SRDP-PR28

UK SAFEGUARDS SUPPORT PROGRAMME

Report on Activities and Progress during the period 1 April 2007 to 31 March 2008

J W A Tushingham

July 2008

UK Safeguards Support for the IAEA

The Safeguards Programme Letter is managed by the UKAEA on behalf of the UK Department for Business, Enterprise and Regulatory Reform. Further information may be obtained from the Manager, Safeguards Programme Letter, UKAEA, The Manor Court, Chilton, Oxfordshire OX11 0RN.

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The results of this work may be used in the formulation of UK Government policy, but the views expressed in this report do not necessarily represent UK Government policy.

United Kingdom Atomic Energy Authority
The Manor Court
Chilton
Oxfordshire OX11 0RN
Tel: +44 1235-43-1840
Fax: +44 1235-43-1826

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EXECUTIVE SUMMARY

The UK Safeguards Support Programme (UKSP) was established in 1981, to provide technical support to the Department of Safeguards of the International Atomic Energy Agency (IAEA) in ensuring the peaceful use of nuclear energy. The UKSP contributes to the Department of Safeguards:

- expertise and advice for the further development of safeguards strategies in new and existing activities and plant in the nuclear fuel cycle;
- services to support the IAEA in analysing nuclear material arising from samples taken in the course of safeguards inspections;
- access to facilities and experts for the training of Agency personnel in advanced techniques applied in safeguards inspections and on fuel cycle plants;
- development of techniques, methods and procedures for safeguarding facilities in the nuclear fuel cycle;
- development and assessment of equipment, instruments and methods for application in safeguarding the nuclear fuel cycle; and
- assistance through the provision of expert staff to complete specialised programmes of work that cannot be resourced through a permanent position with the IAEA.

During the period 1 April 2007 to 31 March 2008, the UKSP contributed to 20 active tasks within the Department of Safeguards R&D Programme, completing work on seven of these. 16 new task proposals were received during the year, of which eight were accepted and six remained pending at the year-end. Activities undertaken included:

- providing support to inspection activities through the analysis of 71 environmental swipe samples;
- continued development of open source information collection capabilities in support of strengthened safeguards; and
- the provision of six training courses, enabling 71 Agency personnel to gain an improved understanding of the nuclear fuel cycle and experience of UK nuclear facilities.

This report reviews the progress on those tasks active during 2007/2008 within the framework of the UKSP.

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J W A Tushingham
United Kingdom Atomic Energy Authority
The Manor Court, UK

INTRODUCTION

Nuclear safeguards are technical measures used to verify that States comply with their international Treaty obligations not to misuse nuclear materials for the manufacture of nuclear explosives. They are an essential part of the nuclear non-proliferation regime. The International Atomic Energy Agency (IAEA) is charged with establishing and administering an international safeguards system to provide assurances that civil nuclear material is used for peaceful purposes.

The United Kingdom Support Programme to IAEA Safeguards (UKSP) is part of the UK contribution to the maintenance of the international safeguards regime, with the aim to assist the IAEA in ensuring the continued and improved effectiveness of its safeguards system.

The UKSP is funded by the UK Department for Business, Enterprise and Regulatory Reform (BERR) and administered on its behalf by the United Kingdom Atomic Energy Authority (UKAEA). A range of contractors undertake work on behalf of the UKSP, which was initiated by the UK Government in 1981 with the following formal objectives:

- to assist the IAEA in the provision of efficient and effective solutions to identified safeguards needs as set out in the IAEA's Safeguards Research and Development Programme;
- to provide the IAEA with essential services and training which are not commercially available or cannot be provided from the Agency's own resources;
- to develop techniques and methods for safeguarding facilities in the fuel cycle, particularly reprocessing plants and enrichment plants;
- to develop techniques and methods for the application of safeguards in general situations; and
- to provide the IAEA with cost-free consultancy, particularly on systems analysis.

Assistance is provided to the IAEA Department of Safeguards in six areas of technical support:

- Area A, Safeguards Strategies;
- Area B, Support for IAEA Analytical Services;
- Area C, Training Courses;
- Area D, Safeguards Procedures;
- Area E, Instrument Development and Assessment; and

- Area F, Consultants and Cost-Free Experts.

This report provides a summary of the progress against specific tasks in each of these six areas during the period 1 April 2007 to 31 March 2008.

AREA A – SAFEGUARDS STRATEGIES

Many of the requests for support to the IAEA are concerned with novel methods and techniques aimed at strengthening safeguards activities. As part of a strengthened safeguards system, the IAEA requires increased amounts and types of information on States' nuclear and nuclear-related activities. This information includes that provided directly by States (e.g. INFCIRC/540 Article 2 declarations), that collected by the IAEA (e.g. environmental sampling data) and other information available to the IAEA (e.g. open source literature and satellite imagery). The information is used to identify any inconsistency between a State's declaration and information available from other sources concerning a State's nuclear activities.

Task Area A5 - Environmental Sampling

Environmental sampling was introduced in 1996 as an IAEA measure to contribute to safeguards conclusions on the absence of undeclared activities at facilities. Collection of environmental samples at nuclear sites by Inspectors, combined with ultra-sensitive measurement techniques, can reveal signatures of past and present activities at locations where nuclear material is handled. These signatures can be used to corroborate the status of declared activities, or to detect undeclared activities.

Task A5(b) - Special Analyses of Environmental Samples Supplied by IAEA

IAEA SP-1 No:	96/XXX-010	**UK Sub-contractors:**	a) AWE Aldermaston b) QinetiQ
IAEA SPRICS No:	UK X01045	**UK Task Manager:**	a) C L Comley b) M R Houlton
IAEA Task Officer:	R Lafolie		

Background to Task

Current implementation of environmental sampling for safeguards focuses primarily on the collection of swipe samples inside enrichment plants and hot cell facilities. Samples are analysed by either bulk or particle analysis techniques, depending on the sampling objectives and the activity levels of the swipes. A Network of Analytical Laboratories (NWAL) for environmental samples has been set up by the IAEA, consisting of Member States' laboratories with particular expertise in techniques suited to environmental sampling. These laboratories complement the Agency's own in-house capabilities, and ensure sufficient analytical capacity to service the diversity of samples and analytical requirements. The NWAL also fulfils an important role by enabling routine inter-laboratory comparisons and cross checks on analytical results.

The UKSP provides the services of two laboratories within the IAEA NWAL for environmental samples. AWE Aldermaston provides fission track Thermal Ionisation Mass Spectrometry (fission track TIMS) analysis of particles, whilst QinetiQ provides a fast-turnaround particle analysis service using Resistive Anode Encoder - Secondary Ion Mass Spectrometry (RAE-SIMS). The two techniques are complementary, and both are routinely requested by the IAEA.

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Summary Report on Activities in 2007/2008

Three batches of IAEA swipe samples were received by AWE during 2007/2008, with a fourth carried over from the previous year. Using fission track analysis, particles containing fissile material were detected and selected for measurement by TIMS. The procedure involved removal of the particles from the swipe material, transfer onto a polycarbonate or lexan frame and irradiation with neutrons in a reactor. Particles containing fissile material were identified from the fission tracks that they produced.

Because fission-track analysis detects fissile material, the technique is more sensitive towards particles with a higher fissile content (for example, high-enriched uranium). This is desirable to the IAEA, because it enables the highest uranium enrichment on a swipe to be identified through measurement by TIMS of only a small number of particles. Particles selected on the basis of their fissile content were subsequently placed upon TIMS filaments and the isotopic composition of uranium and/or plutonium within the particles was determined by mass spectrometry. Additional information on particle morphology was derived from measurements using Scanning Electron Microscopy (SEM).

Including samples carried over from 2006/2007, results from a total of 12 samples were reported by AWE during 2007/2008, with the analysis of a further 3 samples continuing into 2008/2009. The analysis of additional samples was prevented by a prolonged period of maintenance of the reactor used for sample irradiation. The reactor was unavailable from September 2006 to May 2007, and its final closure was subsequently announced for end-March 2008. AWE sought alternative arrangements for sample irradiation, and identified two suitable reactors towards the year-end. Consequently, AWE is expected to be able to continue to provide a fission track TIMS service to the Agency during 2008/2009.

QinetiQ received 15 batches of samples during 2007/2008, for measurement of the uranium isotopic composition of individual particles. 59 samples were analysed by RAE-SIMS, compared with 55 in 2006/2007 and 39 in 2005/2006.

QinetiQ's work involved the recovery of particles from swipes using an ultrasonic technique[1], transfer of the particles to SIMS planchets and measurement. The measurement included an initial scan of all uranium-containing particles by RAE, often providing thousands of results, followed by a more detailed and accurate measurement of the uranium isotopic composition of individual particles of interest by Ion Microprobe (IM). During the initial scan, particles of uranium were identified and recorded with their size, relative locations and individual uranium isotope ratios using specialist software and hardware. More accurate measurement of individual particles was then undertaken using a tightly-focussed primary ion beam (microprobe operating mode) and an electron multiplier for the detector. A uranium swipe standard and sample blanks were analysed as part of the quality control procedure applied to each batch.

It is anticipated that the IAEA will continue to require the analysis of environmental swipe samples by both AWE Aldermaston and QinetiQ in 2008/2009.

[1] The alternative impactor particle extraction technique, developed by the Agency and transferred to QinetiQ under Task UK A01459/B1(n), was successfully implemented on the final batch of samples received from the Agency during 2007/2008.

Task Area A6 - Satellite Imagery in Support of Safeguards

The UKSP has provided assistance in the development of techniques employing satellite imagery for safeguards purposes - particularly for the identification of undeclared facilities and the identification of change in activities within facilities. This work, in addition to that carried out by the US, Germany and Canada, has proven a range of techniques and has confirmed the availability of suitable images on the commercial market for safeguards use.

Task A6(d) - Commercial Satellite Imagery Analysis and Photo Interpretation Support

IAEA SP-1 No:	00/IIS-002	**UK Sub-Contractor:**	-
IAEA SPRICS No:	UK D01329	**UK Task Manager:**	J Tushingham/UKAEA
IAEA Task Officer:	F Claude/S Robb		

Background to Task

On the basis of studies by the Member State Support Programmes, the IAEA decided to develop an in-house technical capability for satellite imagery analysis. The Satellite Imagery Analysis Unit (SIAU) commenced operation during 2001, using commercially available satellite images to gain information in support of safeguards.

The UK supported the work of the SIAU through the provision of an analyst experienced in the interpretation of satellite images pertaining to nuclear facilities and, from 2003, assisted in the procurement of commercially available satellite images and equipment.

Summary Report on Activities in 2007/2008

The UKSP offered a voluntary contribution to the Department of Safeguards for the procurement of satellite images and equipment. However, the Agency responded by requesting that the funds be assigned instead to support open source information collection, and funds were duly assigned for this purpose. The UKSP anticipates that a further contribution to open source information collection/satellite imagery will be made in 2009.

Task Area A7 - Strengthening/Integration of Safeguards

Strengthening safeguards has aimed at providing credible assurance of the absence of undeclared activities in States. Once an assurance has been gained, all of the measures available to the IAEA through traditional and strengthened safeguards systems can be reviewed and combined to produce an integrated safeguards regime. Integrated safeguards is defined as the optimum combination of all safeguards measures available to the IAEA under a comprehensive safeguards agreement, including those from Additional Protocols, that achieves the maximum effectiveness and efficiency within available resources in fulfilling the Agency's safeguards obligations.

Task A7(e) - Conceptual Development Support for Integrated Safeguards

IAEA SP-1 No:	99/PSS-006	**UK Sub-contractor:**	Wind River Consulting
IAEA SPRICS No:	UK C01265	**UK Task Manager:**	R Hooper
IAEA Task Officer:	J Cooley		

Background to Task

The IAEA Department of Safeguards continues to develop and implement integrated safeguards. To complement and supplement the efforts of the Secretariat in this work, support on a number of the related activities has been obtained through Member State Support Programmes and the Standing Advisory Group on Safeguards Implementation (SAGSI). Since 1999, the UKSP has provided funding to support the work of Mr R Hooper, initially within a Group of Experts constituted by the Director General, to assist the Secretariat's development efforts towards implementation of the Additional Protocol and integrated safeguards.

In 2004, a need was identified to provide a paragraph-by-paragraph commentary on INFCIRC/153[2], and an article-by-article commentary on INFCIRC/540[3]. The commentaries were intended to draw upon negotiating histories i.e. what was intended, but would also include Secretariat assertions to the Board on how the measures included in agreements should be interpreted after thirty years of practice. An authoritative commentary was considered to be highly beneficial to the Department of Safeguards in their consultations with States pursuant to implementation of the Additional Protocol and integrated safeguards. Compilation of the extensive reference material needed for the development of the commentary was completed in 2006, based upon the Task Manager's detailed records of the background to INFCIRC/153 and INFCIRC/540. However, there were inevitably aspects that needed to be investigated further, requiring additional input from the Agency, including oral records and legal opinions.

Summary Report on Activities in 2007/2008

The IAEA proposed that the Task Manager correspond with senior participants in the original negotiations of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and the Model Additional Protocol Safeguards Agreements, to gain their personal reflections and insights. In June 2007, the Task Manager participated in an interview of one such participant in the negotiation of Article 3 of the NPT.

The Task Manager prepared papers on several issues intended to be addressed in the commentary, with support from the Agency's Office of Legal Affairs (OLA) and External Relations and Policy Coordination (EXPO). However, limited availability of resources prevented the completion of this work and, consequently, the UKSP sought closure of the task at the end of the year.

[2] INFCIRC/153: "The Structure and Content of Agreements between the Agency and States required in connection with the Treaty on the Non-Proliferation of Nuclear Weapons".
[3] INFCIRC/540: "Model Protocol additional to the Agreement(s) between State(s) and the International Atomic Energy Agency for the application of Safeguards".

Task A7(g) - Enhancement of Physical Model Conversion 1 and Conversion 2 Sections

IAEA SP-1 No:	06/PSS-002	**UK Sub-contractor:**	Nexia Solutions
IAEA SPRICS No:	UK C01660	**UK Task Manager:**	S M Francis
IAEA Task Officer:	M Uzzle		

Background to Task

The Conversion 1 and Conversion 2 chapters of the Physical Model have not been updated since the original issue of the Physical Model in 1998. The Conversion 1 step involves the processing of uranium ore to produce feed material for the enrichment and fuel fabrication stages. Policy paper 18 on the starting point of IAEA safeguards was issued in 2003 to facilitate strengthened safeguards for Conversion 1 facilities. Previous practice had been to apply safeguards measures to only the product of these facilities. The revised policy ensures that safeguards are applied to nuclear material at earlier stages in the Conversion 1 step. The Conversion 2 step involves conversion following uranium enrichment and/or reprocessing, for example for fuel fabrication.

In December 2006, the UKSP accepted the task of providing assistance to the revision of the Conversion chapters of the Physical Model, in collaboration with the US Support Programme. Initial discussions were held during a meeting between the Task Manager and Task Officer in January 2007.

Summary Report on Activities in 2007/2008

A meeting, involving the IAEA, US and UK parties, was held in Vienna from 27-28 June 2007, to discuss the scope of the task. It was agreed that the Conversion 1 & 2 sections would be subject to a complete rewrite, with the UKSP to focus on Conversion 1 whilst the US side would work on Conversion 2. Detailed discussions were held on the structure and content of the two chapters and an agreed scope document was prepared.

Work on preparation of the Conversion 1 chapter commenced, and supporting documentation was gathered to aid in writing the chapter. The introductory paragraphs were completed and population of the more detailed technical sections was progressed. Work was reviewed during a teleconference, held on 28 September 2007 to discuss progress.

A first draft of the narrative of the new Conversion 1 chapter was subsequently completed, using material drawn from a number of sources. The original chapter had been limited in terms of narrative, and only a small amount of the material was suitable for the new document. The existing “Proliferation Pathways” narrative from the UKSP training course (Task UK B01394/C1(f))) proved a useful alternative source document, but with extensive rewriting necessary to meet the required format. Information was also obtained from other sources, some openly available commercial information relating to specific plants and processes.

The draft document was submitted to the Agency with the accompanying list of indicators in January 2008. It is anticipated that the IAEA Task Officer will request that the UK and US parties responsible for the Conversion 1 and Conversion 2 chapters, respectively, peer review

each other's work. The peer review process should highlight any gaps in the narratives and yield additional material. The peer review is expected to be completed during 2008.

Task A7(h) - Support for Novel Technologies (Umbrella Task)

IAEA SP-1 No: 06/TDO-07 **UK Sub-contractor:** -
IAEA SPRICS No: UK A01599 **UK Task Manager:** J Tushingham, UKAEA
IAEA Task Officer: J Whichello/A Monteith

Background to Task

Following the 2004 IAEA General Conference, Project SGTS-08, "Novel Techniques and Instruments for Detection of Undeclared Nuclear Facilities, Materials and Activities", was established within the Department of Safeguards to:

- monitor and address observed deficiencies or vulnerabilities in safeguards approaches, equipment and technology;
- acquire new, or improved, equipment or technology where appropriate; and
- develop and/or use new concepts, approaches, techniques and technology for information analysis and verification activities, in particular with regard to enhanced capabilities to detect undeclared nuclear material and activities.

The UKSP agreed to contribute to the project through an umbrella task, initially to provide a contact point for the identification of appropriate expertise and resources, and participated in a Technical Meeting on the Application of Laser Spectrometry Techniques in IAEA Safeguards during 2006.

Summary Report on Activities in 2007/2008

Activity was limited to a visit by the IAEA Task Officer and Novel Technologies Project Manager to the UK, funded through the UKSP, to hold meetings with staff from QinetiQ and Government Departments. Possible mechanisms for collaboration were explored, and it was agreed that support may be offered through the UKSP.

Advance notification was received of an Experts' Meeting on the subject of laser-induced breakdown spectroscopy (LIBS), and the UKSP agreed to support the participation of a UK expert at the meeting.

The UKSP intends to continue to provide a point of contact with the Agency, to liaise with the Task Officer to identify appropriate UK expertise, and to consider requests for support within the framework of this task.

Task Area A8 - Information Evaluation in Support of a Strengthened Safeguards System

The IAEA needs to collect open-source information on nuclear programmes in different regions of the world. The efficient delivery and analysis of such information plays an

important role in the Department of Safeguards' ability to evaluate Member States' declarations and to detect undeclared activities.

Task A8(d) - Development of Regional Information Collection Capabilities

IAEA SP-1 No:	05/IIS-009	**UK Sub-contractor:**	King's College London
IAEA SPRICS No:	UK D01569	**UK Task Manager:**	J Kidd
IAEA Task Officer:	J Lepingwell		

Background to Task

In support of the Strengthened Safeguards System, the IAEA Department of Safeguards must broaden its access to geographically and linguistically diverse sources of relevant open source information. Information is required, in particular, on nuclear dual use technologies relating to industrial infrastructure and nuclear research and development, as well as information on security, economics, weapons of mass destruction and the politics surrounding such weapons. Detailed surveys are required of States' industrial and nuclear research infrastructure and issues that may induce a State to proliferate.

In November 2001, the UKSP initiated the development of a Regional Information Collection Centre (RICC) within the International Policy Institute, King's College London. The RICC subsequently established methodologies for the collection of regional information to support the production of detailed surveys of States' industrial and nuclear research infrastructures. In July 2003, a second RICC commenced the collection of open source information. Baseline State Profiles were prepared, the two RICCs provided regular abstracts of open source information and completed several research topics. From December 2005, King's College London began the process of updating and translating into XML format the baseline State Profiles, to enhance their presentation through:

- the ability to tag and search on entities such as people, places, things and concepts, allowing more effective use of the data within a database structure;
- rapid updating and incremental development of profiles;
- compatibility with current and future IAEA database systems;
- potential expansion to include tagged materials in multiple languages;
- automatic generation of indices; and
- flexibility in creating different report formats.

Summary Report on Activities in 2007/2008

Collections of abstracts of open source information on nuclear-related issues, gathered from both English and regional language sources, continued to be sent to the IAEA during 2007/2008.

Eight State profiles were prepared, or updated. These were marked up in XML and placed on a restricted website. During the year, the information repository was transformed into a dynamic 'Cocoon' framework, which will enable significant improvements to the URL to be made. A new server was prepared for the repository, to be made available early in 2008/2009.

A single ad-hoc research project was completed, and subsequently marked up in XML, covering nuclear-related research.

Three staff members from King's College visited the Agency in July 2007. They reported progress and obtained advice and feedback on the task, which was due to be completed in January 2008. Options for the continuation of King's College's work were subsequently reviewed, and agreement was reached to extend the task until the end of the financial year. From April 2008, further work will be undertaken within the framework of three new tasks, involving the collection of open source information and further enhancement of the presentation of such information.

Task Area A10 - Support to SSACs

The Agency provides and co-ordinates support to State Systems of Accountancy and Control (SSACs). Support, in the form of technical systems, equipment and computer programs as well as training courses, seminars and workshops, has been provided by the IAEA to establish and enhance SSACs to meet international requirements. Continuing support is required from Member States with experience in nuclear material accounting and control to assist in strengthening the SSACs and to support the implementation of safeguards, particularly implementation of the Additional Protocol.

Task A10 – Support to State Systems of Accountancy and Control (SSACs)

IAEA SP-1 No:	00/OCP-002	**UK Sub-Contractor:**	BERR
IAEA SPRICS No:	UK B01321	**UK Task Manager:**	W McCarthy
IAEA Task Officer:	P Rodriguez		

Background to Task

This task was accepted by the UKSP to enable the UK to contribute to meetings on the implementation of safeguards in the context of newly developed SSACs. From 20-24 October 2003, the UK hosted and chaired an IAEA Technical Meeting on the Format and Preparation of Additional Protocol Declarations. In addition, a financial contribution was made to the IAEA, to assist the Agency in funding the travel and subsistence of participants from some of the States eligible to receive financial support.

The meeting was considered successful, with States obtaining clarification from the IAEA on many Additional Protocol issues. The IAEA subsequently produced revised guidelines as an Agency STR-series report and distributed them, inter alia, to all participants in the meeting.

Summary Report on Activities in 2007/2008

There was no activity to report under this task in 2007/2008, although the UKSP remained willing to consider requests for support to International SSAC Advisory Service Missions.

AREA B - SUPPORT FOR IAEA ANALYTICAL SERVICES

Destructive analysis techniques are the most accurate way of assaying nuclear materials and the methods play an essential role to verify the declarations of facility operators at bulk handling plants. For this purpose, safeguards Inspectors take samples of process material for analysis of elemental and/or isotopic composition. The samples are sent for analysis to the IAEA Safeguards Analytical Laboratory (SAL), or to an accredited member of the IAEA NWAL in a Member State. Since its inception, the UKSP has assisted with all aspects of destructive analysis, from on-site sampling trials through the development of analytical techniques and provision of equipment to the development of processes for the treatment of analysis waste residues. In particular, since 1984, the UKSP has assisted in the development and supply to the IAEA of standards for application to the analysis of inspection samples.

Task Area B1 - Analytical Services

As bulk handling plants become larger, and material throughput increases, so there is a need for greater accuracy of analysis so that diversion of material cannot be hidden within the uncertainty of measurement. The destructive analysis methods employed, and the standards used in their calibration and quality control, must therefore keep pace with developments in the fuel cycle. Safeguards inspection agencies are also interested in taking advantage of any advances in analytical techniques so that independent verification of the operator's declaration can be carried out more effectively. In particular, the implementation of strengthened safeguards and environmental sampling requires the development and implementation of new and improved methodologies for sample collection, preparation and analysis.

Task B1(n) - Improved Particle Analysis Methods

IAEA SP-1 No:	03/SAL-002	**UK Sub-contractor:**	QinetiQ
IAEA SPRICS No:	UK A01459	**UK Task Manager:**	A J Pidduck
IAEA Task Officer:	D Donohue		

Background to Task

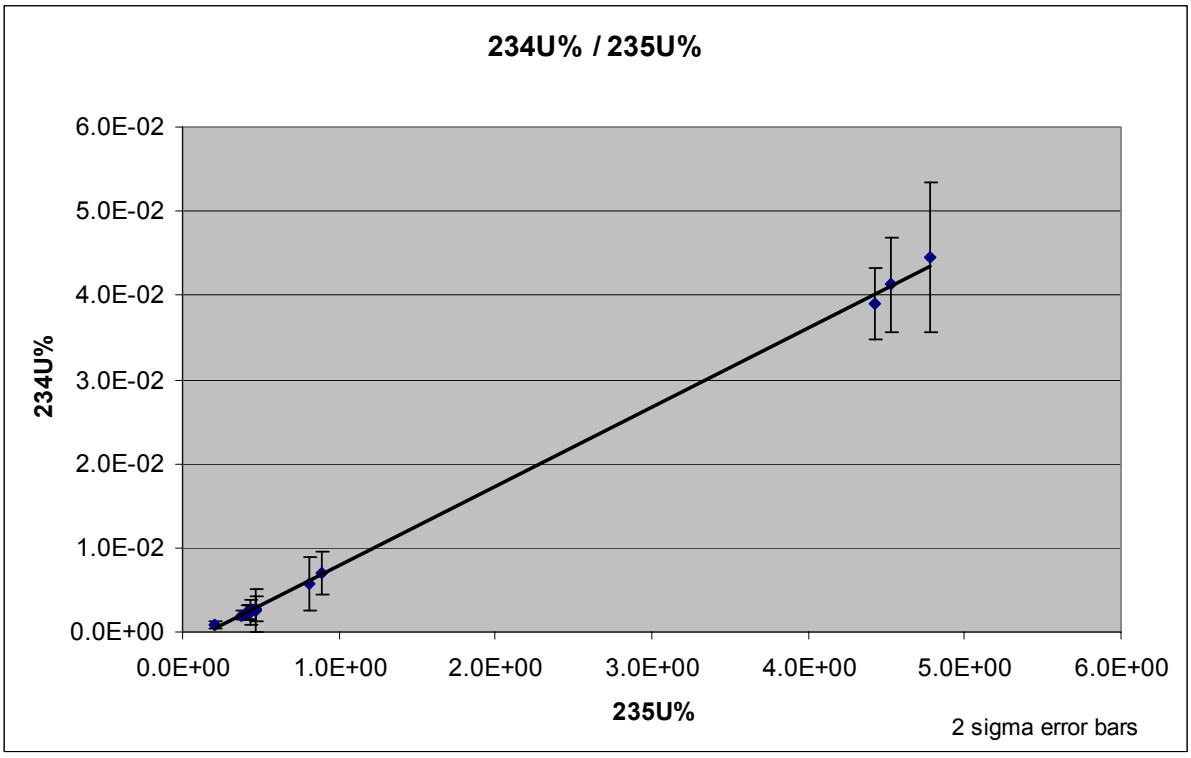
SIMS can provide a rapid sample turnaround for measurement of the isotopic composition of individual particles recovered from swipe samples collected as part of the IAEA environmental sampling programme. However, there are limitations in application of the technique. In particular, recovery of particles from swipe samples can be a problem: low recoveries could require the IAEA Inspectors to return and re-sample at a facility. Improved sensitivity and discrimination of actinide particles is highly desirable, whilst alternative and complementary techniques to SIMS need to be investigated. Additional information on particle morphology and chemical form can assist the Agency in identifying the source of nuclear materials and the processes through which they have been put.

Since February 2004, QinetiQ has used its experience in the analysis of environmental samples by SIMS, and its knowledge in a range of complementary microscopic analysis techniques, to develop improved procedures for the analysis of environmental samples supplied by the IAEA. In particular, a study has been completed on the diagnostic information

that could be obtained from nuclear material samples using SEM-Energy Dispersive X-ray (EDX), IM-SIMS, Transmission Electron Microscopy (TEM), X-ray Photoelectron Spectroscopy (XPS), Auger spectroscopy and Raman spectroscopy. Other work included optimising the efficiency of particle extraction from environmental swipes and the development and supply of a prototype Quality Control test swipe. Results were reported at a Consultants Group Meeting on Particle Analysis for Environmental Samples in November 2005, and also presented at the IAEA Symposium on International Safeguards held in Vienna in October 2006. Work then commenced on the implementation of the Agency's vacuum impactor method for the preparation of SIMS samples and the evaluation of a high-resolution SIMS instrument, and these activities continued into 2007/2008.

Summary Report on Activities in 2007/2008

Isobaric molecular interferences, from co-located non-uranium particles, can introduce errors in SIMS isotope ratio measurements. These errors become increasingly apparent at low mass ratios, and can preclude the measurement of minor isotopes of uranium by SIMS. In principle, these interferences can be overcome using a spectrometer of sufficient mass resolution, such as the Cameca IMS 1270 SIMS ion microscope located at the Natural Environment Research Council (NERC) Microprobe Facility of Edinburgh University. Two, three-day, trial periods of this instrument were completed during the year, during which a range of swipe samples and standards, previously characterised using QinetiQ's Cameca 4F RAE-SIMS instrument, were re-analysed. Considerable progress was made in gaining familiarity with the instrument operation, and in demonstrating more consistent SIMS measurement of minor isotope ratios of uranium particles. This is illustrated by the results from a heavily-loaded swipe sample, below.



The impactor technique, as developed by the Agency, involves vacuuming areas of the swipe and collecting the particles directly on a SIMS planchet. This offers a significant

improvement in preparation time compared with QinetiQ's existing heptane extraction method using ultrasonication. Another potential advantage of the impactor approach is that it is less invasive. QinetiQ's work on the impactor preparation procedure was completed with the examination of seven swipes, varying from heavy to light visible soiling and from rich to sparse uranium loading. Parts of each swipe had previously been subjected to RAE-SIMS measurement of particles extracted by the standard solvent procedure. Vacuum impactors were used to prepare fresh planchets for measurement. $^{235}U/^{238}U$ ratios and SIMS intensity distributions were compared for carbon planchets prepared by the two routes and found to be very similar in each case. The evident advantage of the impactor approach was the flexibility to sample from selected areas of the swipe, relatively non-destructively and free from cotton fibre swarf from cutting the swipe, as well as to achieve a controlled particle loading directly on the carbon planchet for SIMS analysis. Control was obtained through positioning of the impactor nozzle and the vacuuming times used. The overall swipe preparation time was also reduced, although this advantage was offset by the larger area and radially non-uniform particle deposit, requiring longer SIMS analysis times to achieve complete coverage. The impactor method thus has advantages for heavily-loaded and/or inhomogenously soiled swipes.

A local procedure, covering the vacuum impactor preparation method, was issued and the method was subsequently deployed for the analysis of selected swipes from Agency routine sample batches during 2008.

Work on the current task is now complete. However, QinetiQ hopes to continue to develop its capability to analyse swipe samples supplied by the IAEA, involving further trials of the application of high-resolution SIMS under a new task planned for 2008/2009.

Task B1(s) – Study of Chemical Changes in Uranium Oxyfluoride Particles

IAEA SP-1 No:	06/PSA-003	**UK Sub-Contractor:**	QinetiQ
IAEA SPRICS No:	UK A01656	**UK Task Manager:**	A J Pidduck
IAEA Task Officer:	D Donohue		

Background to Task

When traces of uranium hexafluoride are released into moist air, for example at a uranium enrichment plant, the first compound that forms is uranium oxyfluoride, UO_2F_2. This material is unstable and decomposes to form uranium oxide, the rate of decomposition being influenced by exposure to ultraviolet light, moisture and elevated temperature. Measurement of samples taken from enrichment facilities during environmental sampling campaigns can reveal the presence of both uranium particles that contain fluorine and those that do not. A better understanding of the rate of decomposition of uranium oxyfluoride would assist safeguards analysts in understanding the significance of analytical results, in terms of past and current enrichment activities, and hence enable more comprehensive safeguards conclusions to be drawn.

In October 2006, the EC and UK Support Programmes agreed a collaborative study into chemical changes in uranium oxyfluoride particles. The work was to utilise expertise in uranium oxyfluoride particle preparation, at the EC Joint Research Centre (JRC) Institute for Reference Materials and Measurements (IRMM), and QinetiQ's experience in the analysis of

environmental samples by SIMS and other microscopic analysis techniques. The main aim of the study was to examine the possibility that the relative strengths of fluorine-containing peaks in SIMS mass spectra could be used to assess the age of particles encountered in inspection samples. Work commenced in 2006/2007, with a range of measurements being made on twelve different samples prepared at IRMM by vapour-phase hydrolysis of UF_6. The results showed a decrease in the particle fluorine signature during 12-16 months of ageing under laboratory conditions, accelerated significantly by exposure to ultraviolet (UV) light.

Summary Report on Activities in 2007/2008

A set of new samples for measurement by SIMS, SEM and TEM was defined with IRMM, and measurements were made following various treatments including exposure to UV light (up to three months) and heat (to 350°C for six hours). An unexpected observation encountered during previous SIMS analysis, of indistinct particles superimposed upon a uniform background oxyfluoride layer, was repeated during the current work. TEM imaging of two samples prepared by IRMM under conditions of low humidity indicated the presence of chains of linked or fused spherical particles. Lattice images showed that the individual particles comprised nanocrystallites in the 5 – 10nm range.

Additional SIMS measurements were made to: (a) follow the atmospheric decay of UO_2F_2 particle fluorine-signature and morphology for the case of particles prepared under low and high humidity conditions, in order to assess their relative stabilities; (b) complete an analysis matrix of differently aged samples, using SIMS at QinetiQ and SEM, EDX and Raman spectroscopy at IRMM; and (c) use extended sputtering times to test for possible compositional changes within the particles.

A paper was prepared, bringing together the results obtained by collaborators from a range of aged samples, as summarised in the following table.

Sample name	Ageing	F/U SEM-EDX	UF/U IM-SIMS	Raman
G50	2 months	0.20 - 0.25	0.20 (± 0.12)	distinct peak at 865 cm^{-1}
G5	28 months	0.10 - 0.28	0.015 (± 0.008)	peak at 865 cm^{-1} in all 6 particle spectra
G69	4 weeks UV-light exposure	0.04 - 0.14	0.014 (± 0.004)	peak at 865 cm^{-1} in all 8 particle spectra
G108	350 °C for 6 hours	F peak not detected	0.004 (± 0.003)	U_3O_8 features in 40 out of 50 particles
G83	3 months UV-light exposure	F peak not detected	0.0008 (± 0.0001)	peak at 865 cm^{-1} in all 8 particle spectra

The results showed that extended laboratory storage periods (over 2 years) caused significant reductions in fluorine levels as measured by both IM-SIMS and SEM-EDX. Exposure to UV light or heating to 350°C resulted in very low fluorine levels from SIMS, with fluorine undetectable by SEM-EDX. Despite large site-to-site variations, the findings should be helpful in placing limits on particle age based upon the levels of fluorine detected in uranium particles originating from UF_6 operations.

Further SIMS measurements were made, to examine changes in fluorine signals and particle images during extended sputtering times, to test for possible compositional changes within UO_2F_2 particles. These did not appear to be the origin of the large site-to-site variations seen in the UF^+/U^+ and associated ion microprobe signal ratios.

Publication of a final report in Spectrochimica Acta will complete the task.

AREA C - TRAINING COURSES

The IAEA has a long-term requirement for a wide range of safeguards-related training courses. New safeguards Inspectors require training and practical experience on fuel cycle plants and the techniques and procedures to be applied during inspections. More advanced courses are required for senior Inspectors, whilst specialised courses are desirable for other key personnel. To undertake this training, the IAEA needs access to appropriate nuclear facilities, which can only be made available by Member States.

Task Area C1 - Inspectors' Training Courses

The UKSP has provided training courses on a cost-free basis since its inception in 1981. These courses are constantly evolving to meet the changing needs of the Agency and are tailored to meet their specific requirements.

Task C1(c) - DIV Exercise at Bulk Handling Facilities

IAEA SP-1 No: 06/TTR-003
IAEA SPRICS No: UK B01618
IAEA Task Officer: H Barroso

UK Sub-contractor: Nexia Solutions
UK Task Manager: S M Francis

Background to Task

Courses on safeguards at bulk-handling facilities have been run for the benefit of IAEA Inspectors by the UKSP since 1992. During this period, over 200 IAEA Inspectors (usually recent recruits) have received general training and familiarisation aimed at providing an enhanced understanding of operations at a variety of bulk handling facilities.

Prior to 2001, the course included a simulated physical inventory verification (PIV) exercise, using non-destructive analysis (NDA) instrumentation at Springfields. In 2001, the course was reviewed and, at the request of the IAEA, the focus changed to performing a Design Information Verification (DIV) exercise. The course was of three weeks duration, the first week being conducted by the IAEA in-house; the second and third weeks being hosted by BNFL, at Springfields and Sellafield in the UK, and including one day at Capenhurst hosted by Urenco (Capenhurst) Ltd. Consolidation over subsequent years led to the visit to the Urenco enrichment plant being removed (to be incorporated instead into the Comprehensive Inspection Exercise, Task C1(r)) and the overall duration of the UK component of the course was reduced to a single week.

Summary Report on Activities in 2007/2008

The course on safeguards and design verification at bulk handling facilities was successfully delivered to twelve IAEA Inspectors, accompanied by two Agency tutors, from 28 August – 31 August 2007, at the IAEA Headquarters, and from 5 - 12 September 2007, at Sellafield and Springfields in the UK.

The first week of the course introduced the participants to Design Information Evaluation/Verification (DIE/V) and the current IAEA approach to its implementation through a combination of lectures and practical exercises. The latter were designed to promote the development of strategies and work plans related to DIE/V activities. Inspectors were challenged to check the accuracy and completeness of design information and to look for possible routes for the diversion of nuclear material. A representative of Sellafield Ltd attended this Vienna-based component of the course at the Agency's request, primarily to present lectures on reading engineering drawings, the use of Global Positioning System (GPS) units and the use of digital cameras. The participants were split into three groups of four inspectors, remaining in these groups for the duration of the course.

At Sellafield, the course commenced with lectures on the Thermal Oxide Reprocessing Plant (THORP), an operator's perspective on safeguards DIV at the plant and a guided visit around the THORP Receipt and Storage Facilities and Head End Plant. There followed an exercise on the application of selected elements of DIE/V on the THORP plant. To undertake the prescribed DIV activities, the party was joined by experts from THORP operations, who supported an exercise centred on the Head End Plant.

At Springfields, rather than concentrate on a single plant, the Inspectors completed exercises in four areas:

- Pulsed Column Area;
- Harp Tank Area/Dissolution (Residue recovery dissolvers);
- Building 670 (Operational status); and
- Site and General Building.

The final exercise involved verifying a numbered list of buildings against a site plan using the GPS units. The participants were also asked to comment on the scope for undeclared operations on the site.

The course fulfilled the objectives of providing the Inspectors with an enhanced understanding of operations at uranium conversion and reprocessing bulk handling facilities and the necessary basic-level skills for implementing DIE/V at these facilities. The UKSP subsequently agreed to run the same course in 2008.

Task C1(f) - Training on the Nuclear Fuel Cycle and Proliferation Pathways

IAEA SP-1 No:	02/TTR-003/ 07/CTR-004	**UK Sub-contractor:**	Nexia Solutions
IAEA SPRICS No:	UK B01394/ B01698		
IAEA Task Officer:	H Barroso	**UK Task Manager:**	S M Francis

Background to Task

The main objective of strengthened safeguards is to provide assurances of the absence of undeclared nuclear activities in States. Under the Additional Protocol, the Agency has wider access to information and facilities, intended to enhance its capability to detect any clandestine development of a nuclear weapon.

In 1995, a training need was identified for more experienced Inspectors, subsequently addressed by this task, to increase their awareness of the fuel cycle indicators and show them the items concerned, either in photographs or as models. This would assist them in identifying signs of any illicit activity during inspections. Over the next eleven years, the course was run on 19 occasions by the UKSP.

Summary Report on Activities in 2007/2008

Two Nuclear Fuel Cycle and Proliferation Pathways Courses were run in 2007. These concentrated on the safeguards-relevant elements of the nuclear fuel cycle and on the nuclear proliferation pathways associated with its more 'sensitive' activities, such as enrichment, fuel reprocessing, MOX fuel fabrication and power generation from reactors capable of unreported plutonium production.

The 20th Proliferation Pathways Course was delivered over the period 7 – 15 June 2007. In contrast to previous years, the course was held in Vienna in order to minimise the requirements for inspector travel. The 17 participants were mainly from Operations Divisions, with some representatives from Support Divisions. Introductory lectures on Integrated Safeguards, Information Review and Nuclear Export Controls Evaluation were given by Agency personnel, with the Agency also providing technical and administrative support. The UKSP provided three experts, who gave lectures on subjects including conversion, reactors and reprocessing.

The next training course was delivered from 15 - 23 November 2007, again in Vienna. The course followed the same format as the previous one, attracting 15 participants.

Demand from Inspectors for the course remains high and a further two Proliferation Pathways Courses have been requested by the Agency for 2008/2009. These are expected to be held in June and November 2008, and planning for the courses has commenced. For 2008, the courses will be run in response to a new Agency task proposal and a number of revisions will be incorporated into the existing course. These will include new exercises to provide a consistent storyline and context across the series of course modules and, for the first time, formal examination questions that will be incorporated into each module.

Task C1(i) – Advanced Training in Nuclear Fuel Cycle Facilities

IAEA SP-1 No:	05/TTR-002	**UK Sub-contractor:**	Nexia Solutions
IAEA SPRICS No:	UK B01550		
IAEA Task Officer:	H Barroso	**UK Task Manager:**	S M Francis

Background to Task

IAEA Inspectors with additional responsibility to evaluate safeguards compliance in particular States as a whole are known within the IAEA as Country Officers. Arising from the Agency's strengthened and integrated safeguards approach, advanced training was required to provide such personnel with increased knowledge of the process technologies associated with fuel cycle facilities, and an improved understanding and recognition of the equipment and processes, particularly proliferation indicators and dual use equipment and activities. Since a proliferator may choose to adopt old technology, the scope of any training course was

required to cover both new and old equipment. Physical access to reactors, conversion, enrichment and reprocessing facilities on three scales: laboratory, pilot plant and commercial, were specific requirements.

The course was to be targeted at Country Officers of States with significant nuclear activities, and selected staff members with significant responsibility for Complementary Access and State Evaluation activities. Following a feasibility study in 1999, involving a series of visits to enrichment, reprocessing and conversion sites at Capenhurst, Sellafield and Springfields respectively, work was carried out to design a pilot course. This pilot course was successfully completed in 2000 and a full course was provided thereafter on an annual basis.

Summary Report on Activities in 2007/2008

The scheduled 2007 Advanced Training Course in Nuclear Fuel Cycle Facilities was held in the UK during the week of 1 - 5 October, with preliminary sessions in Vienna the week before. A full complement of twelve participants attended the course, accompanied by two Agency course tutors.

The Task Manager was present for the course introduction in Vienna, which included summary presentations of the different elements of the Proliferation Pathways Course. In addition, following presentations by the Agency on satellite imagery analysis techniques, detailed preparatory sessions examined imagery and schematics, drawn up by Agency imagery analysts, of the sites to be visited.

The programme for the UK part of the course was largely the same as for the 2006 course, but with the course commencing at Springfields rather then Sellafield. This offered the advantage of following the fuel cycle through a logical sequence from start to finish.

The two-day itinerary at Springfields included tours of the Oxide Fuels Complex, chemical and uranium metal plants, research and technology laboratories, uranium hexafluoride and enriched uranium residue recovery plants. With continued decommissioning at Springfields, the participants were given a good perspective of how facilities look during both active operations and decommissioning.

At Sellafield, two days of visits included access to the B205 Magnox reprocessing facility and plant area of THORP Receipt and Storage, supplemented by a working demonstration of portable hot cell facilities at the BNFL Technology Centre (BTC) and a tour of Calder Hall. The latter provided an insight into the design and operation of an older type reactor of particular proliferation interest.

The Urenco Capenhurst visit again included two enrichment facilities, providing a valuable contrast between old and new designs of centrifuge plants.

The Agency requested that a second course be held during March 2008, to the same itinerary as the October 2007 course. The UKSP was able to accommodate the request, although with limited access to some plants that were under scheduled maintenance or outages at that time. The second course was held from 6 – 7 March, in Vienna, and from 10 – 14 March in the UK. The Agency maintained a full complement of 12 participants for the course and feedback, on both courses, was very positive.

Dates for the next course have been included in the Department of Safeguards' training schedule, with a single course scheduled for October 2008.

Task C1(l) – Specialist Training for IAEA's Imagery Analysts

IAEA SP-1 No:	03/IIS-001	**UK Sub-Contractor:**	Nexia Solutions
IAEA SPRICS No:	UK B01495		
IAEA Task Officer:	S Robb	**UK Task Manager:**	S M Francis

Background to Task

In order to enhance the expertise of its staff and develop its in-house imagery analysis capability, the IAEA Satellite Imagery Analysis Unit (SIAU) requires the availability of training across a range of technologies. To assist in the identification of nuclear facilities, imagery analysts employed by the SIAU have visited a number of Member States' nuclear facilities, specifically for familiarisation with the flow patterns of the various processes, the buildings and equipment being used and the necessary support facilities, notably electrical, heating, cooling and air handling and filtration services.

The facilities, processes and systems used in UK facilities differ considerably from those available overseas, and an orientation and familiarisation visit was considered important to complement and build upon experience gained elsewhere. Consequently, a UK Visual Indicators Course was held for three imagery analysts from the SIAU in 2004, incorporating in-depth visits to reprocessing, reactor and fuel fabrication facilities along with the Urenco Capenhurst enrichment plant. The Agency requested that the course be repeated following the recruitment of additional imagery analysts.

Summary Report on Activities in 2007/2008

A Visual Indicators course was run in the UK from 18 – 22 June 2007 for the benefit of three IAEA imagery analysts. The group was accompanied by UK experts in satellite imagery, site construction and Geographical Information Systems (GIS).

The course commenced with two days at Sellafield, including tours of THORP Head End and Chemical Separation areas; Calder Hall reactors and turbines; BTC hot cell and glove box facilities; the Magnox Reprocessing Plant; an external tour of old reprocessing and pond storage areas, vitrification and waste encapsulation plants. Access to the BTC provided a good example of small scale facilities, such as those that a proliferator may use in undertaking a clandestine nuclear weapons programme.

At Capenhurst, guided tours of two plants were provided, including cascade halls, UF_6 handling and service areas. These highlighted how a modern centrifuge plant differs from one constructed 20 – 25 years ago. Process service areas and the uranium handling area were also visited.

The final two days, at Springfields, commenced with a walking tour around the site. This was followed by a visit to the Oxide Fuels Complex Conversion and Fuel Fabrication Facilities and tours of main line chemical plants, uranium metal plants and UF_6 building and fluorine cells. A visit to research and technology facilities provided particularly good access

to laboratories, development areas and pilot scale chemical processing rigs, providing a good contrast to the large industrial process plants.

The UKSP anticipates holding a further Visual Indicators course during 2008/2009, in response to the recruitment of new imagery analysts by the Agency.

Task C1(r) - Comprehensive Inspection Exercise at Bulk Handling Facilities

IAEA SP-1 No:	01/TTR-006/ 07/CTR-005	**UK Sub-Contractor:**	Nexia Solutions
IAEA SPRICS No:	UK B01384		
IAEA Task Officer:	P Rodriguez	**UK Task Manager:**	S M Francis

Background to Task

It is essential to provide newly-recruited safeguards Inspectors with a range of practical skills to enable them to perform inspections at bulk handling facilities such as LEU Fuel Fabrication Plants (FFPs), Storage Facilities and Location Outside Facilities (LOFs) handling depleted, natural and low enriched uranium.

A UK-based Comprehensive Inspection Exercise at Bulk Handling Facilities Course was developed at the request of the Agency, to be conducted in two parts. The first of these would take place at the Agency Headquarters, with lectures and practical demonstrations of measurement equipment. The second part, to take place at Springfields, would focus on applying these techniques at a nuclear facility. The inaugural course was successfully held in 2002 and subsequent courses were held annually, in March, from 2003. In 2004, the course was extended to include a visit to Urenco's Capenhurst Enrichment Plant, providing the Inspectors with a wider understanding of different fuel cycle facilities.

Summary Report on Activities in 2007/2008

In response to a new task proposal, arrangements for a seventh Comprehensive Inspection Exercise commenced with a review of plant availability and the options to improve the course. However, efforts were diverted when the Agency requested that the course due for March 2008 be replaced with an additional Advanced Training in Nuclear Fuel Cycle Facilities Course. The UKSP agreed to this change and, consequently, there was no further activity under this task beyond commencing the negotiation of UK arrangements for a March 2009 course.

AREA D - SAFEGUARDS PROCEDURES

A number of large scale reprocessing plants were scheduled to come on stream from the 1990s in Member States and, in view of the fact that such plants are capable of producing high quality separated plutonium, the way in which they would be safeguarded was the subject of much discussion. The IAEA continues to need assistance in areas such as design information verification, authentication, and solution monitoring, if fully effective safeguards are to be applied at such plants. Although aimed primarily at reprocessing plants, many of the methods apply equally to other types of facility in the fuel cycle.

Task Area D2 - Near Real Time Accountancy

Near Real Time Accountancy (NRTA) is a tool for safeguarding large scale reprocessing plants. Due to the highly complex nature of such plants, it can be difficult to determine an accurate estimate of the account. Anomalies can lead to investigations that would impose substantial burdens on Inspectors and Plant Operators. Solution monitoring, which tracks the transfer of solutions through the plant, complements NRTA, and can not only enhance the estimation process, but can also be viewed as a contributor to containment and surveillance.

Task D2(g) – Evaluation Software Co-Development for Solution Monitoring at TRP

IAEA SP-1 No:	06/OA2-003	**UK Sub-Contractor:**	University of Glasgow
IAEA SPRICS No:	UK A01653	**UK Task Manager:**	J Howell
IAEA Task Officer:	R Binner		

Background

Solution volume and mass estimation systems are currently installed in the Plutonium Conversion Demonstration Facility (PCDF) and product storage area of Tokai Reprocessing Plant (TRP), whilst implementation of a comprehensive solution monitoring system is underway at Rokkasho Reprocessing Plant (RRP). The hardware and software systems collect and store solution data such as the level, temperature and density of solution in key vessels. Evaluation of the data collected by such systems should provide additional safeguards assurances of non-diversion of nuclear material. Earlier UK tasks undertaken by Glasgow University specified mathematical algorithms for such evaluation software and provided support to the development of a small solution monitoring evaluation system (SMES), called TAMES, for the Tokai PCDF.

Following on from this work, the Agency requested that Glasgow University assist through the co-development of evaluation software for the solution monitoring system installed in the product storage area of the TRP under a previous task of the Japanese Support Programme. The EC JRC, Ispra, had produced a data analysis and interpretation (DAI)-based SMES that performed the first two stages of the evaluation process: mass/volume estimation and sub-event detection. In October 2006, the UKSP accepted the task of supporting the Agency in the co-development of a shortened version of TAMES, called TAMES-TRP, that would take DAI output as opposed to the raw data. The intention was that the Agency would weave

together, reprogramming where necessary, components supplied by both the JRC, Ispra, and Glasgow University. The specification of the event rules for the redesign of TAMES was produced late in 2006/2007.

Summary Report on Activities in 2007/2008

The Task Manager visited the Agency from 14 – 17 August 2007, and spent time testing the rules on TRP product storage data. Design modifications were identified and implemented, whilst new event rules were identified that needed to be designed and tested at Glasgow. It was agreed that Glasgow should produce a complete package, to take the plant data, evaluate it and display the results. Having done this, the Agency would then produce a more professional version, focussing on the user interface.

Development of a complete package in Python, including a user interface, was completed by end-2007. This was then subjected to extensive testing at Glasgow University, in particular of the pre-processing algorithms, including their associated parameters, and on the event interpretation rules. Flexibility was built into the software package, so that it could be configured to Inspector requirements.

The Task Manager visited the Agency in March 2008, with the aims of delivering the package, demonstrating it and then discussing flexibility issues with the Agency. During testing in Vienna, a number of minor glitches were identified and resolved by the Task Manager, who then made a number of enhancements.

Subsequently, the IAEA Task Officer took the package to TRP, to evaluate the data that is collected off the plant. He expects to feed back any bugs and configuration requirements, and Glasgow will then update the software as required. Finally, the Task Manager will make a presentation on the software to other Inspectors.

AREA E - INSTRUMENT DEVELOPMENT AND ASSESSMENT

It is essential that the IAEA is able to guarantee the effectiveness of its safeguards measures. This requirement extends to the highly specialised equipment developed to contain or monitor nuclear materials, for which the IAEA must seek assurance that it is tamperproof and is being operated correctly. Vulnerability assessments of new and existing equipment are required, whilst manuals and procedures for the operation of safeguards instrumentation require updating on a regular basis.

Task Area E10 – Instrument Vulnerability Assessments

Technical assessments of vulnerabilities are required both during equipment development, to optimise design, and prior to implementation. For the latter, it is important that the IAEA gains assurance through verification by organisations neither connected with the manufacturer nor operating facilities where the equipment may be employed by the IAEA. However, during development, it is more appropriate to employ a vulnerability assessor from the same State as the equipment manufacturer. The assessment techniques applied are usually defined by the IAEA, who may highlight specific features or applications for analysis and results are provided in confidence to the IAEA.

Task E10(h) - Laser Surface Authentication (LSA) Design Vulnerability Assessment

IAEA SP-1 No:	07/TSR-002	**UK Sub-contractor:**	CESG
IAEA SPRICS No:	UK E01691	**UK Task Manager:**	J Tushingham
IAEA Task Officer:	H Undem		(UKAEA)

Background to Task

The LSA system is a new technique, developed within the UK by Ingenia Technology, to identify uniquely materials using an intrinsic surface "fingerprint" extracted by a laser scanning device. Such a method, if successfully proven, could lead to automation of seal identification within the Agency's Seals Laboratory, and could also lead to the ability to authenticate a seal on-site or in situ.

Before proceeding with a complete engineering demonstration, test and evaluation programme, a vulnerability assessment of the developing design by a party independent of the Agency and developer was required. Identification of vulnerabilities at an early stage can lead to elimination of the concept or redesign of the system to mitigate against discovered vulnerabilities.

Summary Report on Activities in 2007/2008

In August 2007, the UKSP accepted the task of providing a vulnerability assessment team, to identify vulnerabilities and work with the Agency and UK developer to overcome them. An initial review meeting was held in Vienna, in September 2007, involving personnel from the Agency, developer and UK contractor.

CESG completed an initial vulnerability assessment of the LSA system, as applied to the Agency metal seal. In the absence of prototype equipment, but with the cooperation of the manufacturer, this focussed on identifying the threat model and assessing the requirements to reduce error probabilities. A confidential report was completed, and forwarded to the Agency in November 2007.

Further work awaits the availability of a prototype instrument for assessment.

Task E10(i) - Vulnerability Assessment of the Agency Metal Sealing System

IAEA SP-1 No:	07/TSR-003	**UK Sub-contractor:**	CESG
IAEA SPRICS No:	UK E01692	**UK Task Manager:**	J Tushingham
IAEA Task Officer:	H Undem		(UKAEA)

Background to Task

The Agency seeks continued assurance of the efficacy of its sealing systems. The metal seal is the most widely used of the Agency's long-term sealing systems, and requires periodic assessment to ensure that it remains secure against technology developments.

Summary Report on Activities in 2007/2008

In August 2007, the UKSP accepted the task of carrying out a vulnerability assessment of the metal seal. Work commenced late in 2007/2008, and results will be reported in confidence to the Agency during 2008/2009.

Task Area E11 - Technical Documentation

The UKSP provides assistance to the Department of Safeguards through the preparation of technical manuals and procedures for NDA instrumentation used by safeguards Inspectors. This work has been undertaken by staff from Canberra-UK Ltd since 1996.

Task E11 - Technical Manuals and Procedures for Safeguards Instrumentation

IAEA SP-1 No:	02/TNS-003/ 08/TAU-001	**UK Sub-contractor:**	Canberra-UK Ltd
IAEA SPRICS No:	UK A01408/ UK A01729	**UK Task Manager:**	C Wilkins
IAEA Task Officer:	S Jung/D Langner		

Background to Task

The Agency requires documentation to a standard format for safeguards instrumentation, including a Reference Manual for Instrumentation and a Checklist Procedure. Task E11 involves re-writing the documentation for existing equipment in the required format and producing documentation for new equipment or existing equipment that has updated software.

During 2006/2007, the contractor prepared, and forwarded to the Agency for review, draft documentation for the Candu Spent Fuel Bundle Verification Basket (CBVB); the Inventory Sample Counter (INVS); the Passive Neutron Coincidence Collar Detector (PNCL); the Fork Detector Irradiated Fuel Measurement System (FDET); and the Fresh MOX Attribute Tester (FMAT).

Summary Report on Activities in 2007/2008

During April 2007, the final proof versions of the checklist procedures for the FDET and FMAT were completed, taking into account the comments and detailed information received from the Agency during a meeting in March 2007.

During the March meeting, the Agency had also provided information required to complete the reference manual and checklist procedures for the INVS and PNCL instruments. The final drafts of these documents were produced during April and sent to the Agency during May 2007. These were accepted by the Task Officer without further modifications being required, completing activity under the current task.

A new task proposal was subsequently received, and a workplan is under development. It is anticipated that the Agency will seek support including the preparation of technical manuals for less portable and more complex equipment.

AREA F - CONSULTANTS AND COST FREE EXPERTS

The IAEA cannot retain sufficient resources within its permanent staff to meet all requirements for highly specialised development and evaluation work. In addition to obtaining assistance from Member State Support Programmes to undertake specific tasks, the IAEA looks to States and Institutions to provide expert staff to fulfil a temporary position at the IAEA's premises in support of such activities. This may involve a full-time role as a Cost Free Expert (CFE), or part-time as a Consultant.

Task Area F1 - Provision of Consultants and Cost Free Experts

CFEs are persons provided by States at no cost to the IAEA to perform specific tasks for which no resources are available within the Secretariat. CFEs are employed as officials of the IAEA, but the cost of that employment, plus overheads, is provided to the IAEA by the donor State or Institution. In situations where the CFE mechanism is inappropriate, for example, in cases where the expert does not attend the IAEA on a full-time basis, it may be more appropriate to offer a Consultant to the Agency. In contrast to CFEs, Consultants are normally funded via the current employer of the staff involved, and not through transfer of funds to the Agency. Both mechanisms provide the means for the IAEA to attract expert staff for the limited period required to complete a specialised work programme.

Task F1(c) - Consultant - Assistance in ISIS Re-engineering Project

IAEA SP-1 No:	02/IIS-005	**UK Sub-Contractor:**	HTSPE
IAEA SPRICS No:	UK D01412	**UK Task Manager:**	C Lockett
IAEA Task Officer:	R Kirkgoeze		

Background to Task

The requirements of strengthened and integrated safeguards have resulted in many new functions being added to the IAEA Safeguards Information System (ISIS) but, due to resource limitations, there has never been an opportunity to invest in a comprehensive reorganisation or upgrade of the information systems. Consequently, two studies were carried out under the US Support Programme to develop an overall plan for an ISIS Re-engineering Project (IRP). The IRP plan estimated that the project would cost €27.2 million for equipment and contracts over a 3.5 year period, and require Agency resources to the equivalent of 30 full-time staff for the duration of the project. For these resources, only partial coverage could be provided through the regular budget.

In addition to the provision of significant extrabudgetary contributions, since 2002, the UKSP has provided a consultant, responsible for technical advice directly to the IRP project team, reviewing the progress of the project and preparing special reports on the project for the Agency.

Summary Report on Activities in 2007/2008

For the majority of the year, the level of interaction between the Agency and UK Consultant was very low, as the IRP progressed towards the end of its second phase. During this time, a watching brief was maintained, with the Consultant receiving updates from the IRP team by e-mail and telephone.

The Consultant visited the Agency in March 2008, to meet with the Director, Safeguards Division of Information Management (SGIM), and the IRP programme management team. During the visit, he discussed the completion of Phases I and II of the project, and the preparations for the launch of Phase III.

During Phase III, the Agency will have the opportunity to involve other suppliers, including internal suppliers and Member State Support Programmes, in project delivery activity. The Consultant met with representatives of SGIM, the procurement group and the user community to discuss progress on the project and the expected future results. Overall, the project appeared to be well-received within the Agency, and there were high expectations for the deliverables that will be produced during Phase III.

The UK Consultant will continue to give ad hoc support to the IRP Project Management Team, providing regular informal progress reports and highlighting any issues to the Director, SGIM.

Task F1(d) – Training on Satellite Imagery Analysis for Safeguards Applications

IAEA SP-1 No:	05/IIS-005	**UK Sub-contractor:**	J E C Cartwright
IAEA SPRICS No:	UK B01655	**UK Task Manager:**	J E C Cartwright
IAEA Task Officer:	K Steinmaus		

Background to Task

Since 2002, the IAEA Department of Safeguards has made use of satellite imagery as an operational tool for safeguards inspections and State Evaluation purposes, and the demand for detailed analytical reports derived from imagery has increased dramatically. The Department wished to develop, in-house, the analytical skills of the present staff of the SIAU and those to be recruited.

Mr Cartwright had fulfilled the role of an imagery analyst, initially as an external consultant and then as a full-time consultant in imagery analysis. During the latter period, he developed a specialised handbook for the imagery analyst, based on the nuclear fuel cycle and all associated facilities and activities. In addition, briefings and presentations to IAEA Inspectors, Country Officers and operations staff were undertaken on satellite imagery capabilities and applications to safeguards. For the specific training of imagery analysts, training tutorials, exercises and assessed examination material were compiled. Following the completion of this period of full-time consultancy, and the recruitment of additional imagery analysts by the Agency, there was a continuing requirement for periodic support to develop fully the potential capabilities of newly recruited imagery analysts and operational staff.

From April 2006, Mr Cartwright supported the work of the Agency in the periodic training of both imagery analysts and safeguards Inspectors.

Summary Report of Activities in 2007/2008

From 15 – 18 May 2007, the Task Manager assisted in the presentation of two Satellite Imagery Awareness courses, co-sponsored by the Canadian and Swedish Support Programmes, providing specific applications of satellite imagery of relevance to safeguards including the Additional Protocol. Prior to these courses, the Task Manager prepared presentational material and handouts that reflected changes agreed following the previous year's courses. An additional short presentation was prepared on geographical location systems, including map reference data, geo-reference systems and grid reference systems.

To reinforce the presentation on geographical location systems, a module on Google Earth satellite imagery was introduced by the Agency. This included lectures on some of the pitfalls of the system and the internet security implications if the system is used without due care. All of the course instructors were involved in the practical exercise that followed.

By using high-resolution imagery of nuclear facilities throughout the world, the Task Manager subsequently demonstrated where satellite imagery had been effectively used not only for planning of site inspections but for the detailed examination of clandestine activities. This included the application of change detection at reactor sites, conversion facilities, enrichment plants, reprocessing facilities, heavy water plant, uranium mining sites and high-active waste storage facilities.

The UKSP anticipates the Task Manager's further support to Vienna-based training of imagery analysts during 2008/2009.

SRDP REPORTS PUBLISHED OR IN PREPARATION DURING 2007/2008

D2(g) **SRDP-R302** "Methods and Algorithms for Tank Monitoring Evaluation Systems", J Howell.

- **SRDP-PR27** "Report on the Activities and Progress during the Period 1 April 2006 to 31 March 2007", J W A Tushingham.

ABBREVIATIONS

Abbreviation	Term
AWE	Atomic Weapons Establishment
BERR	Department for Business, Enterprise and Regulatory Reform
BNFL	British Nuclear Fuels Limited
BTC	BNFL Technology Centre
CESG	Communications-Electronic Security Group
CFE	Cost Free Expert
DAI	Data Analysis and Interpretation
DIE/V	Design Information Evaluation/Verification
DIV	Design Information Verification
EC	European Commission
EDX	Energy Dispersive X-ray
FDET	Fork Detector
FMAT	Fresh MOX Attribute Tester
GPS	Global Positioning System
IAEA	International Atomic Energy Agency
IM	Ion Microprobe
INVS	Inventory Sample Counter
IRMM	Institute for Reference Materials and Measurements
IRP	ISIS Re-engineering Project
ISIS	IAEA Safeguards Information System
JRC	Joint Research Centre of the European Commission
LEU	Low-Enriched Uranium
LSA	Laser Surface Authentication
MOX	Mixed Oxide
NDA	Non-Destructive Analysis
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
NRTA	Near Real Time Accountancy
NWAL	Network of Analytical Laboratories
PCDF	Plutonium Conversion Demonstration Facility, Tokai
PNCL	Passive Neutron Coincidence Collar Detector
RAE	Resistive Anode Encoder
R&D	Research and Development
RICC	Regional Information Collection Centre
RRP	Rokkasho Reprocessing Plant
SAL	IAEA Safeguards Analytical Laboratory
SEM	Scanning Electron Microscopy
SGIM	IAEA Safeguards Division of Information Management
SIAU	IAEA Satellite Imagery Analysis Unit
SIMS	Secondary Ion Mass Spectrometry
SMES	Solution Monitoring Evaluation System
SSAC	State System of Accountancy and Control
TAMES	Tank Monitoring Evaluation System
TEM	Transmission Electron Microscopy
THORP	Thermal Oxide Reprocessing Plant
TIMS	Thermal Ionisation Mass Spectrometry
TRP	Tokai Reprocessing Plant

UK	United Kingdom
UKAEA	United Kingdom Atomic Energy Authority
UKSP	United Kingdom Support Programme
URL	Uniform Resource Locator
US	United States of America
UV	Ultraviolet light
XML	Extensible Markup Language
XPS	X-ray Photoelectron Spectroscopy

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