areas/rooms inaccessible at reactor full power; action to be finished at the end of September 2009.

Extension and improvement of Area Alarming Gamma Monitors (AAGM) system is in progress. During Unit 1 planned outage, 2 of 8 defective monitoring loops (serving 2 rooms inaccessible at full power) were repaired. Until the end of 2008, another 2 loops were repaired and 1 new loop was installed. During 2009 another 1 loop will be improved. During Unit 2 planned outage in 2009, 4 monitoring loops of AAGM system will be improved and 1 new loop will be installed. During Unit 1 planned outage in 2010, the last 3 loops will be improved.

In order to solve “components obsolescence” problems of the Unit 1 gaseous effluent monitoring system, the first two steps of improvement were finalised at the end of 2008; a redundant particulate, iodine and noble gases loop and two passive collectors (tritium, ^{14}C samplers) were installed, similar to the new equipment installed in Unit 2 (same manufacturer). The third step is to install a new noble gases spectrometric loop by the end of 2009, in order to evaluate the individual radioactive isotope releases. The GEM spectrometric noble gases project will be extended in the next year at Unit 2. For the long term, a heavy water de-tritiation facility project is in progress. A pilot-plant is under commissioning to test technology to reduce tritium concentration in the reactor moderator system.

RUSSIAN FEDERATION

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
PWR (VVER)	15	0.694
Reactors in cold shutdown or in decommissioning		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
PWR (VVER)	2	0.078

Summary of national dosimetric trends

Collective doses

In 2008, the total (utilities employees and contractors) effective annual collective dose of 15 Russian operating VVER type reactors was 10.408 man·Sv. This value is 3.199 man·Sv lower than the total collective dose for the year 2007 (13.607 man·Sv). The reduction of the total collective dose is based on technical and organisational actions implemented at the plants. It also corresponds to the decrease of the total planned outage durations (781 and 659 days in 2007 and 2008, respectively). The maximum decrease of the annual collective dose was recorded at Novovoronezh 3-5 Units: from 6.125 man·Sv in total for three operating units in 2007 to 3.609 man·Sv in total for the same units in 2008. In 2008, the average annual collective doses per VVER-440 and VVER-1000 reactors were 1.010 man·Sv and 0.483 man·Sv respectively.

Individual doses

In 2008, there were no individual doses exceeding the main national dose limit (100 mSv averaged over defined periods of 5 years). The control dose level of 20 mSv/year, installed by Concern Energoatom (Russian operating utility) was also not exceeded at any Russian plant with VVERs. One worker received an annual individual dose exceeding 19 mSv. This maximum recorded dose of 19.3 mSv was gradually received over 2008 by a worker of the Kalinin NPP maintenance department involved in the repair of the reactor vessel internals at units 1-3. Annual individual doses at all VVER units in the range between 18 and 19 mSv were received by only 3 persons.

Planned outages duration and collective doses

Reactor	Duration [days]	Collective dose [man·Sv]	Reactor	Duration [days]	Collective dose [man·Sv]
Balakovo 1	63	1.114	Kola 1	59	1.078
Balakovo 2	41	0.354	Kola 2	33	0.410
Balakovo 3	43	0.473	Kola 3	56	0.553
Balakovo 4	no outage	–	Kola 4	38	0.298
Kalinin 1	60	0.774	Novovoronezh 3	50	1.180
Kalinin 2	43	0.416	Novovoronezh 4*	44	1.482
Kalinin 3	45	0.130	Novovoronezh 5	45	0.248
			Volgodonsk 1	39	0.040

* At Novovoronezh 4, an unplanned repair outage was performed from 1-7 March 2008. The total collective dose (utilities employees and contractors) was 0.208 man·Sv for this outage.

Main dose-reduction activities in 2008

- Preparatory activities aimed at implementation of 18 months fuel cycle for VVER-1000 reactors were started.
- A standard program of occupational radiation protection during the specially radiation dangerous works was developed.
- A pilot lot of radiation shields based on tungsten compounds was manufactured.
- A personnel monitoring system in RCA was introduced at Kola NPP.
- A supply of new electronic personnel dosimeters was provided.

Issues of concern for 2009

- Development and arrangements of the conceptual programme "Optimization of occupational radiation protection at concern Energoatom NPPs for the period 2010-2014".
- Continuation of the preparatory activities aimed at implementation of 18 months fuel cycle for VVER-1000 reactors.
- Arrangements and realisation of the preliminary stages of "Best health physicist of NPPs" contest.

SLOVAK REPUBLIC

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
VVER	6	0.154
Reactors in cold shutdown or in decommissioning		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
GCR	1	Not involved in ISOE

Summary of national dosimetric trends

Bohunice NPP (2 units – Bohunice 3 and 4):	The total annual effective dose in Bohunice NPP in 2008 calculated from legal film dosimeters was 561.126 man mSv (employees: 28.553 man mSv; outside workers: 532.573 man mSv). The maximum individual dose was 9.711 mSv (contractor).
JAVYS NPP (2 units – Bohunice 1 and 2):	The total annual effective dose in JAVYS NPP in 2008 calculated from legal film dosimeters was 58.567 man mSv (employees: 10.167 man mSv; outside workers: 48.400 man mSv). The maximum individual dose was 1.613 mSv (employee).
Mochovce NPP (2 units):	The total annual effective dose in Mochovce NPP in 2008 calculated from legal film dosimeters was 308.603 man mSv (employees 26.538 man mSv, outside workers 282.065 man mSv). The maximum individual dose was 3.836 mSv (contractor).

Events influencing dosimetric trends

Bohunice NPP: The higher collective exposure in 2008 continues during the recent years due to the modernisation works in Bohunice NPP.

JAVYS: Unit 1 has not been in the operation since 1 January 2007 due to planned shut down and is in preparation stage for decommissioning. Unit 2 was in operation during all of 2008 without any planned or forced outages.

Mochovce NPP: Standard operation and short outages influenced low dosimetry data results.

Number and duration of outages

Bohunice NPP:	Unit 3:	46 days standard maintenance outage combined with the modernisation works. The total collective exposure was 243.596 man mSv.
	Unit 4:	63.55 days major maintenance outage combined with the modernisation works. The total collective exposure was 287.812 man·mSv.
JAVYS NPP:	Unit 1:	out of operation since 1 January 2007.
	Unit 2:	no outage.
Mochovce NPP:	Unit 1:	33 days of outage combined with 17 days of Unit 2 outage in order to maintain common equipment. The total collective dose was 172.462 man·mSv.
	Unit 2:	23 days of standard outage. Total collective dose was 83.031 man·mSv.

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

New plants on line/plants shut down

New NPP: Completion of Mochovce Units 3 and 4. The basic design for the completion was elaborated and submitted to the state authority for approval. Contracts with the main suppliers were signed and an EIA was prepared.

Shut down of second unit of JAVYS NPP: Unit 2 was shut down on 31 December 2008. Both units (1 and 2) have an operation licence until 2011 (Unit 1: June 2011; Unit 2: October 2011).

Major evolutions

JAVYS NPP: preparation for decommissioning of Units 1, 2; preparation for upgrading the radiation protection systems and releasing materials from the RCA to the environment.

Component or system replacements

Bohunice NPP:	Installation of new system for accident monitoring of radioactivity in live steam.
	Replacement of major electronic parts of stationary NPP radiation protection system – continues to 2009.
	Modernisation of laboratory gamma spectrometry systems by two BEGe detectors, purchase of TRICARB monitor (C-14 and H-3).
	Works with the transformation of existing radiation protection information and work management software into the new software environment.
JAVYS NPP:	Usage of new passive DIS dosimeters for welding.
	Installation of electronic personal dosimetry system into emergency shelters.
Mochovce NPP:	Replacement of major electronic parts of stationary RP systems.

Safety-related issues

Bohunice NPP: Power upraise of Unit 3 to 104% after the outage. *JAVYS NPP:* Preparation for the decommissioning of both units. *Mochovce NPP:* power upraise of unit 1 and 2 to 107%.

New/experimental dose-reduction programmes

Mochovce NPP: Specific chemistry shut-down programme is implemented.

Organisational evolutions

Bohunice NPP, Mochovce NPP: Inclusion of environmental laboratory into the radiation protection department

Technical plans for major work in 2009

Bohunice NPP: Installation of electronic personal dosimetry system into emergency shelters, fire brigade and NDT premises.
Installation of dose rate detectors to emergency shelters and gathering points.
Replacement of major electronic parts of stationary NPP radiation protection system – continues from 2008 to 2009.
Modernisation of continual liquid discharge monitors.
Exchange of site gate personal monitors.

JAVYS NPP: Installation of dose rate detectors to emergency shelters and gathering points.
Modernisation of main radiation control room – preparation for decommissioning projects.

Mochovce NPP: Film badge automatic issuing system at changing rooms.
Upgrading of EPD issuing system.

Regulatory plans for major work in 2009

- Licensing process of the decommissioning of NPP JAVYS V1.
- Inspections of outages in all operated units.

SLOVENIA

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
PWR	1	0.146

Summary of national dosimetric trends

There is one 2-loop PWR operating in Slovenia since 1983 (Krško NPP). It is owned by the state utilities of Slovenia and Croatia. The plant has been continuously upgraded during the last ten years and current gross power is 727 MWe. Gross electrical output for the year 2008 was 6.27 TWh.

Radiological performance indicators, 2008: The collective radiation exposure was 0.146 man-Sv. The maximum individual annual dose was 4.49 mSv; the average dose per person was 0.25 mSv.

Unplanned outage (04.06.08 – 09.06.08): An unplanned outage was performed due to a failure of one of isolation valves in the by-pass line for reactor coolant temperature measurement. The valve was replaced and the other valves were inspected. The collective dose of the unplanned outage was 50 man mSv, the valve replacement contributed 17.1 man·mSv. Maximum individual dose was 3.25 mSv for welding activities.

Trends in collective dose: The three year average dose was 0.63 man Sv.

REPUBLIC OF SOUTH AFRICA

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
PWR	2	0.749

Summary of national dosimetric trends

During 2008, Koeberg Nuclear Power Station had one refuelling outage. The overall dosimetric trend year on year saw a marginal increase comparing the average annual collective dose per unit for 2008 to that of 2007. The 2007 average annual collective dose per unit for Koeberg NPS was 0.736 person·Sv. In 2008, the average annual collective dose per unit increased to 0.749 person Sv.

Events influencing dosimetric trends

A maintenance shutdown was performed on Unit 2 as well as safety related modifications during this outage period. These modifications accounted for 55.19 mSv.

Number and duration of outages

One scheduled maintenance outage was held during 2008. Approximately 84.6% of the total dose accrued during 2008 for Koeberg was due to the 83 day outage on Unit 2. During this outage, 21 modifications were performed in the radiation controlled zone. The highest doses were accrued during modifications to the Reactor Building Sumps (32.63 mSv); installation of Hydrogen Re-Combiners (11.21 mSv) and modifications to the plant Fire System inside the Reactor Building (3.74 mSv). High doses were also accrued during non-routine activities i.e. in-service inspections to the primary system (71.64 mSv); seismic inspections of the reactor building (3.45 mSv); and the inspections on the Containment Tie Rods (56.46 mSv).

Issues of concern in 2009

Koeberg NPS has re-focused on the ALARA programme and has identified and implemented various dose reduction initiatives during 2009.

SPAIN

In 2008 the average dose per refuelling outage was 0.514 person·Sv for PWR (3 units). Per plant, the annual collective doses and the outage collective doses are as follows:

NPP	Type	Outage Coll. Doses (person·Sv)	No. days	Annual Coll. Doses (person·Sv)	Comments
Almaraz I	PWR	0.434	43	0.499	
Almaraz II	PWR	–	–	0.021	No outage
Ascó I	PWR	–	–	0.072	No outage
Ascó II	PWR	0.770	56	0.723	(*)
Vandellos II	PWR	–	–	0.046	No outage
Trillo	PWR	0.337	36	0.382	
S.M Garoña	BWR	–	–	0.353	No outage
Cofrentes	BWR	–	–	0.654	No outage

* The reason for the discrepancy observed between outage and annual collective doses is that the outage doses are operational doses recorded with ED (recording level 0.001 mSv) and the annual doses are official doses recorded with TLD (recording level 0.100 mSv).

Regarding the annual collective dose in PWRs, the average for 2008 was 0.29 person·Sv, while the three-year rolling average was 0.39 person·Sv. Concerning the annual collective dose in BWRs, the average total collective dose was 0.50 person·Sv, similar to other years with no refuelling outage. The three-year rolling average is 1.69 person·Sv.

Year	PWR			BWR		
	Outages	Collective doses (person·Sv)	3-year rolling average	Outages	Collective doses (person·Sv)	3-year rolling average
2003	6	0.43	0.44	2	2.16	1.52
2004	4	0.31	0.41	0	0.46	1.38
2005	5	0.38	0.37	2	2.32	1.65
2006	5	0.38	0.36	0	0.41	1.06
2007	5	0.51	0.42	2	4.15	2.29
2008	3	0.29	0.39	0	0.50	1.69

Cofrentes NPP has had six forced outages for maintenance tasks with a collective dose of 0.238 person Sv. In addition, re-racking tasks resulted in a collective dose of 0.035 person·Sv. The vessel drain line substitution entailed an important drop of the dose rate in the area of over 50%. In 2009 an ambitious plan for dose reduction will be undertaken. This programme will, amongst others, include reduction of corrosion materials in the primary circuit and replacement of components containing cobalt, chemical decontamination of the clean-up system and recirculation loops, removal of hot spots by mechanical decontamination, a programme for the installation of permanent shielding and location of remote vision cameras in high-dose cubicles for leak detection and inspection robots improvement.

S. M. Garoña NPP has had four down-powers and one cold shutdown for maintenance tasks. A new procedure for a better tracking and control of individual doses has been developed and two instrumentation and graduated technicians have been hired. By 2011 a decontamination of the recirculation loops is foreseen.

Due to a fire in the generator, Vandellós II NPP has had an outage of 53 days, but there has been no radiological impact.

Replacement of the containment insulation has been performed at Almaraz II NPP. The new one can be removed and decontaminated much better than the former one. There also are new ALARA Zones (waiting zones in low radiation level places). An important reduction of doses inside containment is expected from now on. A programme for dose reduction at Almaraz I & II and Trillo NPPs has been proposed to the regulator. This programme will include a new hot spot tracking and analysis, the optimisation of training courses for decontamination with the participation of experienced RP technicians and an effort to follow procedures for decontamination.

During 2008, refuelling outage at Ascó II NPP, a "Weld Overlay" project for pressuriser nozzles was performed with an associated collective dose of 0.165 person·Sv. This project will also be performed during 2009 outage at Vandellós II NPP.

In April 2008, a reportable event related to a release of hot particles at Ascó I NPP was reported. Due to this release, a programmed outage of 42 days for surveillance tasks resulted in a collective dose of 0.052 person·Sv. Due to this event, several main corrective actions have been performed: amplification of the scope and frequency of outside areas surveillance, installation of portal detectors for vehicles and at double fence for labour, acquisition of modern PR detectors and modification of decontamination and clean up methodology for the fuel transfer canal. The major evolution in RP staff has been the establishment of a close shift of RP monitors for each unit at Ascó NPP, a new ALARA Operational Supervisor and hiring of an important group of RP personnel to cover the increase of radiological surveillance tasks. This matter is still open and there are pending issues in progress. Nevertheless, there has been neither skin nor internal doses in the huge amount of monitored people.

Regarding Jose Cabrera NPP, currently in a pre-decommissioning phase, the total collective dose was 0.135 person·Sv in 2008. ENRESA, the Spanish radioactive waste management agency, has presented a request to obtain the Dismantling Authorisation for Jose Cabrera NPP. It is expected that this permission will be granted for 2009. An ALARA plan is being developed to decrease the expected doses in 2009 when the spent fuel is stored in casks and placed in the Individual Temporary Storage.

From 28 January – 8 February, the IAEA lead the Integrated Regulatory Review Service (IRRS) to the Spanish Regulatory Body (CSN). The evaluation was better than expected and the main outcomes from the mission were a recommendation to establish a Consultant Committee for clearness and public communication and the collaboration with competent authorities in development of plans for definitive planning of the ultimate disposal site.

Related to the Ascó I incident, the CSN performed several inspections and demands of additional information and issued a Technical Instruction with the request for new programmes for outside surveillance, internal contamination surveillance and decontamination and cleaning of the Fuel Building HVAC, as well as the creation of a team to study, model and analyse the radiological estimation of the incident.

SWEDEN

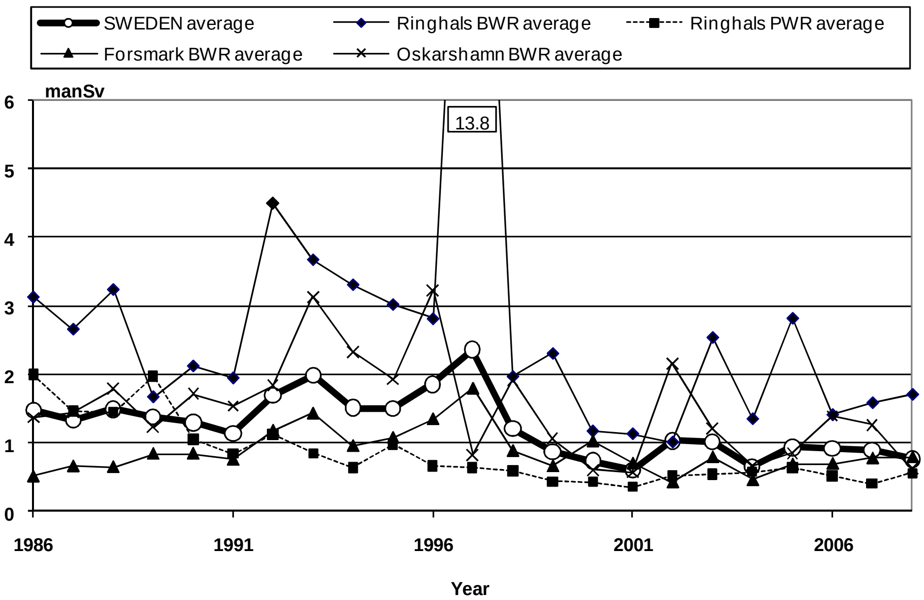
Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
PWR	3	0.56
BWR	7	0.85
Total: All types	10	0.76
Reactors in cold shutdown or in decommissioning		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
BWR	2	0.04

Summary of national dosimetric trends

Since 2005, the collective and individual doses at the Swedish nuclear power plants show a fluctuating trend. During 2008, about 3 000 persons at the NPPs were registered as receiving at least 0.1 mSv (TLD-dose) during at least one month (dosimeter read-out period) of the year. This resulted in a total collective dose in Sweden of 7.7 man Sv, an average individual dose of 1.7 mSv and a highest annual individual dose of 18.6 mSv. Note that the values presented here include the doses received at the two closed reactor units at Barsebäck NPP (101 persons with dose > 0.1 mSv, collective dose: 0.08 man Sv, average dose: 0.8 mSv and max. dose: 9.7 mSv).

Average annual collective dose (man·Sv)



Events influencing dosimetric trends

There are several projects in progress for modernisation, plant life extension, safety related measures (regulatory demands) 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 and outage, which influences the dosimetric trends.

Number and duration of outages

Plant	Type	Duration (Days)	Collective dose (man·Sv)	Comments
Forsmark 1	BWR	57	1.217	As scheduled.
Forsmark 2	BWR	36	0.405	As scheduled.
Forsmark 3	BWR	33	0.275	As scheduled. Additional 72 d unplanned outages caused by cracks in Control Rod Shafts, generic with Oskarshamn 3.
Oskarshamn 1	BWR	32	0.577	Extended 9 d caused by additional work at turbine temperature sensors.
Oskarshamn 2	BWR	32	0.433	Extended 8 d caused by installation of recombination system.
Oskarshamn 3	BWR	93	0.284	Extended 74 d caused by cracks in Control Rod Shafts.
Ringhals 1	BWR	140	1.428	Extended 92 d caused by reconstruction in containment spray system.
Ringhals 2	PWR	52	0.499	Extended 28 d caused by flow capacity problems for auxiliary feed water pumps and balancing of RCP2.
Ringhals 3	PWR	26	0.218	Extended 4 d caused by project delay.
Ringhals 4	PWR	29	0.730	Extended 2 d caused by CRDM work.

(Outage collective dose is registered EPD dose)

Component or system replacements

As a result of ongoing projects for modernisation, plant life extension, safety related measures (regulatory demands) and power upgrades at the Swedish NPPs, there are many components and system modifications/replacements, which result in a significant dose outcome. Examples are modernisation of the pressure relief system (BWR), installation of particle filters (cyclone filters) in the feed water system in order to avoid fuel failures due to foreign materials, modernisation of RPS (Reactor Protection System) and installation of a diversified/ redundant Residual Heat Removal and Cooling Water systems (BWR). The EPD systems have been or will be exchanged at the majority of the Swedish NPPs.

Safety-related issues

Electrical disturbance in outer grid Forsmark 2, risk for fuel dryout was investigated.

Unexpected events

Cracks in Control Rod Shafts led to unplanned shut down for Forsmark 3 and Oskarshamn 3.

New/experimental dose-reduction programmes

Setting department collective dose target value in order to more fully involve departments in planning and follow-up their staff individual and collective doses. A working group was established to find possibilities to standardise the radiation protection sector at the Swedish NPPs, e.g., ways of working, protective equipment, similar work instructions, limit values, software for dose planning etc.

Organisational evolutions

Since the termination of the operation of Barsebäck NPP (BKAB) in 2005, BKAB has opened the site for training courses and research. These possibilities are also open for national and international organisations and companies. This involves activities to enhance basic knowledge of work methods, safety regulations and what is expected to maintain a good safety, ALARA culture and a good professional performance. For information, contact: bengt.sikland@barsebackkraft.se.

Issues of concern in 2009

The Swedish NPPs are carrying through OSART inspections: Forsmark 2008, Oskarshamn 2009 and Ringhals 2010. Preparations and follow-up are resulting in optimisation towards best practice in radiation protection at nuclear power plants.

Technical plans for major work in 2009

Oskarshamn: Modernisation and power upgrade in progress at Unit 3. Power upgrade 18% is planned and major projects are exchange of reactor internals and HP Turbine.

Forsmark: Maintenance of reactor clean-up heat exchanger, measures to eliminate vibrations in pressure relief system, exchange of manway hatch in intermediate heat exchangers, exchange of containment process supervision cameras, exchange of reactor internals, exchange of HP-turbines and intermediate heat exchangers and exchange of control rods (96 pieces of CR and 17 pieces of CR guide tubes).

Ringhals: TWICE project at Ringhals 2 (Ringhals TWo Instrumentation and Control Exchange), which basically is a control room exchange. Modernisation of RPS (Reactor Protection System) and installation of a diversified/redundant Residual Heat Removal and Cooling Water systems (BWR). Replacement of PRZ heaters cabling (PWR). Continuous work with radioactive release optimization.

Regulatory plans for major work in 2009.

In 2009, the Swedish Radiation Safety Authority, SSM, intend to carry out the following activities:

- Continue to develop the radiation protection and safety supervision program.
- Training of new inspectors.
- Clarification of the role of the radiation protection expert at NPP.
- In addition to base regulatory oversight SSM will focus its supervision on the plant modernisation programs.

SWITZERLAND

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
PWR	3	0.461
BWR	2	1.105

Summary of national dosimetric trends

For the last 10 years the average annual collective dose per unit has been in the range of 100-1 200 man.mSv, with a very slow decrease in the 5-year average. In 2008, only 7 persons (of 4 695 occupationally exposed persons) had doses above 10 mSv/yr. The highest individual dose was 13.2 mSv.

Events influencing dosimetric trends

In NPP Beznau 1, during normal operation antimony was released from the filtration plant into primary cooling water resulting in a higher dose rate at the cooling circuit.

In NPP Gösgen, four leaking fuel rods were detected by sipping during the outage. The leakers lead to a small increase of airborne radioactive iodine and noble gas in the containment during opening of reactor vessel. Nobody received an incorporation dose above the detectable value of 0.1 mSv. During start up after outage the increasing concentration of radioactivity in primary cooling water indicated the existence of new leakers. NPP Gösgen decided to continue operating as the activity concentration was well below the specified limit.

In NPP Leibstadt, grinding at a component of the recirculation loop induced airborne activity, which was incorporated by workers who stayed at a distance of more than 10 m without respiration protection. The individual doses estimated by whole body counter measurements are 0.1-0.6 mSv. The grinding was continued after installing a tent with separate exhaust air conditioning.

Number and duration of outages

Each NPP had one planned outage in 2008. The shortest was in NPP Beznau 2 with only 11 days, the other NPP outages were between 26 and 28 days.

New plants on line/plants shut down

In Switzerland three applications for licences of new NPP are filed at the government.

New/experimental dose-reduction programmes

The zinc injection in NPP Gösgen, started in 2005, shows a reduction of average dose rate at the primary cooling circuit in a range of the physical decay of ^{60}Co. The zinc injection prevents clearly the build-up of corrosion products.

UNITED KINGDOM

Dose information

Operating reactors		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
PWR	1	0.264
GCR (AGR)	14	0.167
GCR (Magnox)	4	0.046

Dose information (Cont'd)

Reactors in cold shutdown or in decommissioning		
Reactor type	**Number**	**Average annual collective dose per unit [man·Sv/unit]**
GCR (Magnox)	16	0.048

Summary of national dosimetric trends

With the exception of Sizewell B, all UK nuclear power plants are gas-cooled. Doses were higher than the previous year on the Advanced Gas Cooled Reactors (AGRs) at Hinkley Point and Hunterston because of extensive in-vessel inspection and repairs. However the doses from these two reactor sites still represented more than 90% of the collective dose for the AGRs. At the end of 2008 the rolling three year collective dose trend for the PWR at Sizewell is unchanged at approximately 0.28 man·Sv.

Events influencing dosimetric trends

The average annual collective dose at the AGR sites was again dominated by doses received during in-vessel work at the AGRs at Hinkley Point and Hunterston. Previous inspections of these power plants had detected defects in the boiler pipe work, requiring additional inspections and repairs. This work continued in 2008 necessitating prolonged work inside the reactor vessels, in areas of higher dose rate. A number of dose management initiatives were successfully used including teledosimetry for in-vessel entrants and training on Mock-ups.

Number and duration of outages

The gas-cooled reactors operate to a two-yearly outage frequency so each site typically has one reactor outage per annum. Refuelling of the gas-cooled reactors is carried out on-load. The highest outage doses on the gas-cooled reactors were received at Hinkley Point B and Hunterston B plants with outage doses of approximately 0.33 man·Sv and 0.7 man·Sv respectively. The majority of the doses at Hinkley Point B and Hunterston were associated with in-vessel inspections and repair rather than routine outage tasks. The AGRs at Heysham A and Hartlepool were shut down for the majority of the year to inspect thousands of pre-stressed cables in the Boiler Closure Units. The work required many thousands of RCA hours of inspections, fortunately in very low dose rate areas. Round the clock radiographic inspections (nine thousand radiographs) were performed requiring close radiological protection oversight and support.

The annual dose at Sizewell B was dominated by the ninth Refuelling Outage which contributed 81% of the annual total. The standard outage lasted twenty five days and recorded a collective dose of 0.215 man·Sv, the lowest ever dose for a refuelling outage at the plant.

Decommissioning sites: major evolutions

All Magnox sites are owned by the Nuclear Decommissioning Authority, a government owned management unit, with sites operated or being decommissioned under contract by a number of consortia. Of the original Magnox reactor fleet two sites remain in power operation, Oldbury and Wylfa. The reactors at Oldbury NPP were due to close at the end of 2008 however they have had their operating lives extended, after appropriate regulatory approval. A similar extension to the planned 2010 final shutdown date for Wylfa NPP is also expected subject to satisfactory regulatory approval. Of the permanently shutdown sites some are completely defuelled and are at various stages of decommissioning. Other sites are shutdown with the reactors still fuelled and with air cooling. Defuelling of these sites continue to be rate limited by the capacity of the Sellafield reprocessing plant to receive and process fuel.

UK new nuclear build

In late 2008, EDF Energy acquired the nuclear generation assets of British Energy. EDF Energy have reiterated their intention to construct four PWRs in the United Kingdom, to be built on existing nuclear sites, probably Sizewell and Hinkley Point. Other utilities have expressed an interest in building further nuclear power plants, with strong political support from the UK government. The regulators are carrying out generic licensing assessments of the two PWR reactor types that have been nominated for new build, the Areva/EDF EPR and the Westinghouse-Toshiba AP1000.

UNITED STATES

ALARA challenges in 2008

In 2008, US PWRs sites were challenged with reactor head replacements, steam generator replacements, containment sump modifications, on-going impacts of materials, dissimilar-weld, in-vessel and other inspections at numerous plants. US BWRs sites were challenged with dryer replacements, power uprates and equipment reliability impacts.

Summary of 2008 dose trends

2008 Dose Results Summary			
Reactor Type	**Number**	**Total Collective Dose (person·Sv)**	**Avg Dose per Reactor (person·Sv/unit)**
PWR	69	46.737	0.68
BWR	35	45.224	1.29

The lowest annual average collective dose ever achieved by the 104 operating reactor units in the United States was accomplished in 2008. The average collective dose in 2008 for light water reactors was 0.884 person·Sv/reactor. The total collective dose was 91.961 person·Sv, which is 9% lower than the 2007 total collective dose of 101.18 person·Sv, and 17% lower than 2006 total collective dose.

The 2008 annual collective dose achieved a 50% reduction in the LWR dose recorded ten years ago (in 1995) and is only about one-tenth of the maximum LWR average dose of 7.9 person·Sv/reactor recorded in 1980. The consistent reduction in annual collective dose reflects the industry’s continuing commitment to the lowering of occupational doses by fostering a strong ALARA culture on-site, reducing source term, implementing effective exposure reduction station enhancements and maintaining high equipment reliability.

In 2008, the total collective dose for PWRs was 46.737 person·Sv for 69 reactors. The resulting average collective dose per reactor for PWRs was 0.677 person·Sv/reactor. This average represents a 2% decrease from the 2007 value of 0.69 person·Sv/reactor, and is the lowest average annual dose recorded to date for US PWRs (in 2004 and 2007, 0.71 and 0.69 person·Sv were recorded, respectively). This is the tenth year the average annual PWR dose has been less than 1.00 person·Sv/reactor.

The total collective dose for BWRs in 2008 was 45.224 person·Sv for 35 reactors. The resulting average collective dose for BWRs was 1.292 person·Sv/reactor. The BWR average collective dose for 2008 is the lowest recorded annual average dose per unit for US BWRs ever recorded (the previous lowest average BWR dose of 1.38 person·Sv/unit was recorded in 2001).

Indian Point 3 achieved the lowest US PWR annual collective dose of 0.022 person·Sv. Pilgrim achieved the lowest US BWR annual collective dose of 0.226 person·Sv.

One of the noted differences between the collective doses recorded in 2006, 2007 and 2008 was the number of units having collective doses equal to or less than 0.10 person·Sv for the year. In 2006, five LWRs had collective doses equal to or less than 0.10 person·Sv for the year; in 2007, nine LWRs had annual collective doses in this range and in 2008 only two LWRs had annual collective dose equal or less than 0.10 person·Sv.

In spite of the 2008 total annual collective dose results, the US plants have adopted an approach for continuous improvement in ALARA programs and results at each site. On-site initiatives include dynamic learning laboratories to reinforce good radiation worker practices, ALARA work plans, effective ALARA pre-job briefs, source term reduction programs, efficient outages, enhanced reactor coolant chemistry control, and strong senior management support of the ALARA philosophy. Physical changes to the plants to reduce dose include use of permanent shielding and work platforms to replace temporary shielding and scaffolds.

US nuclear generation

The US 104 units achieved a capacity factor of 91% in 2008. Thirty-five BWR units operate in the US; 14 one unit sites, 9 two unit sites and 1 on a three unit site. Sixty-nine PWR units operated in the US in 2008; 15 one unit sites, 24 two unit sites and 2 three unit sites. Thirty-two companies are licensed to operate nuclear reactors in the US in 31 states. The South Texas Project produced more electricity than any other two-unit nuclear power plant in the US in 2008, for the fifth consecutive year. STP Unit 1 led all 104 reactors nationwide and Unit 2 placed third nationally in electric generation, despite scheduled shutdowns of both units for refuelling and maintenance last year. The reactors ranked ninth and eleventh, respectively, of the 439 units worldwide in production. STP Unit 1 produced 10.8 million megawatt-hours and Unit 2 generated 10.74 million megawatt-hours of electricity. Both units completed breaker-to-breaker production runs by operating continuously between refuelling outages. The plant set an industry record in 2008 by completing a fourth consecutive continuous cycle operation.

Plant life extensions for 20 years more of operation were granted by the US NRC to four US sites including Fitzpatrick, Wolf Creek, Harris and Oyster Creek. Sixteen US sites have plant life extensions requests submitted to the US NRC review. Seventeen US sites are considering future plant life extension submittals. Several US sites have received management approval for funding of major ALARA project plant modifications based on more favourable cost/benefit analysis formulae based on 20 additional years of operation.

There is also the continuing impact of dose accrued due to implementation of modifications related to extended power uprate. Site power uprates approved by the US NRC in 2008 included Susquehanna (13%), Vogtle (1.7%), Hope Creek (15%), Comanche Peak (4.5%), Cooper (1.6%), Davis Besse (1.6%), and Millstone (7%). A total of 17 179.2 MWth was authorized by the 2008 US NRC power uprate approvals. Power update generally requires significant in-plant modifications including BWR moisture separator modifications, turbine modifications and reactor vessel modifications resulting in additional annual dose.

US ALARA inspection procedure update

Since 2000, the US NRC has used the 3-year rolling average collective dose as an indicator of a plant's ALARA performance. In the Significance Determination Process for the Occupational Radiation Safety Cornerstone, each licensee's 3-year rolling average is compared against criteria established earlier (1995-1997) of 1.35 person·Sv/unit for PWRs and 2.40 person·Sv/unit for BWRs to aid in determining the level of ALARA inspections for the next year. For 2006-2008, two PWR units exceeded the PWR criterion and no BWR units exceeded the BWR criterion.

The NRC plans for preparing for potential revisions to (annual and/or five-year) dose limits considering ICRP-103 publication, and the industry is continuing its efforts to understand the implications of potential changes to dose limits and means to mitigate any such changes. US radiation safety discussion are focused on the additional complications of the concept of dose constraints and how, if at all, it may be interpreted/implemented especially at nuclear power plants and in other disciplines, i.e., medicine, industrial and research.

The US NRC is preparing a new Radiation Protection manual for future radiation protection related inspections. The current manual has six inspection areas while the new manual will have eight due to the addition of hazardous material management and emergency planning. The eight inspection modules will be incorporated into a conduct of radiation protection summary procedure. The modules are focused on an observational-based inspections approach.

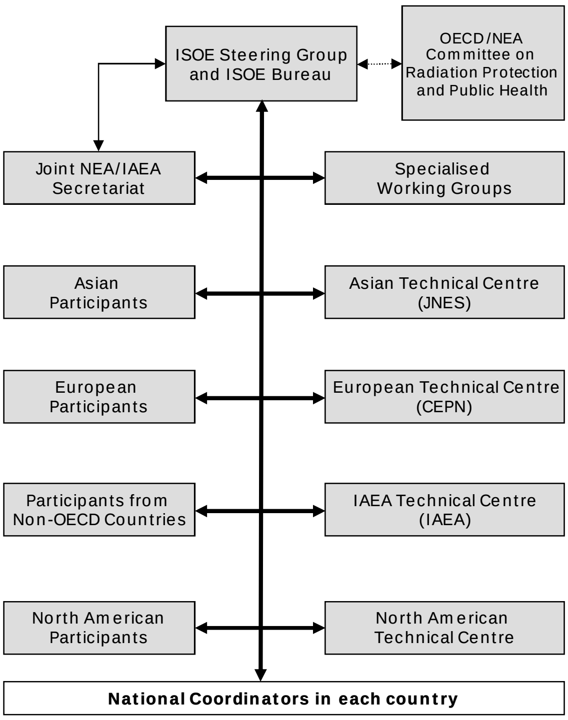
Appendix 1

ISOE ORGANISATIONAL STRUCTURE AND PROPOSED PROGRAMME OF WORK FOR 2009

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. More 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 Appendix 6.



A.2 ISOE Programme of Work for 2009

The ISOE programme of work for the year 2009, approved at the 18th ISOE Steering Group Meeting (November 2007) will include:

1) ISOE database management

Data collection and management

Collection of ISOE 1 and ISOE 2 data: ISOE participants will provide their 2008 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 development and implementation status.

Collection of ISOE 3 reports: The ISOE Network will be used to exchange and record new ISOE 3-type information (i.e., radiation protection-related information for specific operations or tasks). All new ISOE 3 reports will be posted to the ISOE Network ALARA Library using a new form/template to be available on the website. All posted information will be searchable by keywords or topics in order to achieve the ISOE 3 experience exchange objective through implementation of an effective web-based information exchange ALARA-information portal.

Management of the official ISOE databases

On-line Update of Data: Data available through the ISOE Network analysis module will be first updated by ETC in June 2009, and then at regular intervals through the rest of the year. Subject to the development schedule of the on-line data input modules, data submitted directly through the ISOE Network will be available as soon as the data is validated.

Official Database release: The annual CD-ROM of the complete database, including 2008 data, will be released at the end of 2009.

Continued development of ISOEDAT on-line

Phase 2 of the ISOEDAT web migration, focusing on development of web-enabled data entry modules for ISOE 1, will be completed and implemented on the ISOE Network. ETC and NEA will prepare and provide an online help / user's guide for the ISOE 1 questionnaire, as well as undertake a verification of user data in order to setup accounts for on-line data entry. Based on Management Board-approved projects, proposed enhancements to the on-line version of MADRAS, in terms of usability and functionality, will be elaborated by the Technical Centres and WGDA and, subject to approval, implemented on the ISOE Network. These include proposals for modifications addressing data collection/analysis for reactors undergoing decommissioning and for a new query system. Phase 3, which will address migration of the ISOE 2 questionnaire, will be undertaken using the development basis of Phase 2, if deemed appropriate by the Management Board.

2) ISOE Management and Programme Activities

ISOE Steering Group/Management Board

The ISOE Management Board, supported by the ISOE Bureau, will continue to focus on ISOE programme management by reviewing and directing the progress of the programme at its annual meeting, developing and approving the programme of work for the coming year, identifying areas for specific activities, promoting the ISOE programme, and providing direction to its sub-groups.

ISOE Working Group on Data Analysis

The Working Group on Data Analysis (WGDA), or the Technical Centres as appropriate, will:

- Continue to review the completeness and quality of ISOE data collection.

- Undertake and disseminate identified technical analyses of use to the ISOE membership, and contribute to the development of the ISOE Annual Report.
- Validate the online help/user's guide for the ISOEDAT web-enabled data entry module.
- Elaborate technical proposals and implement approved modifications to ISOEDAT to enhance data collection and analysis from nuclear power plants which are in shut-down or some stage of decommissioning.
- Elaborate technical proposals and implement approved enhancements to the ISOEDAT data analysis functions through implementation of a new query system.
- Perform other technical analysis as directed by the Management Board, based on end-user feedback and in support of the ISOE Annual Reports.
- Consider development of a survey on the use of zinc injection to reduce source terms.

Ad-hoc Expert Group on the Revision of the BSS

The Ad-hoc Expert Group on the Revision of the BSS will meet as appropriate to review drafts of the revised International Basic Safety Standards from the perspective of good practice in occupational radiation protection, according to availability of drafts (as provided by the ISOE Joint Secretariat) and opportunities to provided any comments into the revision process through the established NEA/CRPPH review process (as one of the BSS co-sponsoring organisations).

Joint NEA/CRPPH-ISOE Activities: Expert Group on Occupational Exposure

The EGOE was created by the NEA's Committee on Radiation Protection and Public Health (CRPPH), with an invitation to ISOE to participate in its activities. ISOE members will continue to participate in EGOE according to the meeting schedule established by the EGOE.

Schedule of Meetings for 2009

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

ISOE Meetings for 2009 *(excluding ad-hoc meetings)*	May	November
Technical Centre Coordination meeting	×	×
ISOE Bureau	×	×
Working Group on Data Analysis	×	×
19th ISOE Management Board Meeting (Paris)		×

ISOE Publications and Reports

The following ISOE publications and reports will be produced and published in 2008. Products will be made available through the ISOE Network as appropriate.

- **ISOE Annual Report 2007:** Publish the 17th Annual Report (2007) in September 2008.
- **ISOE Terms and Conditions:** Implement the revised ISOE Terms and Conditions (2008-2011).
- **ISOE News:** Continue to electronically issue current ISOE information through the ISOE News, according to ISOE Steering Group decision on frequency of publication.
- **ISOE Symposia Proceedings:** ETC will update the ISOE Network with available symposia proceedings and presentations, as provided to the ETC by each centre.
- **Report:** Work Management to Optimise Occupational Radiological Protection at Nuclear Power Plants.

- **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:** Publish ISOE Brochure and develop and electronic version linked to detailed information on the ISOE Network.

3) ISOE ALARA Symposium

International Symposia

- 2009 ISOE International ALARA Symposium, Vienna, Austria
(12-15 October 2009), organised by IAEA.
- 2010 ISOE International ALARA Symposium, Cambridge, United Kingdom
(17-19 November 2010), organised by ETC.

Regional Symposia

- 2009 ISOE North American ALARA Symposium, Ft. Lauderdale, United States
(12-14 January 2009), organised by NATC.
- 2009 ISOE Asian Regional Symposium, Japan
(Autumn 2009), organised by ATC.

4) ISOE Network Website Management and Technical Centre input

Network Website Management

The redesigned ISOE Network website and ISOEDAT data input module will be implemented. Development and implementation of ISOE Network website enhancements will continue subject to Management Board guidance. Training sessions on the use of the ISOE Network tools will be organised to meet user needs (organised by the ETC on request).

Technical Centre Input for the ISOE Network

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. The ETC will continue to produce synthesis documents of requests posted on the website Forum and those received by e-mail. These documents will also be posted on the website Forum and attached to the request.

5) Information sheets, technical reports and information exchange

Technical Centre Information Sheets planned for 2009		
Yearly analyses	**ATC**	**ETC**
Japanese Dosimetric Results: FY 2008 Data and Trends	×	
Japanese Occupational Exposure During Periodical Inspection at PWRs & BWRs in FY 2008	×	
Korea (Republic of): Summary of National Dosimetric Trends 2008	×	
European Dosimetric Results of 2008		×
Special analyses		
Analysis of the evolution of outage duration		×
Update of Steam Generators Replacements dosimetric results		×

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 globally, according to the access privileges as utility or authority member.

Other new technical centre documents and reports

ETC will prepare a document presenting an analysis of the completeness of the ISOE1 database.

6) ISOE-organised benchmarking visits

The following site benchmarking visits will be organised under ISOE in 2008 by the technical centres in coordination with the ISOE WGDA and Management Board:

Benchmarking Visits for 2009	
ETC	None planned under ISOE. CEPN-EDF visits will be organised using ISOE contacts, but not ISOE finances (e.g., Doel NPP (Belgium) in January 2009)
IAEATC	Benchmarking visits between CANDUs to be investigated.

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 Cooperation Projects to IAEA Member States (non-OECD countries)

Appendix 2

LIST OF ISOE PUBLICATIONS

Reports

1. *Work Management to Optimise Occupational Radiological Protection at Nuclear Power Plants,* OECD, 2009.
2. *Occupational Exposures at Nuclear Power Plants: Seventeenth Annual Report of the ISOE Programme*, *2007*, OECD, 2009.
3. *Occupational Exposures at Nuclear Power Plants: Sixteenth Annual Report of the ISOE Programme*, *2006*, OECD, 2008.
4. *Occupational Exposures at Nuclear Power Plants: Fifteenth Annual Report of the ISOE Programme*, *2005*, OECD, 2007.
5. *Occupational Exposures at Nuclear Power Plants: Fourteenth Annual Report of the ISOE Programme*, *2004*, OECD, 2006.
6. *Occupational Exposures at Nuclear Power Plants: Thirteenth Annual Report of the ISOE Programme*, *2003*, OECD, 2005.
7. *Optimisation in Operational Radiation Protection*, OECD, 2005.
8. *Occupational Exposures at Nuclear Power Plants: Twelfth Annual Report of the ISOE Programme*, *2002*, OECD, 2004.
9. *Occupational Exposure Management at Nuclear Power Plants: Third ISOE European Workshop, Portoroz, Slovenia*, *17-19 April 2002*, OECD 2003.
10. *ISOE – Information Leaflet*, OECD 2003.
11. *Occupational Exposures at Nuclear Power Plants: Eleventh Annual Report of the ISOE Programme*, *2001*, OECD, 2002.
12. *ISOE – Information System on Occupational Exposure*, *Ten Years of Experience*, OECD, 2002.
13. *Occupational Exposures at Nuclear Power Plants: Tenth Annual Report of the ISOE Programme, 2000*, OECD, 2001.
14. *Occupational Exposures at Nuclear Power Plants: Ninth Annual Report of the ISOE Programme, 1999*, OECD, 2000.
15. *Occupational Exposures at Nuclear Power Plants: Eighth Annual Report of the ISOE Programme*, *1998,* OECD, 1999.
16. *Occupational Exposures at Nuclear Power Plants: Seventh Annual Report of the ISOE Programme*, *1997*, OECD, 1999.
17. *Work Management in the Nuclear Power Industry*, OECD, 1997 (also available in Chinese, German, Russian and Spanish).
18. *ISOE – Sixth Annual Report: Occupational Exposures at Nuclear Power Plants: 1969-1996*, OECD, 1998.
19. *ISOE – Fifth Annual Report: Occupational Exposures at Nuclear Power Plants: 1969-1995*, OECD, 1997.
20. *ISOE – Fourth Annual Report: Occupational Exposures at Nuclear Power Plants: 1969-1994*, OECD, 1996.

21. *ISOE – Third Annual Report: Occupational Exposures at Nuclear Power Plants: 1969-1993*, OECD, 1995.
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23. *ISOE – Nuclear Power Plant Occupational Exposures in OECD Countries: 1969-1991*, OECD, 1993.

ISOE News

No. 12:	October 2008	No. 6:	June 2005
No. 11:	Dec 2007	No. 5:	April 2005
No. 10:	July 2007	No. 4:	December 2004
No. 9:	March 2006	No. 3:	July 2004
No. 8:	December 2005	No. 2:	March 2004
No. 7:	October 2005	No. 1:	December 2003

ISOE Information Sheets

Asian Technical Centre

No. 31	November 2007	Korea, Republic of; summary of national dosimetric trends
No. 30	October 2007	Japanese dosimetric results: FY 2006 data and trends
No. 29	November 2006	Japanese Dosimetric Results: FY 2005 Data and Trends
No. 28	November 2005	Japanese Dosimetric Results: FY 2004 Data and Trends
No. 27	November 2004	Achievements and Issues in Radiation Protection in the Republic of Korea
No. 26	November 2004	Japanese occupational exposure during periodic inspection at PWRs and BWRs ended in FY 2003
No. 25	November 2004	Japanese dosimetric results: FY2003 data and trends
No. 24	October 2003	Japanese Occupational Exposure of Shroud Replacements
No. 23	October 2003	Japanese Occupational Exposure of Steam Generator Replacements
No. 22	October 2003	Korea, Republic of; Summary of national dosimetric trends
No. 21	October 2003	Japanese occupational exposure during periodic inspection at PWRs and BWRs ended in FY 2002
No. 20	October 2003	Japanese dosimetric results: FY2002 data and trends
No. 19	October 2002	Korea, Republic of; Summary of national dosimetric trends
No. 18	October 2002	Japanese occupational exposure during periodic inspection at PWRs and BWRs ended in FY 2001
No. 17	October 2002	Japanese dosimetric results: FY2001 data and trends
No. 16	October 2001	Japanese occupational exposure during periodical inspection at PWRs and BWRs ended in FY 2000
No. 15	October 2001	Japanese Dosimetric results: FY 2000 data and trends
No. 14	September 2000	Japanese Occupational Exposure During Periodical Inspection at LWRs Ended in FY 1999
No. 13	September 2000	Japanese Dosimetric Results: FY 1999 Data and Trends
No. 12	October 1999	Japanese Occupational Exposure During Periodical Inspection at LWRs Ended in FY 1998
No. 11	October 1999	Japanese Dosimetric Results: FY 1998 Data and Trends
No. 10	November 1999	Experience of 1st Annual Inspection Outage in an ABWR
No. 9	October 1999	Replacement of Reactor Internals and Full System Decontamination at a Japanese BWR
No. 8	October 1998	Japanese Occupational Exposure During Periodical Inspection at LWRs Ended in FY 1997
No. 7	October 1998	Japanese Dosimetric Results: FY 1997 data

No. 6	September 1997	Japanese Occupational Exposure during Periodical Inspection at LWRs ended in FY 1996
No. 5	September 1997	Japanese Dosimetric Results: FY 1996 data
No. 4	July 1996	Japanese Occupational Exposure during Periodical Inspection at LWRs ended in FY 1995
No. 3	July 1996	Japanese Dosimetric Results: FY 1995 data
No. 2	October 1995	Japanese Occupational Exposure during Periodical Inspection at LWRs ended in FY 1994
No. 1	October 1995	Japanese Dosimetric Results: FY 1994 data

European Technical Centre

No. 47		2007 European dosimetric results
No. 46	October 2007	European dosimetric results for 2006
No. 44	July 2006	Preliminary European dosimetric results for 2005
No. 43	May 2006	Conclusions and recommendations from the Essen Symposium
No. 42	November 2005	Self-employed Workers in Europe
No. 41	October 2005	Update of the annual outage duration and doses in European reactors (1994-2004)
No. 40	August 2005	Workers internal contamination practices survey
No. 39	July 2005	Preliminary European dosimetric results for 2004
No. 38	November 2004	Update of the annual outage duration and doses in European reactors (1993-2003)
No. 37	July 2004	Conclusions and recommendations from the 4th European ISOE workshop on occupational exposure management at NPPs
No. 36	October 2003	Update of the annual outage duration and doses in European reactors (1993-2002)
No. 35	July 2003	Preliminary European dosimetric results for 2002
No. 34	July 2003	Man-Sievert monetary value survey (2002 update)
No. 33	March 2003	Update of the annual outage duration and doses in European reactors (1993-2001)
No. 32	November 2002	Conclusions and Recommendations from the 3rd European ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants
No. 31	July 2002	Preliminary European Dosimetric Results for the year 2001
No. 30	April 2002	Occupational exposure and steam generator replacements – update
No. 29	April 2002	Implementation of Basic Safety Standards in the regulations of European countries
No. 28	December 2001	Trends in collective doses per job from 1995 to 2000
No. 27	October 2001	Annual outage duration and doses in European reactors
No. 26	July 2001	Preliminary European Dosimetric Results for the year 2000
No. 25	June 2000	Conclusions and recommendations from the 2nd EC/ISOE workshop on occupational exposure management at nuclear power plants
No. 24	June 2000	List of BWR and CANDU sister unit groups
No. 23	June 2000	Preliminary European Dosimetric Results 1999
No. 22	May 2000	Analysis of the evolution of collective dose related to insulation jobs in some European PWRs
No. 21	May 2000	Investigation on access and dosimetric follow-up rules in NPPs for foreign workers
No. 20	April 1999	Preliminary European Dosimetric Results 1998
No. 19	October 1998	ISOE 3 data base – New ISOE 3 Questionnaires received (since Sept 1998)
No. 18	September 1998	The Use of the man-Sievert monetary value in 1997
No. 17	December 1998	Occupational Exposure and Steam Generator Replacements, update
No. 16	July 1998	Preliminary European Dosimetric Results for 1997
No. 15	September 1998	PWR collective dose per job 1994-1995-1996 data
No. 14	July 1998	PWR collective dose per job 1994-1995-1996 data
No. 12	September 1997	Occupational exposure and reactor vessel annealing

No. 11	September 1997	Annual individual doses distributions: data available and statistical biases
No. 10	June 1997	Preliminary European Dosimetric Results for 1996
No. 9	December 1996	Reactor Vessel Closure Head Replacement
No. 7	June 1996	Preliminary European Dosimetric Results for 1995
No. 6	April 1996	Overview of the first three Full System Decontamination
No. 4	June 1995	Preliminary European Dosimetric Results for 1994
No. 3	June 1994	First European Dosimetric Results: 1993 data
No. 2	May 1994	The influence of reactor age and installed power on collective dose: 1992 data
No. 1	April 1994	Occupational Exposure and Steam Generator Replacement

IAEA Technical Centre

No. 9	August 2003	Preliminary dosimetric results for 2002
No.8	November 2002	Conclusions and Recommendations from the 3rd European ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants
No. 7	October 2002	Information on exposure data collected for the year 2001
No. 6	June 2001	Preliminary dosimetric results for 2000
No. 5	September 2000	Preliminary dosimetric results for 1999
No. 4	April 1999	IAEA Workshop on implementation and management of the ALARA principle in nuclear power plant operations, Vienna 22-23 April 1998
No. 3	April 1999	IAEA technical co-operation projects on improving occupational radiation protection in nuclear power plants
No. 2	April 1999	IAEA Publications on occupational radiation protection
No. 1	October 1995	ISOE Expert meeting

North American Technical Centre

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

ISOE International and Regional Symposia

Asian Technical Centre

November 2008	Tsuruga, Japan	2008 ISOE International ALARA Symposium
September 2007	Seoul, Korea	2007 ISOE Asian Regional ALARA Symposium
October 2006	Yuzawa, Japan	2006 ISOE Asian Regional ALARA Symposium
November 2005	Hamaoka, Japan	First Asian ALARA Symposium

European Technical Centre

June 2008	Turku, Finland	2008 ISOE European Regional ALARA Symposium
March 2006	Essen, Germany	2006 ISOE International ALARA Symposium
March 2004	Lyon, France	Fourth ISOE European Workshop on Occupational Exposure Management at Nuclear Power Plants
April 2002	Portoroz, Slovenia	Third ISOE European Workshop on Occupational Exposure Management at Nuclear Power Plants
April 2000	Tarragona, Spain	Second EC/ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants
September 1998	Malmö, Sweden	First EC/ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants

North American Technical Centre

January 2008	Ft. Lauderdale, FL, USA	2008 ISOE North American ALARA Symposium
January 2007	Ft. Lauderdale, FL, USA	2007 ISOE International ALARA Symposium
January 2006	Ft. Lauderdale, FL, USA	2006 ISOE North American ALARA Symposium
January 2005	Ft. Lauderdale, FL, USA	2005 ISOE International ALARA Symposium
January 2004	Ft. Lauderdale, FL, USA	2004 North American ALARA Symposium
January 2003	Orlando, FL, USA	2003 International ALARA Symposium
February 2002	Orlando, FL, USA	North-American National ALARA Symposium
February 2001	Orlando, FL, USA	2001 International ALARA Symposium
January 2000	Orlando, FL, USA	North-American National ALARA Symposium
January 1999	Orlando, FL, USA	Second International ALARA Symposium
March 1997	Orlando, FL, USA	First International ALARA Symposium

Appendix 3

STATUS OF ISOE PARTICIPATION UNDER THE RENEWED ISOE TERMS AND CONDITIONS (2008-2011)

Note: This appendix provides the status of ISOE official participation as of time of publication of this report (February 2010)

Officially Participating Utilities: Operating reactors

Country	Utility[1]	Plant name	
Armenia	Armenian (Medzamor) NPP	Medzamor 2	
Belgium	Electrabel	Doel 1, 2, 3, 4	Tihange 1, 2, 3
Brazil	Eletronuclear A/S	Angra 1, 2	
Bulgaria	Nuclear Power Plant Kozloduy	Kozloduy 5, 6	
Canada	Bruce Power Hydro Quebec New Brunswick Power Ontario Power Generation	Bruce A1, A2, A3, A4 Gentilly 2 Pt. Lepreau Darlington 1, 2, 3, 4	Bruce B5, B6, B7, B8 Pickering A1, A2, A3, A4 Pickering B5, B6, B7, B8
China	Guangdong Nuclear Power Joint Venture Co., Ltd Ling Ao Nuclear Power Co. Ltd	Daya Bay 1, 2 Ling Ao 1, 2	
Czech Republic	CEZ	Dukovany 1, 2, 3, 4 Temelin 1, 2	
Finland	Fortum Power and Heat Oy Teollisuuden Voima Oyj	Loviisa 1, 2 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

1. Where multiple owners and/or operators are involved, only Leading Undertakings are listed.

Country	Utility	Plant name	
Germany	E.ON Kernkraft GmbH	Brokdorf Grafenrheinfeld Grohnde	Isar 1, 2 Unterweser
	EnBW Kernkraft 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
Hungary	Magyar Villamos Muvek Zrt	Paks 1, 2, 3, 4	
Japan	Chubu Electric Power Co.	Hamaoka 1, 2, 3, 4, 5	
	Chugoku Electric Power Co.	Shimane 1, 2	
	Hokkaido Electric Power Co.	Tomari 1, 2, 3	
	Hokuriku Electric Power Co.	Shika 1,2	
	Japan Atomic Power Co.	Tokai 2	Tsuruga 1, 2
	Kansai Electric Power Co.	Mihama 1, 2, 3 Ohi 1, 2, 3, 4	Takahama 1, 2, 3, 4
	Kyushu Electric Power Co.	Genkai 1, 2, 3, 4	Sendai 1, 2
	Shikoku Electric Power Co.	Ikata 1, 2, 3	
	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
Korea	Korean Hydro and Nuclear Power	Kori 1, 2, 3, 4 Ulchin 1, 2, 3, 4, 5, 6	Wolsong 1, 2, 3, 4 Yonggwang 1, 2, 3, 4, 5, 6
Mexico	Comisiòn Federal de Electricidad	Laguna Verde 1, 2	
Romania	Societatea Nationala Nuclearelectrica	Cernavoda 1, 2	
Russian Federation	Energoatom Concern OJSC	Balakovo 1, 2, 3, 4 Kalinin 1, 2, 3 Kola 1, 2, 3, 4	Novovoronezh 3, 4, 5 Volgodonsk 1
Slovak Republic	JAVYS Slovenské Electrárne	JAVYS 1, 2 Bohunice 3, 4	Mochovce 1, 2
Slovenia	Nuklearna Elektrarna Krško	Krško 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 (FKA) OKG Aktiebolag (OKG) Ringhals AB (RAB)	Forsmark 1, 2, 3 Oskarshamn 1, 2, 3 Ringhals 1, 2, 3, 4	
Switzerland	Forces Motrices Bernoises (FMB)	Mühleberg	
	Kernkraftwerk Gösgen-Däniken (KGD)	Gösgen	
	Kernkraftwerk Leibstadt AG (KKL)	Leibstadt	
	Axpo AG	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 Generation Ltd.	Sizewell B	

Country	Utility	Plant name	
United States	American Electric Power Co.	D.C. Cook 1, 2	
	Constellation Energy Group	Calvert Cliffs 1, 2 Ginna	Nine Mile Point 1, 2
	Exelon Corporation	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 Point Beach 1, 2 Seabrook	St. Lucie 1, 2 Turkey Point 3, 4
	PPL Susquehanna, LLC	Susquehanna 1, 2	
	South Carolina Electric Co.	Virgil C. Summer 1	
	Southern Nuclear Operating Co.	Vogtle 1, 2	
	Tennessee Valley Authority (TVA)	Browns Ferry 1, 2, 3 Sequoyah 1, 2	Watts Bar 1
	XCel Energy	Monticello	

Officially participating utilities: definitively shutdown reactors

Country	Utility	Plant name	
Bulgaria	Nuclear Power Plant Kozloduy	Kozloduy 1, 2, 3, 4	
Canada	Hydro Quebec Ontario Power Generation	Gentilly 1 NPD	
France	Électricité de France (EDF)	Bugey 1 Chinon A1, A2, A3	Chooz A St. Laurent A1, A2
Germany	E.ON Kernfraft GmbH EnBW Kernkraft AG Energiewerke Nord GmbH RWE Power AG	Würgassen Obrigheim AVR Jülich Mülheim-Kärlich	Stade
Italy	SOGIN	Caorso Garigliano	Latina Trino
Japan	Japan Atomic Energy Agency Japan Atomic Power Co.	Fugen (LWCHWR) Tokai 1	
Lithuania	Ignalina Nuclear Power Plant	Ignalina 1, 2 (Ignalina 2 shutdown 2009/12/31)	
Russian Federation	Energoatom Concern OJSC	Novovoronezh 1, 2	
Spain	UNESA	Jose Cabrera	Vandellos 1
Sweden	Barsebäck Kraft AB (BKAB)	Barsebäck 1, 2	
The Netherlands	BV GKN	Dodewaard	
Ukraine	Ministry of Ukraine of Emergencies and Affairs of Population Protection from the Consequences of Chornobyl Catastrophe	Chernobyl 1, 2, 3	
United States	Exelon Corporation	Dresden 1 Peach Bottom 1	Zion 1, 2

Participating regulatory authorities

Country	Authority
Armenia	Armenian Nuclear Regulatory Authority (ANRA)
Belgium	Federal Agency for Nuclear Control
Brazil	Comissão Nacional de Energia Nuclear
Bulgaria	Bulgarian Nuclear Regulatory Agency
Canada	Canadian Nuclear Safety Commission
Czech Republic	State Office for Nuclear Safety
Finland	Säteilyturvakeskus (STUK)
France	Autorité de sûreté nucléaire (ASN) 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
Japan	Ministry of Economy, Trade and Industry (METI)
Korea	Ministry of Education, Science and Technology (MEST) 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 Nuclear Regulatory Authority
Romania	National Commission for Nuclear Activities Control (CNCAN)
Slovak Republic	Public Health Authority of the Slovak Republic
Slovenia	Slovenian Nuclear Safety Administration (SNSA) Slovenian Radiation Protection Administration (SRPA)
Spain	Consejo de Seguridad Nuclear
Sweden	Swedish Radiation Safety Authority
Switzerland	Swiss Federal Nuclear Safety Inspectorate (ENSI)
Ukraine	State Nuclear Regulatory Committee of Ukraine
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, Rep. of	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: ATC: Asian Technical Centre; IAEATC: IAEA Technical Centre
ETC: European Technical Centre; NATC: North American Technical Centre

ISOE Network and 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)
- United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)

Appendix 4

ISOE BUREAU, SECRETARIAT AND TECHNICAL CENTRES

Bureau of the ISOE Steering Group

	2007	2008	2009	2010
Chairperson (Utilities)	MIZUMACHI, Wataru Japan Nuclear Energy Safety Organisation Japan		SIMIONOV, Vasile Cernavoda NPP Romania	
Chairperson Elect (Utilities)	SIMIONOV, Vasile Cernavoda NPP Romania		ABELA, Gonzague EDF France	
Vice-Chairperson (Authorities)	RIIHILUOMA, Veli Finnish Centre for Radiation and Nuclear Safety (STUK) Finland		HOLAHAN, Vincent US Nuclear Regulatory Commission United States	
Past Chairperson (Utilities)	GAGNON, Jean-Yves Centrale Nucleaire Gentilly-2 Canada		MIZUMACHI, Wataru Japan Nuclear Energy Safety Organisation Japan	

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Appendix 5

ISOE WORKING GROUPS (2008, 2009)

ISOE Working Group on Data Analysis (WGDA)

Chair: ZORRILLA, Sergio (Mexico) – **Vice-Chair:** KAULARD, Jorg (Germany)

Belgium	
PETIT, Philippe	Electrabel
Canada	
DJEFFAL, Salah	Canadian Nuclear Safety Commission
GAGNON, Jean-Yves	Centrale Nucleaire Gentilly-2
Czech Republic	
FARNIKOVA, Monika	Temelin NPP
KOC, Josef	Temelin NPP
France	
ABELA, Gonzague	EDF
BADAJOZ, Caroline	CEPN (ETC)
D'ASCENZO, Lucie	CEPN (ETC)
SCHIEBER, Caroline	CEPN (ETC)
Germany	
KAPTEINAT, Peter	VGB-PowerTech
KAULARD, Jorg	Gesellschaft für Anlagen-und Reaktorsicherheit mbH
STRUB, Erik	Gesellschaft für Anlagen-und Reaktorsicherheit mbH
TAYLOR, Thomas	VGB-PowerTech
Japan	
HAYASHIDA, Yoshihisa	Japan Nuclear Energy Safety Organization (ATC)
MIZUMACHI, Wataru	Japan Nuclear Energy Safety Organization (ATC)
Korea (Republic Of)	
CHOI, Won-Chul	Korea Institute of Nuclear Safety (KINS)
Mexico	
ZORRILLA, Sergio H.	Central Laguna Verde
Romania	
SIMIONOV, Vasile	Cernovoda NPP
Russian Federation	
GLASUNOV, Vadim	Russian Research Institute for Nuclear Power Plant Operation (VNIIAES)
Slovenia	
BREZNIK, Borut	Krsko NPP
Spain	
GARROTE PEREZ, Fernando	TECNATOM
GOMEZ-ARGUELLO GORDILLO, Beatriz	TECNATOM
LABARTA, Teresa	Consejo de Seguridad Nuclear
Sweden	
HENNIGOR, Staffan	Forsmarks Kraftgrupp AB
SVEDBERG, Torgny	Ringhals AB

United States of America	
DOTY, Rick	PPL Susquehanna LLC
HAGEMEYER, Derek	Oak Ridge Associated Universities (ORAU)
HOLAHAN, Vincent	US Nuclear Regulatory Commission
LEWIS, Doris	US Nuclear Regulatory Commission
MILLER, David .W.	D.C. Cook Plant (NATC)

WGDA Expert Group on Work Management

Chair: MIZUMACHI, Wataru (Japan)

France	
ABELA, Gonzague	EDF
BERTIN, Hélène	EDF
DROUET, François	CEPN (ETC)
SCHIEBER, Caroline	CEPN (ETC)
Germany	
STEINEL, Dieter	Philippsburg NPP
Japan	
HAYASHIDA, Yoshihisa	Japan Nuclear Energy Safety Organization (ATC)
MIZUMACHI, Wataru	Japan Nuclear Energy Safety Organization (ATC)
SUGAYA, Junko	Japan NUS Co., Ltd
Korea (Republic of)	
CHOI, Won-Chul	Korea Institute of Nuclear Safety (KINS)
Mexico	
ZORRILLA, Sergio H.	Central Laguna Verde
Romania	
SIMIONOV, Vasile	Cernovoda NPP
Russian Federation	
GLASUNOV, Vadim	Russian Research Institute for Nuclear Power Plant Operation (VNIIAES)
Slovenia	
BREZNIK, Borut	Krsko NPP
Spain	
GARROTE PEREZ, Fernando	TECNATOM
Sweden	
HENNIGOR, Staffan	Forsmarks Kraftgrupp AB
United Kingdom	
LUNN, Matthew	Sizewell B NPP
RENN, Guy	Sizewell B NPP
United States of America	
DOTY, Rick	PPL Susquehanna LLC
HUNSICKER, John	VC Summer NGS
MILLER, David .W.	D.C. Cook Plant (NATC)
OHR, Ken	Quad Cities NGS

WGDA Task Team on Decommissioning

Chair: KAULARD, Jorg (Germany)

Armenia	
AVETISYAN, Aida	Armenian Nuclear Regulatory Authority (ANRA)
France	
CROUAIL, Pascal	CEPN (ETC)
Germany	
JURETZKA, Peter	Stade NPP
KAULARD, Jorg	Gesellschaft für Anlagen-und Reaktorsicherheit mbH

Japan	
HAYASHIDA, Yoshihisa	Japan Nuclear Energy Safety Organization (ATC)
MIZUMACHI, Wataru	Japan Nuclear Energy Safety Organization (ATC)
Mexico	
ZORRILLA, Sergio H.	Central Laguna Verde
Romania	
SIMIONOV, Vasile	Cernovoda NPP
Spain	
ORTIZ RAMIS, Maria Teresa	ENRESA
Sweden	
LINDVALL, Carl Göran	Barsebäck Kraft AB
LORENTZ, Hakan	Barsebäck Kraft AB
United States of America	
MILLER, David W.	D.C. Cook Plant (NATC)

Appendix 6

ISOE MANAGEMENT BOARD AND NATIONAL CO-ORDINATORS (2008, 2009)[1]

Note: ISOE National Co-ordinators identified in **bold**.

Armenia	
ATOYAN, Vovik	Armenian Nuclear Power Plant Company
AVETISYAN, Aida	Armenian Nuclear Regulatory Authority
Belgium	
PETIT, Philippe *(until Sept. 2009)*	Electrabel (Tihange NPP)
NGUYEN Thanh Trung *(from Sept. 2009)*	Electrabel (Tihange NPP)
SCHRAYEN, Virginie	FANC-Federal Agency for Nuclear Control
Brazil	
do AMARAL, Marcos Antônio	Angra 1 & 2 NPP
Bulgaria	
VALTCHEV, Georgi	Kozloduy Nuclear Power Plant
KATZARSKA, Lidia	Bulgarian Nuclear Regulatory Agency
Canada	
TRAHAN, Chris	Bruce Power
DJEFFAL, Salah	Canadian Nuclear Safety Commission
GAGNON, Jean-Yves	Centrale Nucleaire Gentilly-2
VILLEMAIRE, Mike	Pickering NPP
China	
LI, Ruirong	Daya Bay NPS
Czech Republic	
KOC, Josef *(until Sept. 2009)*	Temelin NPP, CEZ a.s.
FARNIKOVA, Monika *(from Sept. 2009)*	Temelin NPP, CEZ a.s.
URBANCIK, Libor	State Office for Nuclear Safety (SUJB)
Finland	
KONTIO, Timo	FortumPower and Heat Oy
RIIHILUOMA, Veli	Centre for Radiation and Nuclear Safety, STUK
France	
ABELA, Gonzague	EDF
GARCIER, Yves	EDF
CORDIER, Gerard	EDF
COUASNON, Olivier	IRSN
CHEVALIER, Sophie	ASN
D’ASCENZO, Lucie	CEPN (ETC)
SCHIEBER, Caroline	CEPN (ETC)

1. The number of names listed in the Management Board does not necessarily reflect the number of votes allocated to a particular country according to the ISOE Terms and Conditions.

Germany	
KAPTEINAT, Peter *(until April 2009)*	VGB-PowerTech
TAYLOR, Thomas *(from April 2009)*	VGB-PowerTech
BASCHNAGEL, Michael	RWE Power AG, Kraftwerk Biblis
FRASCH, Gerhard	Bundesamt für Strahlenschutz
KAULARD, Joerg	Gesellschaft fuer Anlagen-und Reaktorsicherheit mbH
Hungary	
BUJTAS, Tibor	PAKS Nuclear Power Plant Ltd.
Italy	
ZACCARI, Vincenzo *(until Jan. 2009)*	SOGIN Spa
MANCINI, Francesco ***(**from Jan. 2009)*	SOGIN Spa
SGRILLI, Enrico	APAT
Japan	
HAYASHIDA, Yoshihisa	Japan Nuclear Energy Safety Organization (ATC)
KOBAYASHI, Masahide	Japan Nuclear Energy Safety Organization (ATC)
MIZUMACHI, Wataru	Japan Nuclear Energy Safety Organization (ATC)
SUZUKI, Akira	Tokyo Electric Power Company
TSUJI, Masatoshi	Nuclear and Industrial Safety Agency (NISA)
YONEMARU, Kenichi	Kyushu Electric Power Company
KoreA (Republic of)	
CHOI, Won-Chul	Korea Institute of Nuclear Safety (KINS)
An, Yong Min	Korea Hydro and Nuclear Power. Co. Ltd
Mr. Hee-hwan Lee	Korea Hydro and Nuclear Power. Co. Ltd
Lithuania	
PLETNIOV, Victor	Ignalina Nuclear Power Plant
BALCYTIS, Gintautas	Radiation Protection Centre
Mexico	
ZORRILLA, Sergio H.	Central Laguna Verde
The Netherlands	
MEERBACH, Antonius *(until Mar 2009)*	NV EPZ
MEIJER, Hans *(from Mar 2009)*	NV EPZ
VAN DER WERF, Bob *(until Nov. 2008)*	Ministry For Environment
BREAS, Gerard *(from Nov. 2008)*	Ministry For Environment
Pakistan	
NASIM, Bushra	Pakistan Nuclear Regulatory Authority
Romania	
SIMIONOV, Vasile	CNE-PROD Cernavoda NPP
RODNA, Alexandru	National Commission for Nuclear Activities Control
VELICU, Oana	National Commission for Nuclear Activities Control
Russian Federation	
BEZRUKOV, Boris	Concern ROSENERGOATOM
GLASUNOV, Vadim	Russian Research Institute for Nuclear Power Plant Operation (VNIIAES)
Slovak Republic	
DOBIS, Lubomir	Bohunice NPP
VIKTORY, Dusan	Public Health Institute of the Slovak Republic
Slovenia	
BREZNIK, Borut	Krsko NPP
JANZEKOVIC, Helena	Slovenian Nuclear Safety Administration
JUG, Nina	Slovenian Radiation Protection Administration
South Africa (Republic of)	
MAREE, Marc	Koeberg NPS

Spain	
GOMEZ-ARGUELLO GORDILLO, Beatriz	TECNATOM
GARROTE PEREZ, Fernando	TECNATOM
LABARTA, Teresa	Consejo de Seguridad Nuclear
ROSALES CALVO, Maria Luisa	Consejo de Seguridad Nuclear
Sweden	
SVEDBERG, Torgny	Ringhals AB
FRITIOFF, Karin *(from Oct. 2009)*	Swedish Radiation Safety Authority
LINDVALL, Carl Göran	Barsebäck Kraft AB
LUND, Ingemar *(until Oct. 2009)*	Swedish Radiation Safety Authority
SOLSTRAND, Christer	Oskarsham
Switzerland	
JAHN, Swen-Gunnar	HSK, Swiss Nuclear Safety Inspectorate
Ukraine	
LISOVA, Tetyana	Department of Nuclear Energy
United Kingdom	
RENN, Guy	Sizewell B Power Station
ZODIATES, Tasos	Sizewell B Power Station
United States of America	
MILLER, David .W.	D.C. Cook Plant (NATC)
DOTY, Richard	PPL Susquehanna, LLC
GREEN, Bill	Clinton Power Station
HOLAHAN, E. Vincent	U.S. Nuclear Regulatory Commission
LEWIS, Doris	U.S. Nuclear Regulatory Commission
DALY, Patrick	Exelon
OHR, Kenneth	Exelon

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