SRDP-PR32

UK SAFEGUARDS SUPPORT PROGRAMME

Report on Activities and Progress during the period 1 April 2011 to 31 March 2012

J W A Tushingham

August 2012

UK Safeguards Support for the IAEA

The Nuclear Safeguards Programme is managed on behalf of the UK Department of Energy and Climate Change by the National Nuclear Laboratory. Further information on the Programme may be obtained from the Manager, Nuclear Safeguards Programme, National Nuclear Laboratory, Building 168, Harwell Science Campus, Didcot, Oxfordshire OX11 0QT, United Kingdom.

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This work was funded by the UK Department of Energy and Climate Change through the Safeguards Technical Support Programme to IAEA Safeguards.

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.

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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 2011 to 31 March 2012, the UK Support Programme contributed to 25 active tasks within the Department of Safeguards R&D Programme, completing work on 2 of these. 12 task proposals were considered during the year, of which 2 were accepted and 7 remained pending at the year-end. Activities undertaken included:

- continuing support to environmental sampling, with consolidation of UK analytical capabilities at AWE Aldermaston, provision of analytical expertise and the supply of libraries of isotopic data for different reactor and fuel types;
- further support to the design of a new IAEA nuclear material laboratory and a significant extrabudgetary contribution towards its construction;
- continued collection of open information from regional sources of States' industrial and nuclear research infrastructures, plus new insights into proliferation risks;
- delivery of training to IAEA inspectors and analysts, including new courses on negotiation skills and nuclear fuel cycle facilities in the context of State evaluation;
- development of a multichannel digital processing system for fast scintillators that interfaces directly with the IAEA shift register system for multiplicity assay; and

- provision of expertise in satellite imagery, through both training of the Agency's own imagery analysts and a five-year cost-free expert position within the IAEA Satellite Imagery Analysis Unit.

This report provides a summary of the progress on those tasks active during 2011/2012 within the framework of the UKSP.

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National Nuclear Laboratory, Harwell, 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 UK Support Programme is funded by the UK Department of Energy and Climate Change (DECC) and is administered on its behalf by the National Nuclear Laboratory (NNL). 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 2011 to 31 March 2012.

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. The IAEA safeguards system requires increased amounts and types of information on States' nuclear and nuclear-related activities. This information includes that provided directly by States (e.g. Additional Protocol 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 utilised within the Department of Safeguards in the planning and conduct of safeguards and to evaluate the correctness and completeness of State Declarations.

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-contractor:**	AWE Aldermaston
IAEA SPRICS No:	UK X01045	**UK Task Manager:**	P Thompson
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. Environmental swipes are taken by inspectors using 10x10cm cotton or round cellulose wipes of around 2.5cm diameter, the latter designed for use with remote manipulators and used exclusively within hot cells. In either case, the inspector wipes surfaces that may have been exposed to nuclear material, removing a portion of any surface contamination on the wipe for subsequent analysis. 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.

In recent years, the UK Support Programme has provided the services of two laboratories within the IAEA NWAL for environmental samples. AWE Aldermaston provided Fission Track Thermal Ionisation Mass Spectrometry (FT-TIMS) analysis of particles, whilst QinetiQ provided

a particle analysis service using Resistive Anode Encoder - Secondary Ion Mass Spectrometry (RAE-SIMS). The two techniques are complementary, and both were routinely requested by the IAEA.

In November 2010, QinetiQ announced that it was closing its analytical facilities and relinquishing its role as a Network Laboratory. The UK Support Programme subsequently worked with AWE to transfer the existing SIMS capability to its laboratory, with the aim for AWE to resume the provision of a SIMS analytical service whilst maintaining its existing FT-TIMS capability.

Summary Report on Activities in 2011/2012

AWE Aldermaston completed the procurement of a suite of particle analysis instruments from QinetiQ, including RAE-SIMS. Installation was completed within a newly refurbished facility during March 2012. In parallel, four former staff from QinetiQ were recruited by AWE, to ensure continuation of proficiency in the analysis of environmental swipes by RAE-SIMS. The performance of the transferred instruments is expected to be re-validated during the first half of 2012/2013, enabling AWE to resume a full RAE-SIMS service.

Meanwhile, to alleviate a shortfall in capacity within the NWAL during 2011/2012, AWE undertook the analysis of two batches of environmental samples, a total of nine swipe samples, using its existing SIMS instruments. Analysis involved the recovery of particles from swipes using an impactor particle extraction technique, 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. 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.

A further three high-priority samples were analysed by Scanning Electron Microscopy (SEM), providing data on the elemental composition of uranium particles and the presence of materials used within the nuclear fuel cycle.

AWE also completed the analysis of 16 samples by FT-TIMS, before temporarily closing down its service in 2012 for transfer of instruments to a newly refurbished laboratory. 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. Up to 20 particles were measured per sample, with additional information on particle morphology derived from measurements using SEM.

The IAEA will continue to require the analysis of environmental swipe samples by both FT-TIMS and SIMS in 2012/2013, and is looking to AWE Aldermaston to resume a full service as soon as practical.

In addition to direct analytical support, the UK Support Programme funded the participation of two staff members from AWE in the Department of Safeguards' Consultants' Group Meeting on particle analysis, held from 4-6 October 2011.

Task A5(h) – Review and Assessment of Air-Particulate Sampling Field Trials

IAEA SP-1 No:	09/IDS-001	**UK Sub-Contractor:**	Nicholson Environmental
IAEA SPRICS No:	UK A01822	**UK Task Manager:**	K Nicholson
IAEA Task Officer:	A Axelsson/M Penkin		

Background to Task

From 1997-1999, the UK Support Programme was involved in a detailed theoretical study, performed by experts from six Member States and coordinated by the Department of Safeguards, to determine the potential feasibility, practicability, and costs of wide-area environmental sampling (WAES) techniques to detect undeclared reprocessing and/or enrichment activities on a countrywide or large-area basis. The study identified atmospheric sampling as one of the most promising measurement techniques.

Three field trials of air particulate sampling were subsequently undertaken, from 2001 to 2005, to enable the Agency to make an initial evaluation of the potential of the technique as a means to detect undeclared nuclear activities. The first trial was undertaken around a large-scale reprocessing plant (Sellafield, UK), with subsequent trials around a large-scale enrichment plant (Capenhurst, UK) and a small-scale reprocessing operation (Gatchina, Russia). As the three trials were conducted independently and reported over a period of several years, the Agency considered there to be benefit in undertaking a review to integrate and summarise all the findings, the recommendations and the lessons learnt.

The UK Support Programme commenced preparation of the required report in 2009. The report was intended to identify the steps that remained to be taken before WAES might be deployed as an effective safeguards verification measure, including an assessment of the status of techniques.

Summary Report on Activities in 2011/2012

Feedback from the Agency on a draft report was collated and incorporated into a final version by the Task Manager, and subsequently edited and approved for issue late in the financial year. Submission of the report to the Department of Safeguards in April 2012 will complete this task.

Task A5(i) – WIMSD I/O Processor/GUI Development and Training

IAEA SP-1 No:	09/IDS-002	**UK Sub-Contractor:**	Serco Assurance
IAEA SPRICS No:	UK A01853	**UK Task Manager:**	N Davies
IAEA Task Officer:	A Axelsson/A Kochetkov		

Background to Task

Neutronics codes are used by the Department of Safeguards in the evaluation of results from inspection samples. Sample analysis results are compared with results from calculations, to judge whether they are consistent with declared or expected irradiation scenarios. The Agency requested the development of an updated version of an existing neutronics code, WIMSD, to enable staff to run quick generic calculations for typical representations of major reactor types.

The UK did not retain sufficient expertise in the development of WIMSD, whilst transfer of the commercially available WIMS9A code was considered to be too expensive. As an alternative, the Agency and UK Support Programme agreed upon the provision of libraries of isotopic data for different reactor and fuel types, based upon calculations to be performed using the state-of-the-art WIMS9A. Data on the isotopic composition of both reactor fuel and cladding and construction materials was to be provided in stages, during a task that was anticipated to be of one year's duration.

Practical work on the task commenced in September 2010, using a combination of WIMS9A and the FISPIN fuel inventory code. Series of calculations, covering isotopic compositions of fuel and cladding/structural materials for a range of fuel enrichments within Western PWR, Soviet PWR, CANDU, MAGNOX and AGR power reactors were completed. In each case, completed files were transmitted to the Agency together with details of the modelling parameters including: core and fuel geometry; fuel and moderator temperature and density; specific power; and the application of burnable poisons. Work then proceeded with a review of plutonium production and research reactors, to assess the availability of sufficient data to construct a practical model for eight selected reactor types. By the end of March 2011, work had been completed on libraries of data for the heavy-water-moderated NRX type reactor with low-enriched uranium (LEU) and high-enriched uranium (HEU) fuel, Australian HIFAR, Soviet TVR and TRIGA research reactors.

Summary Report on Activities in 2011/2012

2011/2012 saw completion of the original task, involving the modelling of a range of fuel scenarios for the remaining plutonium production and research reactors including the ISPRA reactor; a light water reactor with MTR-type plate fuel; a light water HEU research reactor (Soviet IRT-type); and a water-cooled graphite-moderated plutonium production reactor

(based on Hanford N). In addition, three irradiation scenarios were modelled. Descriptions of the principal modelling assumptions were provided to the Agency alongside each data library.

Following the success of the original task, in September 2011 the Agency requested further work to model additional reactor and fuel combinations. Practical work commenced with descriptions and modelling of the Western pressurised light water reactor (Westinghouse AP1000) with mixed oxide (MOX) fuel made from civil- and weapons-grade plutonium. Similar fuel scenarios were then modelled for the European pressurised light water (EPR-1600) and Russian pressurised light water (WWER-1000) reactors. By end-February 2012, the results from 34 calculations had been reported to the Agency.

Work continued with the calculation of isotopic compositions of fuel and cladding/structural materials for the following additional irradiation scenarios:

- RBMK power reactor (based on RBMK-1000) fuelled with LEU of four different enrichments;
- Irradiation of thorium fuel pins in CANDU bundles;
- IR-40 heavy water research reactor with natural uranium fuel;
- SAFARI tank-in-pool light water research reactor with HEU and LEU fuels; and
- OPAL pool-type light-water-cooled, heavy-water-moderated research reactor with LEU fuel.

Results from the modelling of RBMK and CANDU reactor scenarios were sent to the Agency in March 2012. The task will be completed during the first half of 2012/2013, with calculations of isotopic compositions for fuel and cladding/structural materials for the IR-40, SAFARI and OPAL research reactors under different fuel scenarios.

Task Area A6 - Satellite Imagery in Support of Safeguards

The UK Support Programme 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. Studies have shown that it is possible to develop sophisticated methods for detection of undeclared facilities or activities and to detect a change in activities in a declared facility.

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, NNL
IAEA Task Officer:	K Steinmaus/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 initially through the provision of an analyst experienced in the interpretation of satellite images pertaining to nuclear facilities. From 2003, the UK Support Programme assisted in the procurement of commercially available satellite images and equipment, whilst further support from imagery analysts was provided under Task Area F.

Summary Report on Activities in 2011/2012

A voluntary contribution under this task is offered each calendar year. In January 2012, the Agency responded by requesting that the funds be assigned instead to support open source information collection, and funds were duly utilised for this purpose from the 2011/2012 budget.

The UK Support Programme may consider a further contribution to open source information collection/satellite imagery in 2012/2013.

Task Area A7 – The Planning and Conduct of Safeguards

Strengthened and integrated safeguards has aimed at improving the effectiveness and efficiency of safeguards, in particular through the provision of credible assurance of the absence of undeclared activities in States, through an optimum combination of all safeguards measures available to the IAEA under a comprehensive safeguards agreement including those from Additional Protocols. The IAEA is evolving the State Level Concept (SLC) for the planning, conduct and evaluation of safeguards. The SLC, which is applicable to all States with a safeguards agreement, is objectives-based, less predictable and utilises all safeguards-relevant information about a State.

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

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

Background to Task

Strengthened and integrated safeguards changed the nature of safeguards and the knowledge required of those responsible for its implementation. An appreciation is required of safeguards concepts and how these concepts have become manifest in the legal framework and Agency practice. In 2004, a need was identified to provide a paragraph-by-paragraph commentary on INFCIRC/153, and an article-by-article commentary on INFCIRC/540. The

commentaries were intended to draw from negotiating histories, but would also include Secretariat assertions to the Board on how the measures included in agreements should be interpreted after 30 years of practice. Late in 2004, the Task Manager commenced work to compile the extensive reference material needed for the development of the commentaries.

It had been intended that the first draft would be completed by the end of 2005. However, difficulties encountered in reaching agreement on the scope and level of detail of the commentary, together with priority being given to assisting the Secretariat with preparations for a new Committee of the Board of Governors, delayed progress, and work halted in 2007. In 2009, the Agency renewed its interest in receiving a commentary and the task resumed as a joint undertaking with the IAEA, principally the Section Head for Non-Proliferation and Policy Making within the Office of Legal Affairs (OLA). Work on the commentary subsequently progressed with completion of introductory and background material addressing the IAEA safeguards system and its evolution, the nature of safeguards conclusions and the negotiation of the comprehensive safeguards requirement contained in the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). Sections dealing with the implementation of comprehensive safeguards agreements and the process of strengthening safeguards were also completed, and work commenced on a number of overarching implementation issues.

Summary Report on Activities in 2011/2012

The INFCIRC/153 and /540 commentary is intended to be a highly accessible description of the evolution of safeguards concepts, legal instruments and Agency practice: an internal working document to assist safeguards implementers.

During the first half of 2011/2012, consideration of a number of overarching issues was progressed to the extent possible without access to material in Vienna. These implementation issues included:

- Undeclared nuclear materials;
- Independent verification;
- Definition of a facility;
- Weaponisation;
- Open source information;
- Third party information;
- Environmental sampling;
- Special inspections;
- Unannounced inspections;
- Cooperation and access to individuals; and
- Confidentiality.

In October 2011, Mr Hooper travelled to Vienna, to continue the task in collaboration with OLA. Progress was dependent upon the availability of a compilation of OLA legal opinions regarding safeguards implementation issues, and these were compiled by a Junior Professional Officer (JPO) during the visit. This process took 2½ week's effort on the part of the JPO, with the resulting file of over 1,000 pages expected to provide Mr Hooper with the means to complete a first draft of the commentary. Irrespective of the Commentary, the file of legal

opinions will provide a significant contribution to OLA's ongoing knowledge management requirements.

A copy of a partial draft of the Commentary was provided to OLA upon Mr Hooper's departure from Vienna. Since then, he has continued to provide OLA with a proposed treatment of overarching issues, sending the information in instalments to make it more manageable.

It is hoped that a first draft of the Commentary will be completed during 2012.

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, NNL
IAEA Task Officer:	J Whichello		

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.

In 2006, 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. Since then, the UKSP has participated in Technical and Advisory Meetings on laser spectrometry techniques and antineutrino detection and has funded a visit by the IAEA Task Officer to the UK, in addition to assisting in the identification of appropriate expertise within the UK.

Summary Report on Activities in 2011/2012

An expert in antineutrino detection from Imperial College, London, participated in an ad-hoc expert advisory group on the use of antineutrinos for safeguards applications. The group, comprising twelve experts from six Member States, met in Vienna during September 2011.

The UKSP Coordinator attended a meeting of the Institute of Physics, in February 2012, on the subject of "Novel Methods for the Detection of Nuclear and Radioactive Materials".

Preliminary discussions were held with the Agency over support to Kore Technologies, which is working with the Department of Safeguards on the assessment of a portable gas mass spectrometer.

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

Task A7(k) - Acquisition Path Analysis Methodology and Software Package

IAEA SP-1 No:	10/CCA-004	**UK Sub-Contractor:**	Tessella plc
IAEA SPRICS No:	JNT C01871	**UK Task Manager:**	D Dungate
IAEA Task Officer:	I Tsvetkov/S Munoz		

Background to Task

Acquisition Path Analysis is an essential element of the State Level Concept, to determine whether a proposed set of safeguards measures would provide sufficient detection capability with respect to a specific acquisition path or acquisition strategy. To implement the SLC, it is necessary to perform an ongoing analysis of all safeguards-relevant information concerning a State and its relevance to the acquisition path for that State. Such analysis must be based on accepted safeguards methodology, to ensure the objectiveness and consistency of State evaluations, and should factor in expert judgements and State-specific factors for the evaluation.

The Agency proposed a task to provide a coordinated framework for Member State Support Programmes to work together within a dedicated IAEA work group to produce an accepted methodology, enhanced safeguards knowledge and customised software tools. The UK Support Programme accepted the task, initially to enable Tessella, a technology and consultancy company, to provide input to a proposed workshop on acquisition path analysis methodology.

Summary Report on Activities in 2011/2012

In June 2011, Tessella participated in a workshop comprising a series of presentations from the Agency and Member States followed by three working group sessions. An outcome from the meeting was a proposal that the UK prepare a report describing objective techniques for combining different sources of information into measures of likelihood or confidence in data that can be used in acquisition path analysis. It was agreed that Tessella would undertake work to:

1. Consolidate its understanding of the types of data and uncertainties that are applicable to the acquisition path problem, and what outputs are required;
2. Identify and review candidate techniques from literature and Tessella's previous experience that have the potential to be used in this context;
3. Identify a set of evaluation criteria for the methods and use these to analyse the benefits and drawbacks of each candidate approach; and
4. Select a shortlist of the best candidate techniques for further investigation or prototyping.

Tessella commenced the second of these activities, to identify and review candidate techniques with the potential to be used for combining different sources of information,

including Dempster-Schafer theory, fuzzy logic and possibility theory. However, no further work could be performed, as Tessella awaited specific examples from the Agency of the types of data input to the acquisition path analysis and the outputs required.

In March 2012, the Agency advised that it had almost finished defining the methodology for acquisition path analysis, having moved away from a mathematical approach to one that was less numeric. There was to be increased emphasis on 'estimator language', for example 'low to medium confidence' in propositions. Tessella's experience in qualitative techniques, such as avoiding cognitive biases, was therefore of greater relevance. It was agreed that the final report would include some demonstration of how these techniques work on example data.

Tessella provided a brief description of relevant qualitative techniques, to enable the Agency to provide appropriate data for Tessella to complete its work during 2012/0213.

Task Area A8 - Information Collection in Support of the Safeguards System

The IAEA Department of Safeguards requires broad access to geographically and linguistically diverse sources of safeguards-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. The analysis of such information, on scientific, technical, economic, political and nuclear-related developments, is now an integral component of the State evaluation process.

Task A8(e) – Regional Information Collection Centre 1

IAEA SP-1 No:	08/ICA-003	**UK Sub-contractor:**	King's College London
IAEA SPRICS No:	UK D01730	**UK Task Manager:**	J Kidd
IAEA Task Officer:	C Eldridge		

Background to Task

In November 2001, the UK Support Programme initiated the development of a Regional Information Collection Centre (RICC) within the International Policy Institute, King's College London (KCL). The RICC subsequently established methodologies for the collection of information to support the production of detailed surveys of States' industrial and nuclear research infrastructures. The KCL RICC, established under Task UK D01569, extended the Agency's ability to identify relevant information, without which the Agency's confidence in safeguards conclusions would be reduced.

Upon completion of Task UK D01569, the Agency prepared a new Task Proposal for the provision of open source information, to include monthly provision of scientific and technical original language abstracts, updated country profiles, ad-hoc reports and regular political

updates on the security situation and associated issues. Work commenced under the new task in April 2008.

Summary Report on Activities in 2011/2012

Collections of abstracts of open source information on nuclear-related issues, gathered from both English and regional language sources, were sent monthly to the IAEA during 2011/2012.

Five State Profiles were updated. In addition, an ad-hoc report on the subject of nuclear-related research was prepared. Updates on political issues were researched and sent to the Agency on six occasions during the year.

Activity will continue through 2012/2013, including expansion of existing information collection capabilities, the update of a further four State Profiles, the continued provision of abstracts and political updates and an ad-hoc report on a subject to be specified by the Agency.

Task A8(f) – Regional Information Collection Centre 2

IAEA SP-1 No:	08/ICA-002	**UK Sub-contractor:**	King's College London
IAEA SPRICS No:	UK D01728	**UK Task Manager:**	J Kidd
IAEA Task Officer:	C Eldridge		

Background to Task

From 2003 to 2008, a new RICC collected open source information on a second region. As a successor to this task, the Agency proposed a RICC to focus primarily on emerging nuclear programmes within the region. The new RICC would expand the region, whilst also updating existing reports. In addition, the RICC would continue the regular monitoring of open sources, providing abstracts of new information on a monthly basis. The task of providing this expanded RICC was accepted by the UK Support Programme, and work commenced in April 2008.

Summary Report on Activities in 2011/2012

Collections of abstracts of open source information on nuclear-related issues, gathered from both English and regional language sources, were sent monthly to the IAEA during 2011/2012.

Three State Profiles were updated, together with a new Profile of a fourth State and an ad-hoc report. Reviews on political issues were researched and sent to the Agency on six occasions during the year. This particular activity was undertaken with a financial contribution provided under separate contract between KCL and the Agency.

The work will continue through 2012/2013, to include the updating of four State Profiles and preparation of an ad-hoc report, in addition to the regular research and issue of scientific abstracts and political updates.

Task A8(h) – Improving the Analysis of Trade Data and Non-Technical Indicators for Safeguards-Relevant Proliferation Activities

IAEA SP-1 No:	09/ICA-012	**UK Sub-contractor:**	King's College London
IAEA SPRICS No:	UK D01916	**UK Task Manager:**	I Stewart
IAEA Task Officer:	P Schot		

Background to Task

To assist the process of information collection and analysis within the Department of Safeguards, support is required from Member States to develop methods and skills to find indications of non-declared safeguards-relevant proliferation activities. Task Proposal 09/ICA-012 sought to improve understanding of the availability and feasibility of predictive analytical approaches, develop capabilities to improve the recognition of non-declared activities through the assessment of non-technical indicators and consider methods to improve the acquisition of information. This was expected to include consultancies on trade analysis and export control.

The UK Government has an existing project on proliferation procurement. By December 2011, activities under the project had included:

- Engagement with hundreds of companies and tens of trade associations involved in dual-use industries;
- Gathering and analysing input on compliance and non-proliferation from 75 – 100 British companies; and
- Highlighting to national authorities the role the private sector should play in countering proliferation, together with recommendations on how this role can be realised.

Summary Report on Activities in 2011/2012

The UK project on proliferation procurement is of potential benefit to the Department of Safeguards, providing new insights into proliferation risks and how to enhance proliferation risk analysis and awareness. Task Proposal 09/ICA-012 was accepted by the UK Support Programme in December 2011, to enable the Agency to benefit from the research carried out under the UK project. During the remainder of the year, work included the preparation of proliferation briefs, detailing proliferation concerns and compliance requirements across themes including metals; machinery; and control systems, production of a training module in collaboration with Cranfield University and the launch of a proliferation awareness website.

The project also undertook analysis in two areas that will result in reports to be shared with the Agency during 2012/2013. The first will relate to how the private sector should be engaged to counter proliferation and the second will relate to trends in illicit procurement identified by the project.

AREA B - SUPPORT FOR IAEA ANALYTICAL SERVICES

Destructive Analysis (DA) 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 Nuclear Material Laboratory (NML), or to an accredited member of the IAEA NWAL in a Member State. Since its inception, the UK Support Programme has assisted with all aspects of destructive analysis, from on-site sampling trials through the development of analytical techniques and provision of equipment and standards to the development of processes for the treatment of analysis waste residues. More recently, support has focussed primarily on environmental sample analysis.

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 in order 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 inspectors 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 environmental sampling requires the development of new and improved methodologies for sample collection, preparation and analysis.

Task B1(t) – Consultant: NWAL for Nuclear Materials Expansion Study

IAEA SP-1 No:	08/TTS-004	**UK Sub-Contractor:**	NNL
IAEA SPRICS No:	UK C01742	**UK Task Manager:**	J Tushingham
IAEA Task Officer:	R Lafolie		

Background to Task

In 2006, the Task Manager chaired a workshop, convened by the Agency's Department of Nuclear Science and Applications, to consider the future requirements for analytical support to the Department of Safeguards and the need for renovation, replacement or substitution of the Agency's existing Safeguards Analytical Laboratory for nuclear materials. One of the main recommendations of that workshop was that the Agency should explore the possibility of expanding the existing NWAL for nuclear materials analysis.

Under the current task, the UK Support Programme subsequently explored the possibilities and practicalities of expanding the NWAL, and the degree of expansion required under different scenarios to provide the Department of Safeguards with sufficient analytical support to satisfy the timeliness and performance criteria for safeguards. The Task Manager chaired a Panel of Consultants, convened by the Agency to provide recommendations on the current and future requirements for analytical services, and provided further input to the Agency in respect

of advice on the draft plans for a new laboratory and the constraints on its mission that could be envisaged following the development of appropriate support from the NWAL. He completed a report on options for the utilisation of an NWAL for nuclear materials analysis, with emphasis on how to maintain a sustainable resource to supplement the Agency's in-house capabilities and mitigate against a single point of failure. In addition, he chaired a further Experts' Meeting in June 2010, convened by the Agency to review the conceptual design of the proposed new NML, and participated in a workshop on progress and developments in the programme "Enhancing Capabilities of the Safeguards Analytical Services" (ECAS) that drew significantly on the earlier UKSP contributions.

Summary Report on Activities in 2011/2012

During 2011/2012, the Task Manager provided further support to the ECAS Programme, fulfilling the roles of chairman and secretary to an additional Experts' meeting in May 2011. This meeting reviewed the 30% design for the new NML, reporting its conclusions to the Agency the following month. The overall conclusion of the Consultants was that the design was consistent with the analytical requirements and fully met, and in some cases exceeded, the minimum functional capability as established by the Experts Review Group of June 2010. It was highlighted that planning for transition from the existing laboratory to the new NML should begin as soon as possible, to minimise the impact on the ability of the Agency to meet its analysis requirements during the transition period. A transition plan would need to be fully understood as to considerations impacting personnel, equipment requirements, interim measures and future operational costs.

Additional advice and support was provided on request during the remainder of the year from within the UK. In January 2012, an extrabudgetary voluntary contribution of €500,000 was provided through the UK Support Programme, for application by the Agency in support of the ECAS/NML Programme.

Support will continue to be required by the Department of Safeguards, as it progresses transition arrangements to the new NML, and the UK Support Programme anticipates providing further assistance to the ECAS Programme during 2012/2013.

Task B1(v) – Evaluation of Ultra-High Sensitivity Secondary Ion Mass Spectrometry for Environmental Samples

IAEA SP-1 No:	08/IDS-002	**UK Sub-Contractor:**	AWE
IAEA SPRICS No:	UK A01776	**UK Task Manager:**	A J Pidduck
IAEA Task Officer:	K Vilece/L Sangely		

Background to Task

SIMS is employed by several laboratories within the IAEA NWAL for environmental samples, and the IAEA operates its own instrument in the Clean Laboratory. SIMS offers relatively rapid measurement of samples at moderate mass resolution and sensitivity, but the quality of data for minor isotopes is affected by high molecular ion interferences and low signal strength, leading to high uncertainty in results. The alternative technique of FT-TIMS

offers improved performance in the measurement of minor isotopes, which can provide important information in support of safeguards conclusions or detection of undeclared activities. However, FT-TIMS is available to very few laboratories and it is not considered feasible for the Agency to develop its own in-house FT-TIMS capability.

The Agency requires an independent capability to measure minor isotopes in environmental samples. In the absence of FT-TIMS, a more sophisticated type of SIMS instrument, Large-Geometry (LG) SIMS, was procured by the Agency, with installation to be completed during 2011. This new instrument should offer improvements in ion transmission, mass resolution and simultaneous multiple ion counting, resulting in data of higher quality, optimal for drawing safeguards conclusions. QinetiQ had access to an existing LG-SIMS instrument at Edinburgh University, in addition to its own conventional SIMS instruments. During 2008/2009, the UK Support Programme undertook comparative trials of conventional and LG-SIMS instruments, presenting the initial results at an IAEA Particle Analysis Consultants' Group Meeting in October 2009. Trials continued in 2010/2011, and work subsequently commenced on the preparation of a report on the UK SIMS comparison trials.

Summary Report on Activities in 2011/2012

The Task Manager completed a report summarising the results of earlier measurements by SIMS and SEM on a selection of samples provided by the Agency. This was subsequently revised, to provide updated information on LG-SIMS and the status of the NWAL, for issue in April 2012.

With the cessation of support to environmental sampling from QinetiQ in 2010/2011, and pending the transfer of instrumentation and recruitment of some of QinetiQ's former staff by AWE Aldermaston, the Agency sought expert support from QinetiQ's former staff in commissioning and operation of its own LG-SIMS instrument. The UK Support Programme provided funding to secure the services of a SIMS expert under a Special Service Agreement (SSA), running from December 2011 to February 2012 inclusive, to assist in developing the Agency's in-house capability.

The Agency wishes to continue to utilise the expertise of former QinetiQ staff, as it continues the development of an in-house LG-SIMS capability.

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 UK Support Programme 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	**UK Sub-Contractor:**	NNL
IAEA SPRICS No:	UK B01618	**UK Task Manager:**	S M Francis
IAEA Task Officer:	P Rodriguez/J M Crété/G Berthelot/D Lacey		

Background to Task

Courses on safeguards at bulk-handling facilities have been run for the benefit of IAEA inspectors by the UK Support Programme since 1992. During this period, over 300 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 and the overall duration of the course being reduced to two weeks.

Summary Report on Activities in 2011/2012

The course on safeguards and design verification at bulk handling facilities was successfully delivered to twelve IAEA inspectors, accompanied by two Agency tutors, from 2-12 May 2011. The itinerary included two days of classroom-based training, with lectures on Design Information, the Design Information Questionnaire (DIQ) and processes and essential equipment within reprocessing and LEU conversion and fabrication facilities. These were followed by six days of site visits, taking in facilities at Sellafield and Springfields, with a final day for reporting back and making presentations.

Exercises at Sellafield proceeded over a three-day period, encompassing THORP and Fuel Handling plants. Each group of three participants was given two assignments, with two groups covering General Arrangements and Material Flow and the others covering General Arrangements and Inventory. As in previous years, the party was joined by experts from THORP operations, with one expert assigned to each group.

The second week's schedule, at Springfields, commenced with a tour of the Oxide Fuels Complex and preparatory time for exercises. This was followed by a full day in the B633 Residue Recovery plant, which proved the most useful of the Springfields exercises. The final day on-site at Springfields then involved a site DIV exercise and Essential Equipment exercises within the A670 PWR fuel manufacturing facility. The course was completed off-site, with participants presenting the conclusions of their practical work.

The Agency confirmed its desire for the course to be repeated in May 2012, and arrangements for the 2012 course were subsequently progressed.

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

IAEA SP-1 No:	07/CTR-004	**UK Sub-contractor:**	NNL
IAEA SPRICS No:	UK B01698	**UK Task Manager:**	S M Francis
IAEA Task Officer:	K Dinov/S Pickett		

Background to Task

A principal objective of the IAEA safeguards system is to provide assurance of the absence of undeclared nuclear activities in Member States. Under the Additional Protocol, the Agency has wider access to information and facilities, intended to enhance its capability to detect such clandestine activities. In preparing for this extended role, the Agency developed a 'Physical Model' of the nuclear fuel cycle, drawing out a comprehensive set of indicators of nuclear fuel cycle activities.

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. A course was subsequently developed with the aim to provide:

- A high level of knowledge of process technologies associated with many fuel cycle facilities; and
- An understanding of the most typical technical indicators of possible undeclared activities that would be observable (either visually or analytically) during the implementation of safeguards at such fuel cycle facilities.

Over the next sixteen years, the course was run on 27 occasions by the UK Support Programme.

Summary Report on Activities in 2011/2012

Two Nuclear Fuel Cycle and Proliferation Pathways Courses were run in 2011, in June and November. 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 28th Proliferation Pathways Course was delivered to 16 participants from Operations and Support Divisions, with introductory lectures at IAEA Headquarters followed by a week-long residential course at Puchberg. The introductory lectures covered integrated safeguards and the State Level Approach, demonstrating the relevance of the course to objective-based and information-driven safeguards. The course that followed provided for one day of presentations and exercises per fuel cycle stage, with the UK Support Programme providing five experts who gave lectures on subjects including conversion, enrichment, reprocessing and reactors. For the June course, the reactor and reprocessing modules were revised to incorporate new material.

A further 16 participants attended the 29th Proliferation Pathways Course in November 2011. The course followed the same format as the previous one, with the UK Support Programme again providing five experts. For this course the exercises were revised, with the reprocessing module in particular being more balanced as a result.

Demand from inspectors for the course remains high, and a further two Proliferation Pathways Courses were requested by the Agency for 2012/2013. These are expected to be held in June and November, and planning for the courses commenced during the year. Further revision of course modules is expected, to reflect developments in safeguards and non-proliferation. In particular, it is intended that the enrichment module will be strengthened, to include the most recent developments in laser enrichment.

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

IAEA SP-1 No:	07/CTR-005	**UK Sub-Contractor:**	NNL
IAEA SPRICS No:	UK B01751	**UK Task Manager:**	S M Francis
IAEA Task Officer:	P Rodriguez/J M Crété/D Lacey		

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, 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 – 2007 and from 2009 - 2010. The course was not held in 2011, due to the unavailability of key plant areas and resources at Springfields.

Summary Report on Activities in 2011/2012

The UK Support Programme and Springfields Fuels Limited reviewed the options for a course in March 2012, but concluded that this could only be held during a period of production shutdown. After discussions with the Agency, and in light of an offer from another Member State Support Programme to host a course, it was agreed that a UK-based course would not be included within the Department of Safeguard's Training Plan for 2012.

The UK and IAEA will continue to liaise with respect to the possibility of holding Comprehensive Inspection Exercise events in the UK in future years.

Task C1(t) – Revision to Nuclear Fuel Cycle Training Manuals

IAEA SP-1 No:	07/CTR-010	**UK Sub-Contractor:**	NNL
IAEA SPRICS No:	UK B01727	**UK Task Manager:**	S M Francis
IAEA Task Officer:	S Pickett		

Background to Task

The Department of Safeguards requires up to date information on all parts of the fuel cycle, to train inspectors and to provide information and training to Member States. In 1985, a series of training manuals was prepared that described the technical aspects of fuel fabrication, research reactors, critical assemblies, nuclear power plants and reprocessing plants. In 2007, the Agency requested support in preparing new manuals, to reflect developments in the fuel cycle, plus expansion of the range to include the front end of the fuel cycle, waste and, most importantly, enrichment.

Technical descriptions were required, to include all current technologies and technologies under evaluation or development. Individual Member State Support Programmes were expected to take responsibility for preparation of the different manuals, with the UK Support Programme agreeing to provide the revised Fuel Fabrication and Power Reactor volumes. Work was subsequently undertaken on both manuals, with the Fuel Fabrication manual completed during 2010 and published the following year. However, the Power Reactor manual required further work, to broaden the scope to a worldwide focus, and this was subsequently undertaken before passing the manual to the Agency's Department of Nuclear Energy for review. Meanwhile, the UK Support Programme was requested to commence preparation of a Reprocessing manual. A layout and content were agreed and work commenced on drafting the early sections of the manual.

Summary Report on Activities in 2011/2012

The Task Manager continued with the preparation of a draft of the Reprocessing manual. This was completed during a week-long session in Vienna, in December 2011, which also provided the opportunity to work with the Task Officer and Operations Divisions in sourcing

appropriate illustrations. These, and an additional section on pyroprocessing prepared by the Agency, were incorporated into the manual for final review and editing by the Task Officer.

More limited progress was made on the Power Reactor volume, with the Task Manager completing the revision of sections that dealt with gas-cooled and boiling water reactors. Further consideration of the manual will be required in 2012/2013, to improve the focus on safeguards.

Task C1(u) – Limited Frequency Unannounced Access (LFUA) Training

IAEA SP-1 No:	08/CTR-004	**UK Sub-Contractor:**	Urenco Capenhurst
IAEA SPRICS No:	UK B01797	**UK Task Manager:**	C Taylor
IAEA Task Officer:	P Rodriguez/S Pickett/D Lacey		

Background to Task

Enrichment plants are some of the most proliferation-sensitive nuclear facilities, and it is important for inspectors to be able to implement Limited Frequency Unannounced Access (LFUA) activities in an efficient and effective manner.

In 2008, the Agency requested access to the UK's gas centrifuge enrichment plants at Capenhurst, including their cascade halls, to enable in-situ training. Representatives from Urenco participated in a two-day workshop on the feasibility and practicalities of Enrichment LFUA training, convened by the Agency. Approval was subsequently given by the ETC Quadripartite Committee for IAEA and DG-TrEn Inspectors to have access to cascade areas during an LFUA inspection course, subject to certain restrictions. A pilot LFUA course was held at Capenhurst in December 2009, providing the necessary information and experience to establish and finalise the course content for a regular LFUA course. The first full LFUA course was subsequently run under the Netherlands Support Programme, at Urenco (NL) Almelo, in September 2010, and a second course was run at Capenhurst, in January 2011.

Summary Report on Activities in 2011/2012

A third LFUA course was held at Gronau, under the auspices of the German Support Programme, in October 2011. The course followed the training schedule of the previous events, with a series of lectures, exercises including visual observation and swipe sampling along the agreed LFUA routes, and demonstrations of sampling and mailbox interrogation procedures. The UK Support Programme enabled the continued participation of Urenco UK staff, as part of a team from the three Urenco sites used to facilitate the course.

Further UK support to a fourth LFUA course, to be held at Almelo, is anticipated for 2012/2013. This will be followed by another course at Capenhurst, as Urenco seeks to share the burden for hosting the course between its British, Dutch and German plants.

Task C1(v) – Negotiation Skills Training Course

IAEA SP-1 No:	10/CTR-006	**UK Sub-Contractor:**	ADRg Ambassadors
IAEA SPRICS No:	UK B01874	**UK Task Manager:**	P Jenkins
IAEA Task Officer:	R Barnes		

Background to Task

To deal confidently with awkward situations arising from disagreements with local, regional and State authorities and facility personnel in planning, conducting and reporting safeguards inspections and other activities based on Safeguards Agreements, inspectors need to develop specific listening and negotiation skills. Specific skills include direct/positive speaking, careful listening, open questions, impartiality, confidentiality, emotions, self-esteem and face-saving strategies, handling values, differing ethnic/cultural value systems and dealing with 'spoilers' and 'bad leaders'.

Late in 2010, the UK Support Programme was requested to provide training to senior inspectors in diplomatic negotiation skills, utilising a team of former diplomats with high-level experience in negotiation and professional mediation.

Summary Report on Activities in 2011/2012

During May 2011, the former Permanent Representative of the United Kingdom to the IAEA conducted a detailed needs assessment based on interviews and consultation with Agency staff. This not only facilitated the preparation of course materials, in particular role-play scenarios tailored to the specific situations in which inspectors are likely to need to deploy advanced negotiating techniques, but provided a supply of case histories to the Department of Safeguards knowledge bank.

A course was developed with the purpose to help experienced negotiators fine-tune their skills, with an emphasis on providing insights and guidance applicable in all structured negotiating situations, and specific tips for dealing with inflexible interlocutors and for handling issues arising from cultural differences and difficult personality traits. Four consecutive half-day training sessions were subsequently provided in June 2011by two former UK Ambassadors to twelve senior inspectors and section heads, including role-plays based on real-life professional challenges typically encountered by the participants.

The training was very well received by the Agency, which requested that the course be held on an annual basis. Following a further period of research, to fine-tune the training and provide additional scenarios, a second course on negotiation skills was scheduled for senior inspectors and other Agency personnel involved in negotiations with Member States during May 2012.

Task C1(w) – Advanced Training on NFC Facilities to Assist State Evaluation

IAEA SP-1 No:	11/CTR-004	**UK Sub-contractor:**	NNL
IAEA SPRICS No:	UK B01903	**UK Task Manager:**	S M Francis
IAEA Task Officer:	S Pickett		

Background to Task

In support of the Agency's strengthened and integrated safeguards approach, from 2000 to 2011, the UK Support Programme provided an advanced course in the process technologies associated with fuel cycle facilities and the equipment employed.

The Section Head for training within the Department of Safeguards attended the March 2011 course, to assess its continuing effectiveness against a goal of safeguards that are objectives-based and utilise all safeguards-relevant information. As a result, and following correspondence between the Agency and UK Support Programme, agreement was reached to replace the existing course with one that would provide the opportunity for safeguards staff, in particular inspectors and analysts with significant responsibilities in State Evaluation, to apply knowledge gained and competencies acquired during the Proliferation Pathways course. Physical access to conversion and fuel fabrication plants, reactors and reprocessing plants would still be required, but the new course would not require access to an enrichment plant.

Summary Report on Activities in 2011/2012

Following development of a detailed course schedule, a pilot course was delivered to nine participants in October 2011. This included an introduction in Vienna followed by a week of detailed technical visits to sites, plant and equipment at Sellafield and Springfields. A post-course review and detailed feedback from the course participants was used to optimise the course content.

A second course was held during the last week of March 2012, following an introductory session that focussed on open source information related to the Sellafield and Springfields sites, including satellite imagery. As with the first course, nine participants took part, with three IAEA trainers and UK experts in support. At Sellafield, detailed tours included Calder Hall; the Fuel Handling Plant; MAGNOX and THORP Reprocessing Facilities; the vitrification plant; laboratory areas and the low-level waste facility at Drigg. At Springfields, a similarly detailed level of visits encompassed main line chemical plants; the Oxide Fuels Complex, Enriched Uranium Residues Recovery Plant and fuel fabrication areas.

Overall, feedback from the course participants was very positive. Compared with the pilot course, the course content was considered to be better balanced and the UK Support Programme agreed to host a further course in October 2012, with a fourth course tentatively scheduled for March 2013.

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 initially at reprocessing plants, many of the methods can be adapted to other types of facility in the fuel cycle.

Task Area D2 - Near Real Time Accountancy

Near Real Time Accountancy (NRTA) is a tool developed 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. The methodology of solution monitoring can be adapted to other stages of the fuel cycle, such as enrichment or fuel fabrication, where material flows require monitoring.

Task D2(h) – Development of a Software Tool to Simulate the Nuclear Material Accountancy System for MOX Facilities

IAEA SP-1 No:	10/OA2-001	**UK Sub-Contractor:**	University of Glasgow
IAEA SPRICS No:	UK D01878	**UK Task Manager:**	J Howell
IAEA Task Officer:	K Zhao		

Background

A software tool to simulate the nuclear material accountancy system for MOX facilities was required by the Agency, to support review of the operator's accountancy system design and the refinement of safeguards approaches for the J-MOX facility. The tool would make it possible to simulate the movement of nuclear materials associated with plant operation parameters and generate simulated accountancy records based upon the design specifications of the operator's and inspector's accountancy measurement systems. With such simulated information, the Agency would be able to assess further the properties of statistics in nuclear material accounting under different diversion scenarios, identify major contributors to MUF sources specific to the facility and compare the effectiveness of different safeguards approaches.

Glasgow University had previously worked on the development of a simulation tool for MOX facilities, and the Agency sought development of a prototype software written in Python, set up with model MOX plant parameters for demonstration purposes. The UK Support Programme agreed to fund enhancement of the existing discrete simulation of the movement of material through a MOX facility. Most movements are in cans, so the simulation focuses on their filling, emptying, measurement and storage. The aim is to simulate the data an

operator would have available on a day by day basis, together with the true values behind this data. Accountancy results would then derive from this data, combined with hold-up measurements made in the facility.

Summary Report on Activities in 2011/2012

The existing package required enhancement to accommodate:

- the flexible provision of balance, NDA and DA measurement points;
- simulation of the addition of binding material and of its partial evaporation;
- addition of measurement error models including tare weight handling;
- simulation of heel carry-over in internally re-used cans;
- addition of scrap recycle; and
- the need for graphics, to show the movement of cans etc.

All of the above enhancements were completed between April and December 2011, and a draft report and sample studies were produced. A meeting was held at IAEA Headquarters in December 2011 to review progress, at which the end-users requested further refinement, to provide a more flexible tool, before commencing in-house studies. A number of additional enhancements were identified, requiring:

- output of the build-up of glovebox holdups;
- provision of repeatable random number sequences;
- consideration of the program software control;
- addition of columns for systematic errors; and
- improvements to the recycling component of the simulation, with dosing to be recalculated based upon destructive analysis.

The above enhancements are expected to be completed during 2012/2013.

AREA E - INSTRUMENT DEVELOPMENT AND ASSESSMENT

New types of nuclear plant, and facilities that handle increased throughput of nuclear material, require the development of new instrumentation and equipment in order to apply safeguards in an effective and efficient manner. The effective application of safeguards requires not only new equipment but improved computer systems in order to collate and assess data from a range of sources. Nuclear materials and the instruments used in their verification must be secure and not vulnerable to tampering. 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 during equipment development, to optimise design, prior to implementation and periodically during the lifetime of the equipment, to account for advances in technology. 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, and to foster collaboration between developer and assessor in order to optimise resistance to tamper. The assessment techniques applied may be defined by the IAEA, who will highlight specific features or applications for analysis. Equally, the assessor may be left to utilise a broad range of technologies in an attempt to exploit potential vulnerabilities. The results from assessments are provided in confidence to the IAEA.

Task E10(j) - Laser Surface Authentication Prototype Test and Evaluation

IAEA SP-1 No:	08/TSR-003	**UK Sub-contractor:**	Ingenia Technology
IAEA SPRICS No:	UK E01762	**UK Task Manager:**	J Tushingham, NNL
IAEA Task Officer:	B Wishard		

Background to Task

Laser Surface Authentication (LSA) is a technique developed in the UK, to identify materials using an intrinsic fingerprint extracted by a laser scanning device. Such a method, if successfully proven, could lead to automation of seals identification within the Agency's Seals Laboratory, and could also enable authentication of seals on site or in-situ, in addition to increasing confidence in the integrity of the metal seal.

The Department of Safeguards requested that the UK Support Programme provide financial assistance towards the procurement of two prototype LSA instruments plus one field scanner. These were to be utilised in a vulnerability assessment and parallel development work within the IAEA's seals laboratory. In March 2009, the UK Support Programme completed a voluntary financial contribution towards the procurement of LSA equipment from Ingenia Technology. Ingenia Technology worked directly with the Agency during the following year, supplying two laboratory LSA instruments and a portable scanner for evaluation at the Seals

Laboratory. The performance of the instruments was generally satisfactory, although difficulties were encountered in reading the serial numbers engraved on the seals when using the in-built character recognition software, particularly in the case of mechanically deformed or corroded seals.

Summary Report on Activities in 2011/2012

Ingenia Technology continued to work directly with the Agency, so that this task was effectively on standby from a UK Support Programme perspective. The use of a 2D barcode on the seals was successfully implemented as a solution to the difficulties encountered in reading serial numbers. Meanwhile, the Agency proceeded to a full vulnerability assessment by the General Physics Laboratory, Moscow, which was completed in January 2012. Application of LSA, and further assistance from the UK Support Programme, will depend upon the conclusions from this assessment.

Task Area E11 - Technical Documentation

The Agency requires documentation to a standard format for safeguards instrumentation, including a Reference Manual for Instrumentation and a Checklist Procedure. The UK Support Programme 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:	08/TAU-001	**UK Sub-contractor:**	Canberra UK Ltd
IAEA SPRICS No:	UK A01729	**UK Task Manager:**	C Wilkins
IAEA Task Officer:	H Klein		

Background to Task

Previous tasks, UK A01031 and UK A01408, involved the provision of simplified documentation for instrumentation including 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). A new Task Proposal, for the preparation of further Reference Manuals and Checklist Procedures, was accepted by the UK Support Programme in March 2008. Work subsequently proceeded with completion of documentation for the Active Well Coincidence Counter (AWCC), High-Level Coincidence Counter (HLCC) and Triangular Load Cell.

At the beginning of 2011, two additional instruments were identified by the Agency that required documentation updates:

- ATOMTEX Backpack Radiation Monitor; and

- ICx Raider.

Following a visit to the Agency by Canberra's technical author, both instruments were received on loan. Draft documentation for the Raider was completed, and was in progress for the ATOMTEX by end-March 2011.

Summary Report on Activities in 2011/2012

Draft documentation for the Backpack Radiation Monitor was completed and supplied to the Agency during April 2011, and the instruments were then returned to the Department of Safeguards. Feedback was received from the Task Officer by end-July 2011, including the need to revise both the text and illustrations within the manuals to reflect revisions to the instrument software and proposed use since the documentation was prepared.

Modified documents for the Backpack Radiation Monitor were prepared, and presented to the Agency in November 2011.

In early December 2011, the Agency provided the further loan of an ICx Raider, to enable required updates to the Raider documentation to be carried out. Work on these documents was completed during January 2012 and resubmitted to the Task Officer. The ICx Raider unit was subsequently returned to the Agency.

The UK Support Programme anticipates contributing to the preparation of further documents, in response to requests from the IAEA, during 2012/2013.

Task Area E12 – Development of Remote Monitoring Techniques and Equipment

The UK Support Programme provides support to equipment development tasks in areas where its particular expertise or experience in facility application is essential.

Task E12(c) – Upgrade of the Continuous Enrichment Monitoring System (CEMO)

IAEA SP-1 No:	08/TAU-002	**UK Sub-contractor:**	Canberra-UK Ltd
IAEA SPRICS No:	UK A01763	**UK Task Manager:**	M Wormald
IAEA Task Officer:	A Lebrun		

Background to Task

A continuous enrichment monitoring (CEMO) system had previously been developed under the UK Support Programme, based on low energy resolution gamma spectrometry, to deliver qualitative information on gas centrifuge enrichment plant operational status to the Agency via telephone line. Two systems were installed at a gas centrifuge enrichment plant, and these yielded satisfactory results. However, component and architecture obsolescence, and

association with maintenance-intensive ^{109}Cd sources required for pressure correction purposes, made it desirable to develop an improved CEMO system.

The Agency sought assistance, to enhance its capability to monitor continuously uranium enrichment at the cascade output. This was to be achieved through development of an improved CEMO, within an architecture supporting modular implementation at sites of different size and configuration. The UK Support Programme offered contributions both to the preparation and design of equipment, through feedback on the suitability of different options, and the field testing of a demonstration system. The latter would be subject to approval from the ETC Quadripartite Committee. However, as no other Member State Support Programme offered support to the task, work within the UK was ultimately limited to the preparation of a report describing options for a new CEMO, particularly in the context of reduced maintenance and increased reliability.

Summary Report on Activities in 2011/2012

The final report on options for a new CEMO was issued to the Agency in June 2011. The broad conclusion of the report was that a modified CEMO, designed to use pressure information provided by gauges under the control of the operator, was feasible. The proposed solution would see most of the hardware and software functions transferred into the measurement head, and estimates of the cost of equipment development, manufacture and implementation, as Canberra UK would approach the project, were included.

The report was subsequently used by the Agency to refine the user requirements for an on-line enrichment monitor, under development by the US Support Programme.

Task E12(d) – On-Line Enrichment Monitor (OLEM)

IAEA SP-1 No:	10/TAU-004	**UK Sub-contractor:**	-
IAEA SPRICS No:	UK A01868	**UK Task Manager:**	J Tushingham, NNL
IAEA Task Officer:	L Smith		

Background to Task

The concept of an On-Line Enrichment Monitor (OLEM), enabling a relative enrichment measurement on a header pipe, is seen by the Agency as a powerful and direct way to support the goal of ^{235}U material balance in large-scale enrichment plants. The intention would be to install OLEM at Gas Centrifuge Enrichment Plants to monitor permanently and accurately the uranium enrichment of uranium hexafluoride in unit header pipes through application of passive gamma spectrometric measurements.

Task Proposal 10/TAU-004 was issued by the Agency in March 2010, with the scope to develop the measurement technology and system architecture required to measure and record accurate enrichment of the uranium hexafluoride circulated in the three high pressure unit header pipes (Feed, Product and Tails) of each enrichment unit. A phased approach was foreseen, commencing with system design and cost evaluation against IAEA user requirements. This was to be followed, subject to positive evaluation, by manufacture and subsequent demonstration on an appropriate test bed facility.

Urenco agreed to allow a field test of an OLEM of US origin at its Capenhurst enrichment plant. Contractual arrangements were agreed late in 2010. US and Agency parties subsequently met at Urenco Capenhurst in January 2011, to enable the US side to gather preliminary analysis data at a product header pipe location and to discuss the preliminary results with meeting participants.

Summary Report on Activities in 2011/2012

An on-site field trial progressed through 2011/2012 without call on the resources of the UK Support Programme. Urenco (Capenhurst) worked directly with the IAEA and US parties to facilitate testing.

Task E12(e) – Support for the Safeguards Systems at the JNFL MOX Fuel Fabrication Plant (J-MOX)

IAEA SP-1 No:	08/OA2-001	**UK Sub-contractor:**	Hybrid Instruments
IAEA SPRICS No:	UK A01887	**UK Task Manager:**	M Joyce
IAEA Task Officer:	A Lavietes		

Background to Task

Neutron detectors play an essential role in NDA systems for plutonium measurement, such as those that will be required to be installed at J-MOX. ^{3}He is widely used in neutron detectors due to its outstanding γ-ray rejection properties. Recently, a world-shortage of ^{3}He has led to renewed interest in systems based upon ^{10}B and even ^{6}Li. However, what all these systems lack is an ability to detect fast neutrons: the neutrons emitted by plutonium must be slowed down to energies in thermal equilibrium with their surroundings.

The Mixed Field Analyser (MFA) produced by Hybrid Instruments, a UK start-up company, is a small, portable instrument that performs real-time neutron/gamma discrimination of scintillator pulses for direct input into a data acquisition and analysis system. The instrument was evaluated by the IAEA, at its Headquarters in Vienna and then at Rokkasho in Japan, and found to offer superior performance to any other development in neutron detection. The UK Support Programme was requested to enable its further development and the first phase of the task, upgrade of the Agency's existing instruments, was subsequently completed during 2010/2011.

Summary Report on Activities in 2011/2012

The second phase of the project involved the development of an advanced MFA with the following performance specification enhancements:

- Three parallel data processing channels;
- One million counts per second throughput per channel;
- Signal processing timing jitter of less than 5ns;
- Channel to channel timing jitter of less than 5ns; and

- An industrial operating temperature range of -40°C to +85°C.

The Phase 2 design was completed and optimised, improving size; reliability; and channel timing, whilst affording the ability to integrate four detectors. Work proceeded with additional developments including:

- A means to incorporate a nonlinear threshold for optimisation of neutron/gamma discrimination;
- Improvements to the graphic user interface; and
- Upgrading of the dynamic range of the preamplifier input circuitry, for compatibility with the IAEA Special Liquid Cell

One unit was subjected to a period of testing at the National Physical Laboratory, confirming performance and functionality. Further arrangements for user evaluation were subsequently pursued by the Agency.

The outcome of the task was successful testing of the only multichannel digital processing system for fast scintillators which interfaces directly to the IAEA shift register system for multiplicity assay. As such, the Agency is expected to request further development, leading to a prototype measurement instrument, during 2012/2013.

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:	J Becar		

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 UK Support Programme made available 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 Director-SGIM and DDG-Safeguards.

Summary Report on Activities in 2011/2012

The UK's consultant remained available to give ad hoc support to the IRP Project Management Team, provide informal progress reports and highlight any issues to the Director, SGIM. The Agency anticipated requesting support for a health check of the contractual situation before the end of 2011. However, no request for support was received, and consequently no work was undertaken on this task during the year.

Task F1(d) – Consultant: 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/S Robb		

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 CFE 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 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 operations 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 2011/2012

The Agency proposed a new programme for a two-day Satellite Imagery Awareness training course, built upon needs expressed by Operations and Analysis Divisions. In November 2011, two back-to-back sessions of the revised course, supported by the Swedish and UK Support Programmes, were held in Vienna. The Task Manager contributed:

- A brief history of satellite imagery analysis;
- An interactive session on basic imagery analysis skills;
- Globetrotting, using imagery analysis skills to assess worldwide nuclear facilities; and
- Geolocation, a basic introduction to coordinate systems.

A week of specialised nuclear fuel cycle imagery analysis training was also provided, in March 2012. This included introductory training for two newly recruited analysts and more specialised sessions directed primarily towards imagery analysts actively employed on priority analytical duties. In addition to existing course material on the nuclear fuel cycle, a number of new presentations were offered including various aspects of explosive ordnance and fertilizer production plant and facilities.

Further support is anticipated to be provided during 2012/2013 including, in May 2012, participation in an IAEA workshop on satellite imagery in support of safeguards activities, at which the Task Manager will provide the keynote speech.

Task F1(e) – Expert: Satellite Imagery/Geospatial Analyst

IAEA SP-1 No:	08/ICA-010	**UK Sub-contractor:**	M Flory
IAEA SPRICS No:	UK D01794	**UK Task Manager:**	J Tushingham, NNL
IAEA Task Officer:	K Steinmaus		

Background to Task

In order to respond effectively to increasing demands for imagery-driven products and services, the SIAU needs to maintain and grow its current analytical capabilities. CFEs are required in the areas of satellite imagery and geospatial analysis, to supplement in-house expertise, to analyse commercial satellite imagery and related geospatial information, and to contribute to the enhancement and automation of analytical processes within the Unit.

During 2008, the Agency approached a number of Member State Support Programmes, seeking the nomination of imagery experts for two-year posts within the SIAU. The Agency accepted the UK Support Programme's nomination of a candidate for the position of satellite imagery cost-free expert in January 2009, and an extrabudgetary voluntary contribution, equivalent to the costs associated with the first year of employment of the expert by the Agency, was made the following month. The nominated CFE commenced work with the Agency in September 2009, in a position that was subsequently extended to September 2012.

Summary Report of Activities in 2011/2012

The UKSP-sponsored imagery analyst completed his second year with the Agency, and commenced a third year working within the SIAU. During this period, he continued to gain familiarity with the workflow within the unit, and the production of imagery analysis reports in support of safeguards monitoring and verification activities. He authored several reports, suggesting process improvements based on his experience as an imagery analyst, whilst continuing to work closely with Agency staff in operations and evaluation divisions. He participated in training and site awareness visits, to maintain and develop relevant skills and expertise, and developed additional training materials in support of SIAU and other Agency personnel.

In addition, following the Japan earthquake of March 2011 and subsequent developments, he supported the Agency's Incident and Emergency Centre through daily imagery analysis of

Japanese nuclear sites and the dissemination of imagery-derived products for use in Member State briefings on the crisis.

Agreement was reached for the imagery analyst's duties to extend for a total of five years, and an extrabudgetary contribution to support the fourth and fifth year's activities was made to the Agency at the end of the 2011/2012 financial year.

Task F1(f) – Nuclear Fuel Cycle Specialist Assistance

IAEA SP-1 No:	09/ICA-004	**UK Sub-contractor:**	Various
IAEA SPRICS No:	UK D01819	**UK Task Manager:**	J Tushingham, NNL
IAEA Task Officer:	S Robb		

Background to Task

The SIAU requires technical support from specialists in the nuclear fuel cycle, to assist on priority imagery analysis tasks to complement or supplement in-house expertise. This task was accepted in order that the UK might provide such support on an ad-hoc basis, in response to specific requests.

Following acceptance of the task, it became apparent that there was a wider requirement, within the Department of Safeguards as a whole, for ad-hoc technical support. The scope of the task was subsequently expanded in order to accommodate this requirement.

Summary Report of Activities in 2011/2012

During the year, the UK Support Programme provided expert assistance in three areas.

The first involved a week-long technical consultancy in October/November 2011, to assist in the design of a safeguards approach for a facility.

A second expert provided advice on aspects of the front end of the nuclear fuel cycle in November 2011.

Finally, an expert in process monitoring continued to support the Agency. Four visits to IAEA Headquarters were made for this purpose during the year, in addition to which the expert prepared a small program that may be used by inspectors in the field. This work remained ongoing at the end of the year.

The UK Support Programme was also requested to support a bespoke Vienna-based training event. Preparation for this training was in progress at the year-end.

ADDITIONAL MEETINGS AND ACTIVITIES

The UK Support Programme receives each year a small number of requests outwith specific tasks, for members of the UK nuclear industry or associated experts and advisors to attend safeguards-related meetings convened by or contributing to the Department of Safeguards. During 2011/2012, support was provided to enable the attendance of appropriate experts in the following technical meetings and workshops:

"Technical Meeting on the Accountancy and Control of Nuclear Material for Nuclear Security at Facilities", 26-28 April 2011, Vienna.

"Drafting Group Meeting on the use of Nuclear Material Control and Accountancy for Nuclear Security at Facilities", 26-30 September 2011, Vienna.

"Consultancy Meeting on Proliferation Resistance Aspects of Process Management and Process Monitoring/Operating Data", 28-30 September 2011, Vienna.

"Technical Meeting on Particle Analysis of Environmental Samples for Safeguards", 4-6 October 2011, Vienna.

"Workshop on Sealing, Containment and Authentication Technologies", 9-11 November 2011, Vienna.

"Workshop on Science and Technology Innovation and IAEA Department of Safeguards Long-term R&D", 16-20 January 2012, Vienna.

"Member State Support Programme Coordinators' Meeting", 13-16 March 2012, Vienna.

In addition, the UK Support Programme continued to provide funds to enable staff from the Department of Safeguards to undertake approved visits in connection with activities under the UKSP.

SRDP REPORTS PUBLISHED OR IN PREPARATION DURING 2011/2012

A5(h) **SRDP-R305** "Review of Air Particulate Sampling for Potential Application in Safeguards", K W Nicholson. (Approved for issue)

B1(v) **SRDP-R308** "A Comparison of Standard SIMS, Large-Geometry SIMS and SEM-EDX Analysis of Selected Environmental Swipe Samples", A J Pidduck, M R Houlton, G M Williams and P O Jackson. (Approved for issue)

E12(c) **SRDP-R304** "A Study of Options for Continuous Enrichment Monitors for use in Nuclear Safeguards of Gas Centrifuge Enrichment Plants", M Wormald. (Issued June 2011)

SRDP-PR31 "Report on the Activities and Progress during the Period 1 April 2010 to 31 March 2011", J W A Tushingham. (Issued August 2011)

ABBREVIATIONS

Abbreviation	Term
AGR	Advanced Gas-cooled Reactor
AWE	Atomic Weapons Establishment
BNFL	British Nuclear Fuels Limited
CANDU	Canadian Deuterium Uranium Reactor
CEMO	Continuous Enrichment Monitor
CFE	Cost Free Expert
DA	Destructive Analysis
DDG	Deputy Director General
DG-TrEn	Directorate General for Transport and Energy of the European Commission
DIQ	Design Information Questionnaire
DIV	Design Information Verification
ECAS	Enhancing Capabilities of the Safeguards Analytical Services
ETC	Enrichment Technology Company
FFP	Fuel Fabrication Plant
FISPIN	A Fuel Inventory Code
FT-TIMS	Fission Track-Thermal Ionisation Mass Spectrometry
GUI	Graphic User Interface
HEU	High-Enriched Uranium
HIFAR	High Flux Australian Reactor
IAEA	International Atomic Energy Agency
INFCIRC	IAEA Information Circular
I/O	Input/Output
IRP	ISIS Re-engineering Project
IRT, ISPRA	Designs of research reactor
ISIS	IAEA Safeguards Information System
J-MOX	Japanese Mixed Oxide facility
JPO	Junior Professional Officer
KCL	King's College, London
LEU	Low-Enriched Uranium
LFUA	Limited Frequency Unannounced Access
LG-SIMS	Large Geometry-Secondary Ion Mass Spectrometer
LOF	Location Outside Facility
LSA	Laser Surface Authentication
MAGNOX	A graphite-moderated, gas-cooled reactor (originally with MAGnesium Non-OXidising fuel cladding)
MFA	Mixed Field Analyser
MOX	Mixed Oxide
MTR	Materials Test Reactor
MUF	Material Unaccounted For
NDA	Non-Destructive Analysis
NFC	Nuclear Fuel Cycle
NML	Nuclear Material Laboratory
NNL	National Nuclear Laboratory
NRX	A heavy-water-moderated, light-water-cooled research reactor
NWAL	Network of Analytical Laboratories

OLA	IAEA Office of Legal Affairs
OLEM	On-Line Enrichment Monitor
PWR	Pressurised Water Reactor
R&D	Research and Development
RAE	Resistive Anode Encoder
RBMK	A graphite-moderated, water cooled reactor
RICC	Regional Information Collection Centre
SEM	Scanning Electron Microscopy
SGIM	IAEA Safeguards Division of Information Management
SIAU	IAEA Satellite Imagery Analysis Unit
SIMS	Secondary Ion Mass Spectrometry
SLC	State Level Concept
SSA	Special Service Agreement
THORP	Thermal Oxide Reprocessing Plant, Sellafield
TIMS	Thermal Ionisation Mass Spectrometry
TRIGA	A pool-type reactor
TVR	A design of research reactor
UK	United Kingdom
UKSP	United Kingdom Support Programme
US	United States of America
WAES	Wide Area Environmental Sampling
WIMS	Winfrith Improved Multigroup Scheme, a neutronics code

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