



SRDP-PR35

Department
of Energy &
Climate Change

UK SAFEGUARDS SUPPORT PROGRAMME

**Report on Activities and Progress during the period
1 April 2014 to 31 March 2015**

J W A Tushingham

August 2015

UK Safeguards Support for the IAEA

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This work was funded by the UK Department of Energy and Climate Change through the UK 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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UK SAFEGUARDS SUPPORT PROGRAMME

Report on Activities and Progress during the period 1 April 2014 to 31 March 2015

J W A Tushingham

EXECUTIVE SUMMARY

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

- 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 2014 to 31 March 2015, the UK Support Programme contributed to 27 of its 33 active tasks within the IAEA Department of Safeguards Technical Support Programme, whilst a further two tasks were ‘on standby’. Activities undertaken included:

- continuing support to environmental sampling: with the analysis of 40 inspection samples; validation of an improved analytical technique; and reactor modelling to support the evaluation of analytical data;

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- promotion of UK technology solutions to meet current and future safeguards challenges identified in the Department of Safeguards' Instrumentation Technology Foresight project;
- provision of open source information, with nine State Profiles updated and two ad-hoc reports issued; and the completion of 14 manufacturing base reports on the global manufacturing base of specific proliferation-relevant technologies;
- application of new analytical capacity to the characterisation of samples;
- delivery of 14 training events to IAEA inspectors, analysts and senior staff, including an expansion of support in the areas of analytical and negotiation skills, leadership and performance training, whilst retaining a portfolio of courses utilising UK expertise and facilities of the nuclear fuel cycle;
- completion of the rationalisation of safeguards forms and working papers used within the Department of Safeguards;
- completion of commissioning and acceptance testing of an advanced neutron measurement technology in readiness for pilot implementation in the field; and
- provision of expertise and software relevant to the assessment of data available to the Department of Safeguards, including the provision of funding for an expert position within the Department of Safeguards.

This report provides a summary of the progress on those tasks active during 2014/2015 within the framework of the UK Support Programme. It excludes tasks that were maintained 'on standby' throughout the year at the request of the Agency.

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UK SAFEGUARDS SUPPORT PROGRAMME

Report on Activities and Progress during the period 1 April 2014 to 31 March 2015

J W A Tushingham

National Nuclear Laboratory, 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 UK Support Programme, 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 Department of Safeguards Development and Implementation Support Programme for Nuclear Verification;
- 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.

In January 2013, the IAEA Department of Safeguards issued a Long-Term R&D Plan, covering the twelve-year period 2012-2023, setting out the capabilities that the Department of Safeguards needs in order to achieve its strategic objectives. The Long-Term R&D Plan covers a wide variety of areas such as safeguards concepts and approaches; detection of undeclared nuclear material and activities; safeguards equipment and communications; information technology, collection, analysis and security; analytical services; new mandates; and training.

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The specification of long-term capabilities provides a framework to assist Member State Support Programmes (MSSPs), including the UK Support Programme, in deciding where their resources can best be used, and also guides the Department of Safeguards in the formulation of projects within a biennial programme of support.

The IAEA's biennial Development and Implementation Support (D&IS) Programme for Nuclear Verification 2014-2015 is composed of 22 projects. These projects are themselves composed of over 300 'tasks'. Each project contains objectives, targets and activities that are defined for the relevant two-year period. Both internal tasks, carried out by IAEA staff and consultants, and external tasks, carried out under MSSPs, are included in the projects.

The UK Support Programme is one of 20 MSSPs (plus the European Commission) that provide support to the Department of Safeguards. The Support Programmes work singly and in collaboration to fulfil the priority needs of the Department of Safeguards, taking into account their individual expertise and resources.

Support is provided in response to specific 'Task Proposals', known as SP-1s, issued through the Support Programmes Coordination Team of the Department of Safeguards. Within the UK, each SP-1 is assessed against capabilities and priorities before the UK Support Programme's decision to accept or decline the Task Proposal is communicated to the Department of Safeguards. Appropriate arrangements are then made for a programme of work to be undertaken to meet the Department of Safeguards' need.

The UK currently provides support to the IAEA Department of Safeguards in six technical areas:

- 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.

Each task undertaken within the UK Support Programme is assigned to one these six Task Areas, cross-referenced to the Department of Safeguards' Long-Term Capability and D&IS Project to which each task relates.

This report provides a summary of the progress against specific tasks in each of these six areas during the period 1 April 2014 to 31 March 2015.

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 at all stages of the nuclear fuel cycle. As part of a strengthened safeguards system, the IAEA requires increased amounts and types of information on States' nuclear and nuclear-related activities. This information includes that provided directly by States (e.g. INFCIRC/540 Article 2 declarations), that collected by the IAEA (e.g. environmental sampling data) and other information available to the IAEA (e.g. open source literature and satellite imagery). The information is used to identify any inconsistency between a State's declaration and information available from other sources concerning a State's nuclear activities, and to optimise the strategy for safeguards implementation within the State.

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 techniques for ultra-sensitive measurement and interpretation of results, 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. As such, the programme directly meets the strengthened safeguards objective of increasing the assurance of the absence of undeclared nuclear material and activities. Results and conclusions from environmental sampling contribute to the State evaluation process and have an impact upon revisions to the facility attachments and safeguards approaches.

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:	A J Pidduck
IAEA Task Officer:	C Hoffmann		

Background to Task

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

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Until 2010, the UK Support Programme provided the services of two laboratories within the IAEA NWAL for environmental samples. AWE Aldermaston undertook 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). Fission-track analysis detects fissile material, making the technique more sensitive towards particles with a higher fissile content, whilst TIMS can provide high accuracy in the measurement of both major and minor isotopes. This combination 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. Whilst FT-TIMS is capable of providing greater accuracy in analytical results, and a capability to measure minor isotopes of particular importance for data evaluation, RAE-SIMS has the potential for more rapid turnaround in sample analysis. RAE-SIMS involves an initial scan, during which particles of uranium are identified and recorded with their size, relative locations and individual uranium isotope ratios using specialist software (PSearch) and RAE hardware. More accurate measurement of individual particles is then undertaken using a tightly-focussed primary ion beam (microprobe operating mode) and an electron multiplier for the detector. The two techniques of FT-TIMS and RAE-SIMS are complementary, and both are routinely requested by the IAEA, whilst a relatively new development in SIMS – Large Geometry (LG) SIMS – offers the sample turnaround benefits of SIMS but with an accuracy approaching that of TIMS.

In November 2010, for commercial reasons, 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 Aldermaston to transfer the existing SIMS capability to its laboratory, consolidating UK particle analysis capabilities at AWE.

Summary Report on Activities in 2014/2015

AWE Aldermaston continued to provide an FT-TIMS capability during 2014/2015, completing the analysis of five batches of environmental swipe samples: a total of 25 swipes. 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. 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 Scanning Electron Microscopy (SEM).

In parallel with FT-TIMS work, AWE completed the analysis of 10 inspection samples by RAE-SIMS during the year. 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. A uranium swipe standard and sample blanks were analysed as part of the quality control procedure applied to each batch.

The number of samples analysed by SIMS was lower than was historically the case, as AWE focussed on the development of an improved LG-SIMS capability in the second half of the financial year. Following successful validation of the LG-SIMS for IAEA work under Task B1(v), the first batch of five environmental swipe samples to be analysed by LG-SIMS at AWE was completed end-March 2015.

In total, AWE Aldermaston completed the analysis of 40 swipe samples during the course of 2014/2015.

The IAEA will continue to require the analysis of environmental swipe samples by both FT-TIMS and LG-SIMS in 2015/2016, and is looking to AWE Aldermaston to maintain a full particle analysis service.

Task A5(i) – WIMS Reactor Calculations

IAEA SP-1 No:	09/IDS-002	UK Sub-Contractor:	Amec
IAEA SPRICS No:	UK A01853	UK Task Manager:	B Matthews
IAEA Task Officer:	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. In 2010, the UK Support Programme agreed to 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 code in combination with the FISPIN fuel inventory code. Series of calculations, covering isotopic compositions of fuel and cladding/structural materials for a range of fuel enrichments under various irradiation scenarios within ten types of power reactor and eleven plutonium production or research reactors, were subsequently 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. Additional calculations were completed to estimate uncertainties (due to geometry factors) for uranium and plutonium isotopes generated/depleted in power reactor fuel for the examples of PWR and CANDU reactors.

Further work commenced in December 2012, targeted at a range of fast reactors and more complex research reactors. In comparison to the reactor physics calculations that are required to derive flux, cross section and inventory data for thermal reactor fuels, those required for fast spectrum systems are more complex, with reactor fuel and breeder elements often irradiated in regions where both the magnitude and the energy spectrum of the neutron flux can change rapidly. Therefore, it was important to provide an accurate representation of both resonance shielding and burn-up effects which may be significant.

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To enable the geometry and material properties of each reactor core to be defined, and to propose a calculation method for each reactor, work commenced with the development of a modelling specification for each of the ten reactors under study.

Modelling specifications for the first four reactors were completed during the fourth quarter of 2012/2013, with the remaining specifications completed by July 2013.

Following on from this study, work commenced to determine the optimum modelling route for calculating isotopic compositions and one group actinide (Th – Cm) cross sections using WIMS-PANTHER-FISPIN, for some burn-up steps for a model of a reactor as a finite core model with critical rod positions. This study was completed during December 2013, with the conclusion that the WIMS-PANTHER-FISPIN combination provides a feasible route for whole core fuel burn-up modelling of the reactor.

Summary Report on Activities in 2014/2015

Further modelling of the reactor was undertaken during 2014/2015. In the absence of detailed information regarding control rod insertions, the Agency advised on assumptions to be made; whilst accurate reflector data and a detailed energy group scheme were modelled. The WIMS-PANTHER model of the reactor at start of life was then verified against an alternative methodology, the MONK Monte Carlo code, to confirm its accuracy. Once a definitive and verified WIMS-PANTHER-FISPIN model of the reactor core had been produced, inventory data was calculated for a range of fuel types and core locations.

Provision of the inventory data requested by the Agency was completed in September 2014.

Following on from the above study, further work was undertaken on a reactor considered for plutonium disposition. This activity required:

- Preparation of cross sections for all core materials using WIMS ECCO, with a fine energy group scheme appropriate for fast spectrum systems;
- Preparation of a whole core model using WIMS SNAP to provide a three-dimensional diffusion theory flux solution;
- Definition of a batch refuelling scheme to derive an equilibrium core to achieve the desired burn-up whilst maintaining criticality;
- Preparation of a whole core model using WIMS CACTUS to provide a three dimensional transport theory flux solution, and thereby apply where appropriate a transport connection to the SNAP diffusion theory flux solution; and
- Burn-up calculations and provision of material averaged inventory data for core fuel and breeder materials.

Modelling of the reactor was near completion at the end of the financial year, with results to be reported during April 2015.

The Agency's priority within this task is now for further modelling of a reactor to accommodate different fuel types and core locations. This is expected to commence following the provision of revised fuel data from the Agency.

Task A5(j) – Analysis Results and Metadata for the Springfields UOC Sample Collection

IAEA SP-1 No:	12/IFC-002	UK Sub-Contractor:	AWE
IAEA SPRICS No:	UK D01968	UK Task Manager:	P Turner/P Thompson
IAEA Task Officer:	M Penkin		

Background to Task

Under a UK-US initiative, 2006 saw the transfer of archive samples of uranium ore concentrate (UOC) from Springfields to USDoE, ITU and AWE Aldermaston laboratories for use in studies to develop capabilities to fingerprint nuclear materials and verify their declared origin. A substantial body of work was subsequently undertaken, outwith the UK Support Programme, to characterise the samples through a range of analytical measurements and also to research their origins, associated geology and the processes involved in their production. Data was reviewed during a meeting in Karlsruhe, in October 2011, which was also attended by Agency staff with responsibilities for the analysis of data from environmental sampling and destructive analysis for safeguards purposes.

Following the Karlsruhe meeting, the Agency sought an agreement whereby the data obtained could be used by the Department of Safeguards. Task 12/IFC-002 was subsequently issued to the Support Programmes of the EC, US and UK, seeking support in populating the Department of Safeguards' own database of trace element and isotopic signatures of UOC of various origins, along with the relevant information (metadata) about ore geological characteristics, time of UOC production and details of the concentration process. The datasets of UOC signatures and associated metadata would then be used by safeguards data analysts, for reference in safeguards evaluations involving assessment of provenance of UOC samples collected by IAEA inspectors.

Task Proposal 12/IFC-002 was accepted by the three Member State Support Programmes, as a collaborative effort. AWE liaised with the other laboratories involved, reviewing the available metadata and seeking to combine the spreadsheets of data into a single draft reference document. In parallel, AWE progressed its measurement of certified reference materials and compiled current analytical data. Arrangements commenced for a coordination meeting between the parties, to progress the task to a conclusion.

Summary Report on Activities in 2014/2015

It was agreed late-June 2014 that AWE would review and issue sample metadata from the Springfields UOC collection, whilst Los Alamos National Laboratory (LANL) would collate and analyse the analytical data from the US, AWE and ITU. AWE compiled a new version of the metadata, based on responses from Lawrence Livermore National Laboratory (LLNL) and further information obtained by AWE, including deductions from the analytical records provided by Springfields. This document was sent out to participants for final comment, with the intention to issue formally by end-2014. In parallel, AWE provided its analytical data, to the agreed format, to allow LANL to complete the data analysis.

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A teleconference was held in January 2015, to discuss delivery of the required data. The participants' goal was to provide data that adhered as closely as possible to that requested by the Agency, within the constraints inherent to the combined LANL-AWE-ITU dataset. Data consistency was proposed to be evaluated using the results from 12 samples that were analysed by all three laboratories.

Data consistency between the three sets of laboratory results will be evaluated and discussed within the final report, which is expected to be completed and issued to the Agency mid-2015. This will complete the current task.

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:	S Robb		

Background to Task

On the basis of studies by the MSSPs, 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 2014/2015

In October 2014, the UK Support Programme offered a voluntary contribution to the Department of Safeguards: for the procurement of satellite images and equipment; or to

support open source information collection through tasks placed with King's College London (KCL). The Agency responded by requesting that the funds be transferred to the Agency, for the procurement of commercial satellite imagery and other open source information. Funds were duly transferred for this purpose from the 2014/2015 budget of the UK Support Programme, to be utilised in support of this activity during 2015. The UK Support Programme anticipates that a further contribution to open source information collection/satellite imagery will be offered in 2015/2016.

Task Area A7 - Strengthening/Integration of Safeguards

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

IAEA safeguards implementation is now evolving to an approach that makes greater use of the IAEA's ability to consider the State as a whole. It involves a comprehensive evaluation of all safeguards-relevant information regarding a State, and the use of objective State-specific factors to draw up a State-level approach (SLA) for each State. The implementation of SLAs will enable the IAEA to make best use of its resources and focus effort on areas of greater safeguards significance. The use of generic objectives common to all States with the same type of safeguards agreement (and, where applicable, Additional Protocol) enables differentiation without discrimination.

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	UK Task Manager:	R Hooper
IAEA Task Officer:	J Cooley/M Hori		

Background to Task

Strengthened and integrated safeguards has 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. The Task Manager commenced work to compile the extensive reference material needed for the development of the commentaries. In 2009, the

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task continued as a joint undertaking with the IAEA, principally the Section Head for Non-Proliferation and Policy Making within the Office of Legal Affairs (OLA).

The INFCIRC/153 and /540 commentary was 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. Work on the commentary progressed, including research of Agency archives and interaction with OLA during month-long periods at IAEA Headquarters in October 2011 and 2012. Introductory and background material was completed, addressing: the IAEA safeguards system and its evolution; the nature of safeguards conclusions; and the negotiation of the comprehensive safeguards requirement contained in the 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. By end-March 2013, work on the overarching issues was completed, and an outline of the steps involved in implementing a Comprehensive Safeguards Agreement and an Additional Protocol was prepared. This outline provided the organisational basis for identifying the implementation issues/problems that have accompanied the implementation process.

In October 2013, the Task Manager completed a third four-week period at IAEA Headquarters: progressing the Commentary to the extent where it was near completion, with only two chapters outstanding. These were intended to address in detail the implementation of Comprehensive Safeguards Agreements and Additional Protocols, and were framed by the Task Manager but required completion by OLA.

Summary Report on Activities in 2014/2015

Staff retirement from OLA and a loss of institutional memory within the Department of Safeguards compounded difficulties in completing the commentaries during 2014/2015, whilst highlighting their importance.

The fact that the Commentary has been “in production” for a long time is not considered an issue, as the small amount of material that is dated is readily dealt with. When complete, it will still be the most definitive document on the legal basis of Agency safeguards that is intended for implementers. Work to complete the Commentary is accepted as requiring access to files that only exist at the Agency, and the Task Manager continued to correspond with OLA and await developments during the remainder of the year.

Mr Hooper’s work on the Commentary is now complete, and its publication as an internal document is dependent upon activity within the Department of Safeguards. This task has been placed on standby, enabling the UK Support Programme to continue to promote the value of the Commentary, but with no further work envisaged on the part of the UK Support Programme. It is expected that the task will be closed on the occasion of the 2015 UKSP Annual Review Meeting, in October 2015.

Task A7(h) - Support to Instrumentation Technology Foresight (Umbrella Task)

IAEA SP-1 No: 06/TDO-007 **UK Sub-Contractor:** -
IAEA SPRICS No: UK A01599 **UK Task Manager:** J Tushingham, NNL
IAEA Task Officer: J Kocjan/T Sobolev

Background to Task

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

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

The UK Support Programme accepted this task end-March 2006, initially to provide a contact point within the UK for the identification of appropriate expertise and resources, with the acceptance of individual sub-tasks to be considered on a case-by-case basis. The UK is currently one of 17 Member States to have accepted this umbrella task. Since 2006, the task has enabled UK expert participation in a number of technical meetings associated with novel technologies, together with preliminary evaluation of such technologies.

Summary Report on Activities in 2014/2015

The UK Support Programme engaged the UK’s Office for Nuclear Regulation (ONR) in facilitating testing of a prototype robust plastic-based antineutrino detector, developed by University of Liverpool, in the vicinity of a UK gas-cooled nuclear reactor.

Installation of equipment was completed during the first half of 2014, and the instrument was subsequently used to monitor the reactor before, during and after start-up. This testing continued through the year. In December 2014, following promising results, a consortium including the University of Liverpool were awarded a UK Technology Strategy Board (TSB) grant to develop the system to market readiness. Meanwhile, the Liverpool University developers began to consider requirements to test an improved detector at a second reactor facility.

The UK Support Programme assisted the Agency in seeking contributions from UK commercial companies to an Agency technology evaluation of core components of an autonomous indoor positioning system for safeguards. Cambridge Consultants liaised with the Agency over aspects of indoor positioning during the remainder of the year, in particular the analysis and map-matching of data obtained during collection trials. This work will continue in 2015/2016.

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In March 2015, the Agency began to investigate technologies associated with gamma imaging. A formal call for support to a Technology Evaluation Workshop is anticipated for the first quarter of 2015/2016.

The task will continue to be used to satisfy ad-hoc requests from the Agency for participation in technical meetings and technology evaluation workshops on specific topics, and may be used for the initial stages of development work of instrumentation identified as of potential value to safeguards implementation.

Task A7(j) – Guidance for Designers and Operators on Design Features and Measures to Facilitate the Implementation of Safeguards at Future Nuclear Fuel Cycle Facilities

IAEA SP-1 No:	08/CCA-002	UK Sub-Contractor:	-
IAEA SPRICS No:	UK C01755	UK Task Manager:	J Tushingam, NNL
IAEA Task Officer:	J Sprinkle/M Hori		

Background to Task

In June 2007, the Standing Advisory Group on Safeguards Implementation (SAGSI) advised the Department of Safeguards that it should develop documentation that can serve as guidance for the inclusion of safeguards considerations at an early stage of nuclear technology designs. This, and needs arising from the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO); the Generation IV International Forum (GIF) Proliferation Resistance and Physical Protection (PR&PP) Expert Group; and the International Framework for Nuclear Energy Cooperation (IFNEC), led the Agency to propose a task to provide concise guidance for Member States.

This task was accepted by the UK Support Programme in June 2008, initially to support the development of basic guidance to encourage States to consider safeguards during the conceptual planning for nuclear facilities. Mr S Francis, NNL, participated in a technical workshop, convened by the Agency in October 2008, that focussed on facility design and plant operation features that facilitate the implementation of effective and cost efficient IAEA safeguards. The workshop was viewed by the Agency as an important resource and input for drafting an overview report describing the basic principles of IAEA safeguards and fundamental design features and measures that facilitate the implementation of international safeguards. The document “International Safeguards in Nuclear Facility Design and Construction” was subsequently prepared and published in the IAEA Nuclear Energy series.

Further workshops were held in September 2012 and March 2013, to commence the preparation of facility-specific documents. The focus of the first meeting was nuclear reactors, and a draft document, “International Safeguards in the Design of Nuclear Reactors”, was subsequently prepared by the Agency. DECC and ONR Safeguards reviewed the document and provided feedback, before it was finalised within the Agency for issue in 2013. During the second meeting, three new guidance documents addressing the consideration of safeguards in the design process for conversion, fuel fabrication and spent fuel management

facilities were drafted, with the first two documents subsequently reviewed by Mr S Francis and Mr S Johnson, Springfields Fuels Ltd, respectively.

In September 2013, Mr A Homer, Sellafield Site Ltd, participated in a workshop convened by the Agency to draft guidance for reprocessing plants. He subsequently continued to support the Agency's initiative by assisting with review and revision of the draft guidance document "International Safeguards in the Design of Reprocessing Plants".

Summary Report on Activities in 2014/2015

There was no significant activity associated with this task on the part of the UK Support Programme during the period covered by this report.

In June 2014, the Task Officer provided the latest draft guidance for considering safeguards in the design and construction of long term spent fuel management facilities. The following month, the UK Support Programme was provided with the published IAEA Nuclear Energy Series report NP-T-2.9, "International Safeguards in the Design of Nuclear Reactors" whilst, in February 2015, the latest draft of the document providing guidance for safeguards by design in spent fuel reprocessing plants was distributed by the Agency for review.

The Agency is now considering a follow-on task, to promote the guidance and to identify potential safeguards measures for innovative fuel cycle facilities and processes.

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:	S Munoz		

Background to Task

The IAEA is continuing to enhance the effectiveness and efficiency of safeguards by further developing and applying a holistic approach that focuses on the nuclear programme of the State as a whole, rather than the sum of its declared nuclear facilities: the so-called State-level concept. Development of the State-level concept is possible due to the availability of increased quantities and quality of safeguards-relevant information. 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. 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. Tessella, a UK technology and consultancy company, provided input to a workshop on acquisition path analysis methodology, convened by the Agency in June 2011. An outcome from the meeting

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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. Tessella was provided with example data on a fictitious State by the Agency, prior to a meeting between Tessella technical staff and Agency personnel in October 2012. During the meeting, Tessella presented its work to date, focusing on cognitive biases that affect people's ability to combine information, and candidate techniques that may help with these problems. These techniques were discussed with the Agency, and usability tests were carried out to see how comprehensible and useful the candidate techniques were. Following this feedback, priorities were agreed for the remaining part of the study.

Tessella's draft report was forwarded to the Agency for review in January 2013, and feedback from the Agency was incorporated into a revised report. A meeting was held with the Agency in May 2013, during which the Task Manager gave a presentation on the contents of the report and conducted a workshop to illustrate the recommended techniques, using some example scenarios provided by the IAEA.

From 24-25 February 2014, Tessella participated in a second workshop, convened by the Agency to share and review the work from the different MSSPs that had contributed to the task.

Summary Report on Activities in 2014/2015

There was little progress within the Joint Task during 2014/2015, as the MSSPs awaited the conclusions from the Agency's testing of a Guide on how to conduct acquisition path analysis within a State-level Approach.

It was recognised by many of the 2014 workshop participants that, although the workshop was a good forum for discussion, more active participation of inspectors and country officers would be needed. The Department of Safeguards intends to develop a workplan for the next two years, in which its requirements and needs will be clearly formulated. The UK Support Programme will respond to the workplan based upon its resources and priorities, for example by providing consultancy on software development.

Task A7(1) – Member State Contributions to IAEA Topical Guidance on Safeguards Implementation

IAEA SP-1 No:	12/CPC-001	UK Sub-Contractor:	Sellafield Site Ltd ONR Safeguards
IAEA SPRICS No:	JNT C01959	UK Task Manager:	J Tushingham, NNL
IAEA Task Officer:	C Mathews		

Background to Task

Task Proposal 12/CPC-001 sought the participation of experts from Member States and their input into the development of IAEA guidance documents on various topics relevant to safeguards implementation. Guidance was required in order to assist States in better understanding safeguards obligations and to share good practices that have resulted from experience and evolution over years of implementation. These detailed topical guidance

documents would build upon the Guidance for States Implementing Comprehensive Safeguards Agreements and Additional Protocols. They are intended for use by regulatory authorities; facility operators and licensed users of nuclear material; nuclear facility designers; safeguards students and practitioners; and professionals of the IAEA.

The IAEA intended to organise two expert meetings focused on each specific topic and document. The outcome of the first meeting on each topic would be a plan for preparing and submitting input to the guidance document and an annotated skeleton of the document with the input for each section summarised. Participants would then prepare input as agreed in the plan, prior to a second meeting to review and improve the draft document before it was finalised by the IAEA. Each document was expected to be published approximately 18 months after the first meeting.

Mr N Edmonds, Sellafield Safeguards Department, participated in a workshop convened by the Agency in April 2013, providing input to a guidance document on facilitating IAEA in-field activities. Given the unique nature of Sellafield site, with a wide range of inspection activities and scenarios, Mr Edmonds was subsequently tasked to provide advice, examples and guidance on a number of topics that were included within a first draft of the “SIP Guide on Facilitating Verification Activities”. The IAEA distributed and coordinated selected assignments, and these were completed prior to his participation in a second technical meeting on the subject, held at IAEA Headquarters in November 2013. Subsequently, Mr Edmonds assisted in editing the draft guide, prior to its review within the Agency and subsequent publication.

In November 2013, the Task Officer requested support to the development of two further IAEA Safeguards Implementation Practice Guides:

- SIP Guide on Provision of Information to the IAEA (nuclear material reports, Additional Protocol declarations, design information, import/export information etc); and
- SIP Guide on Collaborative Approaches to Safeguards Implementation.

Experts from within ONR Safeguards were identified as being most able to give an effective UK contribution on these subjects. Subsequently, Mr L Johnson participated in the first meeting on provision of information, in February 2014, with Mr M Beaman participating in the first meeting on collaborative approaches, in March 2014.

Summary Report on Activities in 2014/2015

Development of the new guides followed the format of the previous work, with the second meeting on each subject held in November 2014. Mr L Johnson participated in the meeting to review a draft “Safeguards Implementation Practices Guide on Provision of Information to the IAEA”, whilst Mr M Beaman participated in the meeting to review a draft “Safeguards Implementation Practices Guide on Collaborative Approaches to Safeguards Implementation”.

During 2015, the Agency plans to organise a workshop at IAEA Headquarters, to familiarise participating safeguards practitioners with the SIP Guide on Facilitating IAEA Verification Activities and, in the course of working through exercises and sharing expertise and

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experience among the participants, to demonstrate the use of the SIP Guides and the effectiveness of peer interactions to solve problems and continuously improve.

Task A7(m) – Textbook on International Safeguards

IAEA SP-1 No:	10/CCA-007	UK Sub-Contractor:	-
IAEA SPRICS No:	JNT C01914	UK Task Manager:	J Tushingham, NNL
IAEA Task Officer:	C Mathews		

Background to Task

To address needs associated with anticipated growth in nuclear power and technology applications, universities around the world are introducing international safeguards and non-proliferation subject matter into selected courses. The Agency proposed the preparation of a textbook, with input and expert review from MSSPs, to counter the potential development of textbooks according to national policies, commercial opportunities and university tenure considerations. If such works inaccurately portray the IAEA and/or the safeguards system, the Agency would otherwise be hard-pressed to correct the message.

The Support Programmes of Argentina, Australia, the EC, Finland, Germany, Japan, the Republic of Korea, Sweden, the UK and US expressed interest in supporting the task. A meeting of MSSP Coordinators was held in March 2012, during which a draft table of contents was reviewed, and existing materials and expertise within each State were discussed. Following the meeting, Australia, the EC, Sweden and the UK provided material including the European Safeguards Research and Development Association (ESARDA) textbook. However, clarity was still required regarding the specific contributions envisioned by each MSSP and no lead author/editor was identified.

During 2013, the Agency identified an appropriate lead author for the textbook, with the intention that he be hired directly by the IAEA and for work to commence in 2014. In September 2013, the UK Support Programme provided an extrabudgetary contribution to part-fund retention by the Agency of the lead author, with other MSSPs pledging similar amounts. However, during the fourth quarter of 2013/2014, it became clear that the lead author would be unlikely to be able to support the project as originally envisaged.

Summary Report on Activities in 2014/2015

A revised approach is now expected to result in a more succinct ‘primer’ that draws upon and references existing material. Further consideration to the purpose and content of the document was given during the financial year, with close involvement of the Department of Safeguards’ Training Section. Meanwhile, this task was placed ‘on standby’ at the UKSP Annual Review Meeting of October 2014.

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

In support of the strengthened safeguards system, the IAEA Department of Safeguards requires broad access to geographically and linguistically diverse sources of relevant open source information. Information is required, in particular, on nuclear dual use technologies relating to industrial infrastructure and nuclear research and development, as well as information on security, economics, weapons of mass destruction and the politics surrounding such weapons. Detailed surveys are required of States' industrial and nuclear research infrastructure and issues that may induce a State to proliferate. The collection and 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/M Fowler

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 2014/2015

Collections of abstracts of open source information on nuclear-related issues in the region, gathered from both English and regional language sources, were sent monthly to the IAEA during 2014/2015.

Four State Profiles were updated, covering specific subjects requested by the Agency. In addition, an ad-hoc report was prepared to a specification agreed with the Agency. Updates on political issues in the region were researched and sent to the Agency on six occasions during the year.

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Activity will continue through 2015/2016, 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/M Fowler

Background to Task

From 2003 to 2008, a second 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 an expanded region, whilst also updating existing reports for some States. 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 2014/2015

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 2014/2015.

Five updates of State Profiles were prepared, together with an ad-hoc report on specific aspects of nuclear infrastructure and activities. Reviews on political issues were researched and sent to the Agency 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 2015/2016, 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 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: M Ardhammar

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. The UK Government has an existing open-source project on proliferation procurement, established within King's College London, providing new insights into proliferation risks and how to enhance proliferation risk analysis and awareness. The project includes engagement with companies and trade associations involved in dual-use industries, gathering and analysing input on compliance and non-proliferation and highlighting the role of the private sector in countering proliferation. Task Proposal 09/ICA-012 was accepted by the UK Support Programme in December 2011, initially to enable the Agency to benefit from the research carried out under the UK project.

During 2011 and 2012, work included the preparation of proliferation briefs, detailing proliferation concerns and compliance requirements across themes including metals; machinery; and control systems. A paper and presentation on illicit trade were prepared and shared with the Agency during a conference in October 2012, prior to publication of the paper in an academic journal. The paper provided a net assessment of a State's nuclear-related procurement requirements based upon open source and illicit trade data. Work was also undertaken on the proliferation risks associated with proliferation-sensitive composite materials. Data drawn from the UK Government project's work on illicit trade was combined with knowledge drawn from experts in the manufacture of certain technologies and materials, and the information was shared with the IAEA.

The following year, the UK Support Programme was requested to consider the provision of resources to enable the preparation of a number of "Manufacturing Base Reports" (MBRs), each addressing a specific proliferation-relevant technology.

Summary Report on Activities in 2014/2015

14 MBRs were completed during the year, providing open source information including: suppliers/manufacturers and/or producers of manufacturing equipment; uses and control status; and aspirants and prospects for future expansion of the supply base. In addition, four illicit procurement case studies and a report on *Trade Data and State Evaluation* were provided. A further two MBRs and a compendium on selected technologies were near-completion at the year-end.

Work is expected to continue in 2015/2016, including the completion of additional MBRs on priority subjects and a report on trends in illicit procurement.

Task Area A11 – Management Support

Management support tasks are, in general, intended to enhance the implementation of safeguards, which is important in view of the limited resources within which the IAEA Department of Safeguards must work.

Task A11(b) – Performance Indicators Support

IAEA SP-1 No:	13/CPD-001	UK Sub-Contractor:	The Advanced Performance Institute
IAEA SPRICS No:	UK C02005	UK Task Manager:	B Marr
IAEA Task Officer:	W Stanley		

Background to Task

The Department of Safeguards is undertaking an initiative to develop a comprehensive performance measurement system. The Performance Indicators Initiative (PII) seeks to improve the Department’s reporting to its stakeholders regarding the conclusions drawn from the implementation of safeguards, and to measure internal performance in achieving its strategic objectives.

In 2014, the Agency sought expert guidance and support in developing relevant performance indicators through which to monitor the efficiency and effectiveness of safeguards verification and supporting processes. Specifically, an expert was sought to develop and present a workshop on the subject.

Summary Report on Activities in 2014/2015

The UK Support Programme accepted the task in July 2014, engaging Mr B Marr of the Advanced Performance Institute.

Mr Marr designed a workshop to address the need for foundational knowledge and understanding, whilst also facilitating interactive work on a draft strategy map. The workshop was subsequently delivered to members of the Performance Indicator Working Group (PIWG), representing all of the Divisions and Offices of the Department of Safeguards, during September 2014.

In addition, following the workshop, a coaching session that summarised general performance management methodology and the output of the workshop was delivered to the Safeguards Management Committee. A further session, on visualisation of performance indicators, was delivered to the Chair of the PIWG.

Following the success of the September 2014 workshop, and further developments within the Agency, the UK Support Programme will engage Mr Marr to review the latest version of the PIWG’s “strategy on a page” and the resulting Key Performance Questions (KPQ) and Key Performance Indicators (KPI). Following this review, Mr Marr will facilitate a two-day workshop, during April 2015. Further support may be requested later in the year.

AREA B - SUPPORT FOR IAEA ANALYTICAL SERVICES

Destructive Analysis (DA) provides the most accurate means to assay 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's own laboratory, 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 assessment of processes for the treatment of analysis waste residues. More recently, support has focussed primarily on the Agency project "Enhancing Capabilities of the Safeguards Analytical Services" (ECAS), and also continued support to the development of environmental sampling capabilities.

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 strengthened safeguards and environmental sampling requires the development and implementation of new and improved methodologies for sample collection, preparation and analysis.

Task B1(t) – Implementation Support to Nuclear Material Laboratory

IAEA SP-1 No:	08/TTS-004	UK Sub-Contractor:	A. NNL B. NPL C. -
IAEA SPRICS No:	UK C01742	UK Task Manager:	A. E Johnston B. S Jerome C. J Tushingam
IAEA Task Officer:	C Mansoux		

Background to Task

In 2006, the UKSP Coordinator 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.

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

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different scenarios to provide the Department of Safeguards with sufficient analytical support to satisfy the timeliness and performance criteria for safeguards. The UKSP Coordinator 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 Nuclear Material Laboratory (NML) 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 further Experts' Meetings, convened by the Agency to review the design of the proposed new NML, and participated in workshops on progress and developments in the ECAS project that drew significantly on the earlier UK Support Programme contributions.

Additional advice and support was provided on request from within the UK. In each of January 2012 and February 2013, extrabudgetary voluntary contributions of €500,000 were provided through the UK Support Programme, for application by the Agency in support of the ECAS/NML project. In December 2013, the Agency identified additional requirements for financial support to the ECAS project. These were associated with the transition of analytical services from the old Safeguards Analytical Laboratory to the new NML, plus some additional construction work and supporting infrastructure. The Agency noted the particular practical value of earlier UK contributions and, with this in mind, the UK Support Programme offered a further extrabudgetary voluntary contribution to be utilised as the Agency saw fit to maximise its benefit to the ECAS project, without the need for it to be applied to a specific work package. A €400k contribution was subsequently transferred to the Agency's bank account, and formally accepted by the IAEA in March 2014.

Meanwhile, with completion of the construction of the new NML during 2013, the Agency's needs turned to support for the implementation of analytical services. In September 2013, Mr S Jerome of the National Physical Laboratory (NPL) met Agency staff at Seibersdorf, to discuss possible support from NPL to the Department of Safeguards. Following this meeting, in December 2013, the Agency requested by letter that the UK Support Programme enable the production of a range of certified reference materials by NPL.

Summary Report on Activities in 2014/2015

During 2014/2015, NPL commenced plans to prepare the following reference materials:

- A highly-enriched ^{233}U spike, for determination of uranium amounts in swipe samples;
- A ^{243}Am spike, for use in age determination of plutonium; and
- A ^{237}Np spike, for use in determination of neptunium amount in spent nuclear fuel samples for flow sheet verification on reprocessing plants.

In addition, the provision of a set of five mixed Np/Pu isotopic reference materials was requested as an option. The Agency's request was accepted, but protracted contract negotiations between the UK parties involved prevented commencement of the task during 2014.

In parallel with support to the construction and commissioning of the Agency's new nuclear material laboratory, a requirement emerged for the characterisation of samples using a range of physical and chemical analysis techniques. Following visits to NNL's Preston laboratory at Springfields, agreement was reached for the characterisation of samples supplied by the IAEA. This work commenced in February 2014, and continued through the period covered by this report.

Support will continue to be required by the Department of Safeguards, as it completes transition arrangements to the new NML and undertakes the analysis of inspection samples within its new facility.

Task B1(v) – Implementation Support to Environmental Sample Laboratory

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:	L Sangely		

Background to Task

The Agency required an independent capability to measure minor isotopes in environmental samples. In the absence of FT-TIMS, as described under Task A5(b), a more sophisticated large-geometry SIMS instrument, LG-SIMS, was considered. Compared with conventional SIMS, this new instrument offers 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 commenced on the preparation of a full report on the UK SIMS comparison trials. This was subsequently revised, to provide updated information on LG-SIMS and the status of the NWAL, and issued in April 2012. Meanwhile, the Agency procured its own LG-SIMS instrument, with installation completed during 2011.

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 LG-SIMS instrument. The UK Support Programme provided funding to secure the services of Mr A Simons under a Special Service Agreement, running from December 2011 to February 2012 inclusive. During this period, Mr Simons assisted in developing the Agency's in-house capability. Two SIMS experts from AWE subsequently participated in an informal meeting of NWAL members on the subject of LG-SIMS uranium particle analysis in October 2012 and, later that month, AWE hosted a visit by two staff members from the IAEA Safeguards Office of Analytical Services (SGAS). This enabled presentation of the results from AWE's SIMS re-validation exercise and provided the

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opportunity to discuss AWE's capabilities and visit laboratories utilised in support of low-level analyses.

The Agency's LG-SIMS instrument is now in routine operation, and AWE procured its own LG-SIMS instrument in 2013.

Summary Report on Activities in 2014/2015

Installation of a Cameca 1280HR high-mass-resolution SIMS instrument at AWE was completed in April 2014. After a period of training, work was undertaken to collect data to demonstrate application of the instrument for IAEA environmental swipe analysis. This work followed the methodology previously used to validate the 4f SIMS instrument for Agency application.

A report on work carried out to validate AWE's newly-installed LG-SIMS instrument for application to IAEA environmental swipes analysis was completed, and issued to the Agency in December 2014. The report was accepted by the Agency, enabling AWE to commence the analysis of environmental swipe samples using the 1280HR SIMS under Task A5(b).

In parallel, a short project was undertaken to investigate methods for the removal of poorly-adhered particles from SIMS planchets.

The Agency wishes to maintain access to the expertise of AWE staff, as it continues the development of its in-house and NWAL capabilities.

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) - Design Information Verification at Bulk Handling Facilities Training Course

IAEA SP-1 No:	13/CTR-003	UK Sub-Contractor:	NNL
IAEA SPRICS No:	UK B01990	UK Task Manager:	S M Francis
IAEA Task Officer:	G Berthelot		

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, approximately 375 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.

In January 2014, the Agency submitted a new Task Proposal seeking the continued provision of a DIV training course, building upon the predecessor training course under Task UK B01618. In addition to the training of safeguards inspectors, the new course would target members of State Evaluation Groups (SEGs) whose performance within such groups requires them to understand and make full use of DIV at bulk handling facilities (BHF) when performing State evaluation and preparing safeguards implementation plans. The Task Proposal was accepted in February 2014, with the course to be held on an annual basis.

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Summary Report on Activities in 2014/2015

The 2014 course on safeguards and design verification at bulk handling facilities was successfully delivered from 12 – 22 May 2014, for the benefit of 12 course participants. Presentations on Conversion/Fuel Fabrication and Reprocessing technologies were revised and reintroduced to the two day opening session of the course. The introductory days at both Springfields and Sellafield included lectures and practical exercises, but were dominated by preparation time for the plant exercises. At Springfields, the participants were split into four groups of three, with two groups being assigned to a technical guide in each plant. Mr M Brody (Consultant) and Mr S Johnson (Springfields Fuels Ltd) provided support to the Springfields component of the course, with a day-long exercise in the Oxide Fuels Complex targeting an initial DIV visit to a newly declared facility; whilst the Enriched Uranium Residues Recovery Plant (EURRP) provided for the verification of detailed process flow diagrams across a diverse and complex facility.

The agenda and strategy for the Sellafield part of the course was essentially unchanged from the previous year. Exercises based in the Thermal Oxide Reprocessing Plant (THORP) were carried out over a single day, with the course participants instructed to lead the direction of the tours, whilst a Design Information Questionnaire (DIQ) exercise was successfully held in the Phase 2 and Phase 3 areas of the NNL Central Laboratory.

Based upon the participants' presentations that followed the exercises, each group demonstrated an understanding of the facilities and successfully completed each exercise. Feedback from the participants and IAEA Task Officer was very positive.

The IAEA has requested that a course on Safeguards at Bulk Handling Facilities be conducted in 2015. Dates have been agreed for the course, with the first week at Springfields and the second week at Sellafield.

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

IAEA SP-1 No:	13/CTR-004	UK Sub-contractor:	NNL
IAEA SPRICS No:	UK B01991	UK Task Manager:	S M Francis
IAEA Task Officer:	S Pickett		

Background to Task

A principal objective of the IAEA strengthened 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;
- An understanding of associated facilities, equipment and activities; 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 nineteen years, the course was run on 33 occasions by the UK Support Programme.

In January 2014, the Agency submitted a new Task Proposal incorporating experience and lessons learned from the courses carried out under the predecessor task, UK B01698. The new proposal aimed to address training needs more efficiently by increasing interactivity in the course, engaging trainees more and allowing a more effective evaluation of trainees' performance. It would continue to consist of lectures, individual and group exercises, to enhance inspector and analyst knowledge of the safeguards-relevant elements of the nuclear fuel cycle and the observable nuclear fuel cycle and proliferation indicators. The course would address topics including:

- General principles and process technologies associated with conversion, fuel fabrication, enrichment, nuclear power generation and fuel reprocessing;
- Basic technologies indicative of nuclear explosive device manufacturing processes involving nuclear material and the associated facilities, equipment and activities; and
- Practices useful for identifying indicators throughout the nuclear fuel cycle activities.

The Task Proposal was accepted in February 2014.

Summary Report on Activities in 2014/2015

The first course under the new task took place from 16 – 20 June 2014 at Puchberg, Austria, preceded by an introductory session at IAEA Headquarters on 13 June. The course commenced with the Task Manager providing an introduction and concluding with the “Inquisitive Inspector”. Agency presentations were slightly modified from the previous course, to incorporate aspects of the State-level Approach and a practical exercise on related issues. There followed a week-long residential course at Puchberg, with each day dedicated to one of the five modules of the fuel cycle. Course exercises followed each module, maintaining a consistent scenario through the course.

At the request of the Agency, the UK Support Programme did not provide a course in November 2014, but took the opportunity to work towards revising the course material where necessary.

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Two courses have been requested by the Agency in 2015, to be held from 12-19 June and 13-20 November, at Puchberg. Each course will involve presentations to the Agency participants by a team of UK experts and specialists in the nuclear fuel cycle and proliferation indicators.

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 updated 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.

The Agency required individual technical descriptions of all relevant parts of the fuel cycle, including all current technologies and technologies under evaluation or development. These technologies were to be assessed by the contractor, and agreed with the Agency, prior to preparation of the new manuals. Following detailed review and agreement with the Agency, work was undertaken by the UK Support Programme on both the fuel fabrication manual and the power reactor manual, with the former being completed during 2010. The fuel fabrication manual was published in 2011.

The Agency subsequently requested additional support in a number of areas, including preparation of a Reprocessing manual. A first draft was completed during a week-long session in Vienna, in December 2011, and an additional section on pyroprocessing prepared by the Agency was incorporated into the manual. A second request involved the core physics section of the Research Reactors manual, authored by the US Support Programme, to review and potentially re-characterise the ‘types of research reactor’ section and to edit the TRIGA reactor section. This work was completed and passed to the Agency during 2012.

A more extensive review was required of the Reprocessing manual, and this was undertaken by an expert from Sellafield Ltd. Following review with the Task Officer in November 2012, revisions were completed, and the revised version was provided to the Agency in March 2013.

Summary Report on Activities in 2014/2015

2014 saw Mr M Thomas and Mr K Hesketh, NNL, assist with final proof reading and checking of the consistency between pictures and text for the Nuclear Power Plant Manual, which was subsequently published by the Department of Safeguards in October 2014.

Mr M Thomas and Mr K Hesketh also commenced revision of accelerator-driven neutron sources within the Research Reactor manual. Completion of this, the final chapter required for the Research Reactor manual, and a final proof reading of the manual by Mr Francis, enabled the manual to be submitted for printing at the end of 2014.

Mr Francis completed a draft of the Conversion chapter for the Mining, Milling and Conversion Manual, and this was submitted to the Task Officer mid-September 2014. Final proof reading and organisation of the draft was undertaken in December 2014, prior to it being submitted to the IAEA technical author.

Additional work is expected to be requested from the Task Officer in 2015/2016, to review and revise additional manuals.

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:	M Peers
IAEA Task Officer:	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, convened by the Agency, on the feasibility and practicalities of Enrichment LFUA training. Approval was subsequently given by the Quadripartite Committee Safeguards Working Group, 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. Subsequent courses followed a similar schedule of lectures, exercises including visual observation and swipe sampling along the agreed LFUA routes, and demonstrations of sampling and mailbox interrogation procedures. Courses were run at Almelo (September 2010), Capenhurst (January 2011) and Gronau (October 2011) under the respective Support Programmes of the Netherlands, the UK and Germany, with the UK Support Programme facilitating additional support from Urenco Capenhurst to the Almelo and Gronau courses.

A fourth course, at Almelo in October 2012, was redesigned with the intention that the course continue on an annual basis with a focus on practical safeguards at an enrichment plant.

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Summary Report on Activities in 2014/2015

The latest course on practical safeguards at enrichment plants was held under the auspices of the German Support Programme at Gronau, Germany, during the final week of November 2014. Urenco Capenhurst staff did not actively support the course, but staff from Capenhurst were included as trainees.

The next training course is provisionally scheduled for three days in September 2015, at Urenco Capenhurst. The course is expected to be run to the same format as the previous course, with the UK Support Programme facilitating IAEA participation in the training.

Task C1(v) – Training in Negotiation Skills

IAEA SP-1 No:	10/CTR-006	UK Sub-Contractor:	Ambassador Partnership
IAEA SPRICS No:	UK B01874	UK Task Manager:	P Jenkins
IAEA Task Officer:	G Berthelot		

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. These 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 ‘spoilors’ 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. 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. 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 2011 by 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. A second diplomatic negotiation skills training course was held in Vienna in April 2012, following a period of further research and fine-tuning of the course content. Two former UK diplomats provided training in core negotiation skills; asking and listening; and advanced negotiation to an audience of inspectors, and led role-plays targeting IAEA scenarios. Feedback from the Agency enabled the course to be further developed prior to its third delivery in October 2013.

In February 2014, the Head of the Department of Safeguards’ Training Section advised the UK Support Programme of a requirement to offer negotiation skills training, including

Managed Access training, to inspectors. The Task Manager subsequently commenced arrangements to hold the additional training events, liaising with the Agency to develop a specific course programme.

Summary Report on Activities in 2014/2015

From 23 - 25 April 2014, the course “Negotiation Skills and the Concept and Practice of Managed Access” was held to provide senior inspectors with training and experience of negotiation techniques relevant to their duties in the context of managed access. The course was repeated to a second group of inspectors from 2 - 4 June 2014.

From 15 – 16 May 2014, additional support was provided to the Department of Safeguards’ existing Communications Skills course, including a presentation and role play on the theme of negotiation skills.

In July 2014, the Agency requested the participation of The Ambassador Partnership in a development programme for managers of the Department of Safeguards. The objective was to complement the development programme offered by the Agency to Section Heads and Directors in the areas of managerial skills and leadership, in order to meet the specific needs of the Department of Safeguards. Following acceptance of the task by the UK Support Programme, The Ambassador Partnership worked with the Department of Safeguards, to develop a training event to cover the core competencies of communications, decision making and change orientation.

The course on “Leadership Skills” was subsequently delivered over a three-day period from 7-9 October 2014 at IAEA Headquarters. The course included:

- Presentations on managing change, and facilitated discussions on IAEA Change Programmes and Safeguards in 2020;
- Communicating, public speaking, chairing meetings and dealing with conflict, with role-play on mediating between competing claims; and
- Making decisions, including presentations, exercises and role-play.

A further course on Diplomatic Negotiation Skills was presented from 1 – 4 September 2014.

The UK Support Programme anticipates a request from the Agency to facilitate two Negotiation Skills, one Managed Access Skills, one Communication Skills and two Leadership Skills courses under this task in 2015/2016. These will be delivered by the Ambassador Partnership.

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

Arising from the Agency’s strengthened and integrated safeguards approach, advanced training was required: to provide increased knowledge of the process technologies associated with fuel cycle facilities; and an improved understanding and recognition of the equipment and processes, particularly proliferation indicators and dual use equipment and activities. Because a proliferator may choose to adopt old technology, the scope of any training course was required to cover both new and old equipment. Physical access to reactors, conversion, enrichment and reprocessing facilities on three scales: laboratory, pilot plant and commercial, were specific requirements. From 2000 to 2011, the UK Support Programme provided training in the process technologies associated with fuel cycle facilities and the equipment employed.

Following the March 2011 course, 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. Following development of a detailed course schedule, a pilot course was delivered to nine participants in October 2011. Feedback from the course was generally positive, although some improvements were identified. Revisions were then made before the first full course, which was delivered to a group of twelve inspectors and analysts in March 2012. A further two courses were held in October and March of financial years 2012/2013 and 2013/2014, to a similar schedule but with nine participants on each course.

Summary Report on Activities in 2014/2015

The seventh course ‘Advanced Training on NFC Facilities to Assist State Evaluation’ was held during September 2014, for the benefit of nine course participants: six inspectors and three analysts. This followed the format of the previous course, with an introduction in Vienna providing summary presentations on the Sellafield and Springfields sites, imagery analysis techniques and open source analysis. This was followed by detailed preparatory sessions looking at site imagery and schematics, plus an examination of a package of open source information relating to the UK sites.

The UK component of the course commenced with a site visit to Sellafield, including Calder Hall, AGR and Magnox Fuel Handling Plant and the Sellafield Ion Exchange Effluent Plant (SIXEP) facility. The following day, a visit to Magnox Reprocessing was coupled with an extensive walk that included external areas of the old separation plants, Windscale Piles and ponds. Visits to THORP Receipt and Storage, Head End and Chemical Separation areas provided a contrast between old and new facilities. The final day at Sellafield included visits to

the Low Level Waste Repository (LLWR), Drigg, and NNL Central Laboratory facilities, before travel to Springfields.

Mr M Brody supported the two days at Springfields, which included visits to the Main Line Chemical Plants, the hex/fluorine plant, and the Oxide Fuels Complex. Due to a Euratom PIV, it was not possible to visit the Enriched Uranium Residues Recovery Plant. Instead, Mr Brody gave a technical talk on the plant, supplemented by pictures and flow diagrams provided by the Task Manager. As with Sellafield, the Springfields component included a site tour on foot, focussing on areas not covered by the individual plant visits, including features on or around the perimeter path.

The participants completed their course reports on the Friday afternoon, and each group made a presentation on their findings from the week's activities. The course closed with a presentation from the Agency, summarising the week's events and the main material flows and processes that had been observed.

The eighth course was held to a similar format during March 2015, again for nine course participants, but with some changes to accommodate improved plant availability. Feedback from both courses was very positive, and will be used to fine-tune further courses anticipated for October 2015 and March 2016.

Task C1(x) – Developing Analytical Skills for Safeguards

IAEA SP-1 No:	12/CTR-001	UK Sub-contractor:	-
IAEA SPRICS No:	UK B01940	UK Task Manager:	J Moore
IAEA Task Officer:	J M Créte		

Background to Task

Within the State-level approach to integrated safeguards, consistency analysis of declared nuclear capabilities of States, using available sources of information; nuclear material acquisition path analysis; and preparation of relevant information collection and processing plans, requires strong individual as well as collaborative analytical skills.

In 2011, the Department of Safeguards sought to strengthen the level of professional analytical capability within its work. The US Support Programme already ran a two-day workshop, providing familiarisation with a range of techniques, whilst a three-day course through the Australian Support Programme considered their application. A five-day course was requested from the UK, to provide greater depth and rigour than could be achieved in the brief coverage within the US workshop, whilst complementing the Australian course.

Following a series of meetings in Vienna, UK experts prepared a detailed draft of the proposed course content, which was subsequently finalised in consultation with the Agency. A 'dry run' of the course was held in the UK in October 2012, followed by a pilot course at IAEA Headquarters the following month, delivered by three UK experts to 13 inspectors and analysts from the Department of Safeguards. The pilot was largely based upon material taught in the UK, with some adjustments to provide new exercise material that focussed on a nuclear issue.

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Feedback from the Agency was very positive and, subject to the availability of the UK experts, the UK Support Programme was requested to facilitate a further two training courses in 2013. These were to be presented in the context of a phased transition towards presentation of the training in-house by the Agency, the intention being to embed the specialised analytical skills and appreciation within the Department of Safeguards.

The two courses were successfully held in May and October/November 2013. During the May course, the three UK course tutors sought to identify IAEA staff capable of taking over the training in the future, the intention being to reduce to two the number of UK representatives for the next course. The October 2013 analytical training skills training course was then held with some modules presented by an Agency training team, with UK participation reduced to two trainers. The opportunity was also taken to facilitate participation of two SEG members, identified to assist in future courses, in a ‘Train the Trainers’ course in the UK.

Summary Report on Activities in 2014/2015

UK staff continued to support training in analytical skills during the course of 2014/2015.

From 21 – 25 July 2014, two UK trainers, with the active participation of three trainers from the IAEA, delivered an Analytical Skills training course; and repeated the activity from 3 – 7 November 2014. During the courses, the participants were engaged in highly interactive exercises, to enhance individual and collaborative skills for analysis of State information, learning and practicing a range of relevant techniques.

Meanwhile, in September 2014, the Task Officer began to explore with the UKSP Coordinator the possibility and practicalities of the UK providing a three-day “Train the Trainer” course for IAEA staff planning to take over delivery of the course in 2015. The Task Manager confirmed that this would be a good way to embed and reinforce the Agency’s training capability in this area of expertise. A training session was scheduled for March 2015, but subsequently postponed to accommodate at the request of the UK Support Programme.

As a prelude to the Agency delivering its first totally in-house training course, the UK will seek to reschedule the three-day “Train the Trainer” course for June 2015. This will involve two UK trainers.

In addition, the UK has offered to make available one of its experts to observe the first training event to be delivered by the Agency, in order to provide feedback and advise on any improvements that may be required.

Task C1(y) – Specialised Training and Visits to Nuclear Facilities

IAEA SP-1 No:	12/CTR-006	UK Sub-contractor:	1. Byrom & Ridout 2. NNL 3. Ambassador Partnership 4. NNL
IAEA SPRICS No:	UK B01936	UK Task Manager:	J Tushingham, NNL
IAEA Task Officer:	K Dinov		

Background to Task

Agency staff require specialised skills and competences to implement effectively international safeguards. The Training Section of the Department of Safeguards provides systematic training for staff performing safeguards functions, and the identified training needs are addressed within the annual Safeguards Departmental Training Programme. However, urgent training needs may emerge that are not covered by planned training courses. These needs go first through the IAEA's internal committee, which oversees the overall training programme, to ensure consistency with the programme. A new course may then be designed at short notice, possibly requiring support from experts or access to nuclear facilities, laboratories or sites from Member States.

This task, functioning as an umbrella task, aims to give the required flexibility, reactivity and capacity for the Training Section to organise such courses under a formal arrangement with the UK Support Programme but with the minimum delay. It is intended to provide flexibility for the Safeguards Training Section to request support from UK experts or access to UK nuclear facilities, laboratories or sites in order to provide training on a short timescale, to meet operational needs and deadlines. It was first used to enable a UK contribution to the training of a specific group of inspectors in Vienna, in December 2012. No support was provided in 2013/2014.

Summary Report on Activities in 2014/2015

2014/2015 saw the completion of four training activities:

- Two UK consultants, Mr Byrom and Mr Ridout, provided a three-day course, "Interviewing Techniques for Safeguards Inspectors", during July 2014. The objective was to train staff in the fundamental techniques to prepare, conduct and evaluate interviews that can take place during meetings, inspections and/or formal interviews, in order to collect information necessary to support the analysis of State-declared information.
- A three-day workshop was held in September 2014, for the benefit of three imagery analysts and two inspectors, incorporating visits to three sites that offered a range of reactor facilities. The purpose was to provide the team with a detailed knowledge of such reactors and their associated infrastructure and to examine specific items of equipment at the facilities.
- The Ambassador Partnership complemented the development programme offered by the Agency to Section Heads and Directors in the areas of managerial skills and leadership, in order to meet the specific needs of the Department of Safeguards. A

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course on “Leadership Skills” was delivered over a three-day period during October 2014 at IAEA Headquarters, and subsequently incorporated into Task C1(v).

- UK experts provided further bespoke training, based on the Proliferation Pathways course but focussed on the specific needs of a small group of inspectors. A two-day workshop was held in Vienna during March 2015, with Mr S Francis and Mr M Thomas presenting lectures on conversion/fuel fabrication and power/research reactors, respectively.

The UK Support Programme expects to continue to receive requests for training-related support outwith the Safeguards Departmental Training Programme. Use of this task for ad-hoc training will ensure the involvement of the Safeguards Training Section and should promote training that meets operational needs and deadlines in a timely, effective and efficient manner.

AREA D - SAFEGUARDS PROCEDURES

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

Task Area D2 - Near Real Time Accountancy

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

Background

A software tool to simulate the nuclear material accountancy system for mixed oxide (MOX) facilities was required by the Agency, to support the review of the operator's accountancy system design and refinement of approaches for the JNFL MOX Fuel Fabrication Plant (J-MOX). The software 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 different statistics in nuclear material accounting for J-MOX 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 would

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focus on their filling, emptying, measurement and storage. The aim was 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.

A number of enhancements to the existing package were completed between April and December 2011, and a draft report and sample studies were produced. Three further stages of refinements were subsequently implemented, with the new, flexible, MOX software installed and demonstrated at each stage. A close collaboration between the Task Manager, Task Officer and an Agency cost-free expert (CFE) led to the development of a software tool with a number of features that reflected the likely realistic operation of a MOX plant, as opposed to its nominal design operation. The simulation package - SimMOX - was now a great deal more flexible, so that the IAEA could enter proprietary information and perform studies. Improved equations were agreed during a further review, to remove certain assumptions when performing detailed can calculations that were unlikely to be valid at J-MOX. Re-programming commenced, to investigate the implications of incorporating these revisions, with work completed from the UK.

A report on the SimMOX software tool was completed, incorporating revisions identified during a visit to the Agency in March 2013. In order to complete the task, the assumptions underlying the software tool required analysis and, if necessary, modification. However, in August 2013, the Task Officer informed the UK Support Programme that, for the next year, the resources required at the IAEA to support completion of this activity would not be available. It was foreseen that, by late-2014, the necessary support from the Agency could resume.

Summary Report on Activities in 2014/2015

The task resumed in September 2014, with the Task Manager contributing to a paper and presentation for inclusion in the 2014 IAEA Safeguards Symposium. The paper content was based on the simulation tool, as reported in SRDP-R310 and delivered to the IAEA as SimMOX4.0.

A visit was made to the IAEA during November 2014, to configure SimMOX4.0 to simulate a facility defined by the Department of Safeguards. During the visit, it became clear that the current scope of SimMOX lacked certain features that were essential when simulating material flow through the facility of interest, so the IAEA Task Officer requested various amendments. SimMOX4.0 was configured successfully during the visit, with the exception of these features.

The Task Officer was concerned with the collected-material, hold-up and waste models incorporated into SimMOX4.0, and also requested a more detailed recycle simulation. A more general representation of the primary dosing stage was required, and for different outputs to enable a more appropriate interface to be made to IAEA evaluation packages. Both these changes were made to a new version, SimMOX5.0, and delivered to the Agency late-January 2015. During the visit, the Department of Safeguards' lead on MOX data evaluation requested that the Task Manager work with Agency staff, who would provide an interface to

evaluation tools for NRTA and other data streams, and form plant specifications, scenes, and test cases to reflect MOX performance.

The aim is to produce a working simulation and safeguards system evaluation tool for a particular facility. The version delivered at the end of January 2015 is sufficient for the Agency to work on the NRTA interface and to produce a detailed specification. The Task Manager will need to perform extensive testing, before the implications of how various scenes might affect safeguards systems performance can be examined by the Agency with a view to recommending changes to the safeguards system design.

The intention is that a number of addenda will be added to SRDP-R310 to record the various updates.

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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 application of strengthened and integrated 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 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 regular assistance to the Department of Safeguards through the preparation of technical manuals and procedures for NDA instrumentation used by safeguards inspectors, and considers additional support on request.

Task E11 - Technical Manuals and Procedures for Safeguards Instrumentation

IAEA SP-1 No:	08/TAU-001	UK Sub-contractor:	A. Canberra UK Ltd B. PDQM Ltd
IAEA SPRICS No:	UK A01729	UK Task Manager:	A. C Wilkins B. P Doherty
IAEA Task Officer:	H Klein/B Munyon		

Background to Task

Canberra UK has undertaken the preparation of reference manuals and checklist procedures for safeguards instrumentation since 1996. 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); Triangular Load Cell; ATOMTEX Backpack Radiation Monitor; ICx Raider; crane weighers and cylinder reference weight; and the mini multichannel analyser, the mMCA-527.

In a separate initiative on the part of the Department of Safeguards, to achieve quality improvements for safeguards forms and working papers (F/WPs), the Agency provided a letter request in October 2013 seeking an appropriate expert to:

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- Review the importance and frequency of use of all F/WPs;
- Select the most important and frequently used F/WPs and review their correctness and completeness;
- Select a common graphical design and rewrite selected F/WPs; and
- Draft a guide on F/WP preparation.

By the end of the financial year, 33 forms had been reviewed and transferred to a format that allowed user-friendly input of data in protected cells and selection from menus.

Summary Report on Activities in 2014/2015

The rationalisation of safeguards forms and working papers was progressed to a successful conclusion during the first quarter of 2014/2015. In total, 50 F/WPs were processed, reviewed and improved and a guide on “Design and preparation of working papers and forms” was drafted for Agency review and approval.

In October 2014, the Agency requested assistance from the UK Support Programme in producing documentation for the handheld Raman spectrometry-based material identifier ‘FirstDefender RM’ for complementary access missions. A target for completion of draft documents of December 2014 was requested. Unfortunately, the request coincided with loss from the Support Programme of the author previously used to prepare such documents. This activity will now be undertaken during 2015/2016.

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

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, or in cases where the UK has advanced technologies available that cannot be provided from elsewhere.

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 Tushingam, NNL
IAEA Task Officer:	J Ely		

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 ²³⁵U material balance in large-scale gas centrifuge enrichment plants (GCEPs). The intention would be to install OLEM at GCEPs, 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.

Under a collaborative programme involving Urenco and USDoE, Urenco Capenhurst facilitated the sharing of information and lessons learned from the testing of enrichment monitoring technologies. Under the US Support Programme (USSP), Oak Ridge National Laboratory (ORNL) completed Phase I of an OLEM development task and the IAEA, USDoE and USSP negotiated a collaborative Phase II to be performed by ORNL and LANL. Under this collaboration, experience and lessons learned from the LANL/Urenco field testing of a passive online enrichment monitor at Capenhurst from 2011 were incorporated into the OLEM development path. Following on from this activity, field testing of two prototype systems was progressed at Urenco Almelo.

Summary Report on Activities in 2014/2015

Urenco continued to facilitate the sharing of information and lessons learned from the collaborative Urenco/USDoE testing of enrichment technologies, without call on the resources of the UK Support Programme. In addition, discussions continued with Urenco USA regarding the possibility of OLEM field trials at the Eunice, New Mexico facility.

The UK Support Programme remains available, to facilitate IAEA activities related to this task, should support be requested by the Agency.

Task E12(f) – Fast Neutron Detector Pulse Shape Discriminator System

IAEA SP-1 No:	12/TSI-001	UK Sub-contractor:	Hybrid Instruments
IAEA SPRICS No:	UK A01951	UK Task Manager:	M Joyce
IAEA Task Officer:	N Mascarenhas/R Plenteda		

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. ^3He is widely used in neutron detectors due to its outstanding γ -ray rejection properties. Recently, a world-shortage of ^3He has led to renewed interest in systems based upon ^{10}B and even ^6Li . 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.

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During 2010, the UK Support Programme was approached by the Department of Safeguards to provide support under Task UK A01887, Support for the Safeguards Systems at J-MOX, to continue the development of an innovative alternative to ^3He -based detectors based upon liquid scintillation detectors and a pulse shape discriminator (PSD) developed by Hybrid Instruments. Work on the upgrade of existing prototype instrumentation at J-MOX was completed during 2010/2011, followed by the design and manufacture of an improved device in 2011/2012. The successful completion of this work led to a request to develop a plant-scale integrated measurement system under a new Task, E12(f)/UK A01951.

Under respective tasks of the UK and Netherlands Support Programmes, Hybrid Instruments and Scionix worked to integrate an array of 16 PSD modules and detectors into a single detector system to the IAEA's specification. The project comprised: (1) the supply and integration of a 4-channel PSD instrument; (2) the development and manufacture of a 16-channel PSD module; and (3) integration of the 16-channel module, with each phase originally envisaged to have a duration of three months. Development and manufacture of both the 4- and 16-channel PSD modules was completed by end-March 2013.

The following year saw completion of commissioning tests at the University of Birmingham, the National Physical Laboratory and the IAEA Seibersdorf Laboratories. Initial testing at Seibersdorf was supported by an engineer from Hybrid Instruments, with issues affecting the instrument's cooling, interfacing and event sequencing successfully resolved through design modifications. The final instrument provided excellent pulse-shape discrimination and returned significant improvements in multiplicity order sensitivity: effectively moving the capability on from doubles event assay to demonstrable efficiency for quads. This led to the identification of further near-term potential opportunities that included:

- Plutonium assay;
- Curium assay and discrete isotopics;
- Isotopic signatures of nuclear material; and
- Measurement of low-enriched uranium (LEU) in gadolinium-doped VVER fuel assemblies.

Further testing at ITU Karlsruhe, utilising a variety of sample materials, raised some issues associated with user interfaces and data presentation. Hybrid Instruments reviewed the required enhancements and developed a strategy for their implementation.

Summary Report on Activities in 2014/2015

Critical issues identified with the Hybrid Instruments system during testing at ITU were addressed during the first half of 2014, prior to commissioning and acceptance testing of the system.

Following completion of commissioning and acceptance testing of the 16-channel mixed-field analyser (MFA) instrument at IAEA Headquarters during September 2014, Hybrid Instruments staff accompanied the Task Officer to JRC Ispra for benchmarking during October 2014. The system proved to work extremely well, demonstrating its superior performance over a ^3He system for new fuel measurement; as well as its potential for other

applications. All of the analytical requirements were demonstrated, and some minor adjustments incorporated.

The system was retained at Ispra for some further measurements by the JRC team prior to its return to Vienna. The Agency subsequently declared proof of concept with the existing instrument to have been successful.

The intention is now to move towards pilot implementation in the field, including formal authorisation of the system for inspection use. This will entail extensive testing and documentation efforts and, whilst further technological development is not being considered in the near-term, continued support from Hybrid Instruments is expected to be required to resolve any problems and to optimise usability of the system.

A formal project is being put in place by the Agency, and a request for support from the UK is anticipated to be received once the Agency has concluded its own project and internal resource arrangements.

Task Area E15 – Computer Systems

The Department of Safeguards relies upon computer systems for the storage, collation and retrieval of safeguards data for use in safeguards evaluations. Adoption of strengthened safeguards measures, the Additional Protocol and Integrated Safeguards has resulted in a dramatic increase in the amount of data and information received and analysed. Developments to existing systems and the introduction of new systems are therefore required in order that the Agency maintains its capability for effective assessment of safeguards-relevant information.

Task E15(b) – SPRICS 2.0

IAEA SP-1 No:	04/SPA-001	UK Sub-contractor:	-
IAEA SPRICS No:	UK A01511	UK Task Manager:	J Tushingam, NNL
IAEA Task Officer:	S Kerbeck		

Background to Task

In 2005, the UK Support Programme contributed towards the Agency's procurement of a new computerised records system, SPRICS 2.0, for the Support Programmes Administration. The development of the system was protracted, as a result of the requirement for integration with overarching development of a new IT system for the Department of Safeguards.

Quality assurance testing of SPRICS 2.0 by the Agency was completed during 2013, after which the system was made available to the UKSP Coordinator for beta testing. Supported by Mr Francis, NNL, and Mr Sainsbury, DECC, the interactions between MSSP Coordinator, Task Manager, Reviewer and Agency were successfully tested. Issues identified during testing were subsequently resolved by the Agency.

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Summary Report on Activities in 2014/2015

The UKSP Coordinator concluded input to the beta testing of SPRICS 2.0 during April 2014. Following the completion of data migration by the Agency, in September 2014 the Task Officer wrote to all identified UKSP points of contact, requesting them to register in IAEA Nucleus, in order to gain access to SPRICS 2.0. Further details were subsequently provided to Task Managers by the UKSP Coordinator, with the intention that the Agency and UK Support Programme would agree a phased transition of communications to SPRICS 2.0.

Access to SPRICS 2.0 for MSSP users was made available in December 2014.

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(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:	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 activity, 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

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Cartwright supported the work of the Agency in the periodic training of both imagery analysts and safeguards inspectors. In 2013, Mr Cartwright's support was limited to participation in two satellite imagery awareness courses.

Summary Report of Activities in 2014/2015

Mr Cartwright was unable to provide any training support in 2014/2015.

Vienna-based specialist training for IAEA imagery analysts and satellite imagery awareness courses for inspectors continues to be desirable. The Head of the SIAU has requested that the UK Support Programme seek an analyst to assist with the training.

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 could be a wider benefit, within the Department of Safeguards as a whole, from technical support to the review and assessment of information from a variety of sources including, but not limited to, satellite imagery. The scope of the task was subsequently expanded in order to accommodate this requirement.

Summary Report of Activities in 2014/2015

During the year, the UK Support Programme provided expert assistance through nuclear fuel cycle technical studies and modelling developments in support of safeguards.

Subject to the availability of resources, the UK Support Programme intends to continue to offer technical support within the framework of this task in response to urgent and ad-hoc requests from the Agency.

Task F1(g) – Expert – NFC Technology Expert

IAEA SP-1 No:	14/ISF-001	UK Sub-contractor:	(S Francis)
IAEA SPRICS No:	UK D02013	UK Task Manager:	J Tushingham, NNL
IAEA Task Officer:	M Fowler		

Background to Task

The evaluation of nuclear activities within a State and the process required to draw safeguards conclusions require the analysis of information from wide and diverse sources. These activities require technical expertise with a broad and deep knowledge of NFC-related equipment, infrastructure and processes.

Summary Report of Activities in 2014/2015

In July 2014, the Department of Safeguards issued a Task Proposal seeking an NFC technology expert, to be located within the Safeguards Division of Information Management (SGIM), to provide technical analysis in support of nuclear sites and activities. The research and assessments conducted by the expert would be used by SGIM and the operations divisions as input to the State Evaluation Process, contributing to the Department's annual conclusions on Safeguards Implementation in States.

The UK Support Programme consulted widely within the UK nuclear industry and identified an appropriate candidate, who was nominated late-2014 and is expected to take up a position with the IAEA in June 2015 in what will be initially a two-year appointment. Funding for the first year was provided from the 2014/2015 UKSP budget.

Funding for the second year of the two-year CFE position is expected to be transferred during 2016.

Task Area F2 – Support to Technical Meetings and Conferences

In addition to workshops and technical meetings associated with specific tasks, or focussed on areas of safeguards to which the UK may make a significant technical contribution, the IAEA periodically convenes safeguards-related meetings and conferences on broader themes. It is in the UK's interests to ensure the effectiveness of meetings convened by the Department of Safeguards: to foster dialogue and information exchange with Member States, the nuclear industry and the broader non-proliferation community.

Task F2(a) – Support for the 2014 Safeguards Symposium

IAEA SP-1 No:	13/CPC-002	UK Sub-contractor:	-
IAEA SPRICS No:	JNT C01980	UK Task Manager:	J Tushingham, NNL
IAEA Task Officer:	A Hamilton		

Background to Task

Every four years, the IAEA Department of Safeguards organises a safeguards symposium. These symposia provide an important forum for interaction between the IAEA and its Member States on a wide variety of international safeguards and nuclear non-proliferation issues. The previous such event, the "Symposium on International Safeguards: Preparing for Future Verification Challenges", was held in Vienna in November 2010.

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The 2014 Safeguards Symposium was to be organised by the IAEA in cooperation with ESARDA and the Institute of Nuclear Materials Management (INMM). Entitled “Symposium on International Safeguards: Linking Strategy, Implementation and People”, it was intended to focus around the Department’s Long-Term R&D Plan, 2012-2023.

During 2013, the Agency requested assistance from the Member State Support Programmes to:

1. Review abstracts and attend the paper selection committee meeting(s);
2. Support design and implementation of the programme;
3. Support design and implementation of the accompanying exhibition;
4. Take the lead role for conference recording.

In November 2013, the UK Support Programme accepted the related Task Proposal, initially to provide the UKSP Coordinator’s support to review and development of the technical programme. Subsequently, it supported the second requested activity through the provision of an extrabudgetary contribution to hire a Vienna-based contractor familiar with the Agency, to assist in programme design and implementation.

Summary Report of Activities in 2014/2015

From 23 June – 27 June 2014, the Task Manager, together with representatives from the Support Programmes of the EC and France, supported the Agency from Vienna. There, they worked through over 360 abstracts and 40 proposed sessions to consolidate and map out a draft programme for the symposium. The following week, 30 June – 3 July, the Task Manager was able to continue to develop the programme and offer advice on its presentation to interested parties within the Agency.

Further support to development of the symposium programme was provided from within the UK. Arrangements were concluded for the Task Manager to chair one technical session of the symposium and work commenced on the preparation of posters to support a symposium stand dedicated to the Member State Support Programmes.

The IAEA Safeguards Symposium was successfully held in Vienna from 20-24 October 2014. In addition to chairing a session of the Symposium, and supporting stands of the MSSPs and ESARDA, the Task Manager continued to support the administration of the symposium, primarily through involvement in judging “best posters” within the various poster sessions.

ADDITIONAL MEETINGS AND ACTIVITIES

The UK Support Programme receives each year a small number of requests 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 2014/2015, the UK Support Programme facilitated expert participation in a Technology Evaluation Workshop of Core Components of an Autonomous Navigation and Positioning System for Safeguards, 3 - 4 April 2014; and in a Technical Meeting on Reference Materials for Destructive Analysis in the Nuclear Fuel Cycle, 2 – 4 September 2014.

The UK Support Programme continued to provide funds to enable staff from the Department of Safeguards to undertake approved visits in connection with activities associated with the UKSP.

SRDP AND OTHER REPORTS PUBLISHED OR IN PREPARATION DURING 2014/2015

Reports Published or In Preparation under the auspices of the UK Support Programme during 2014/2015 included:

- A8(h)** **SRDP-R313/1** “Heavy Water (Deuterium Oxide) Manufacturing Base Report” (Issued September 2014)
- SRDP-R313/2** “Composites Manufacturing Base Report” (Issued September 2014)
- SRDP-R313/3** “Vacuum Gauges Manufacturing Base Report” (Issued September 2014)
- SRDP-R313/4** “Zirconium Manufacturing Base Report” (Issued September 2014)
- SRDP-R313/5** “Controlled Atmosphere Furnaces Manufacturing Base Report” (Issued September 2014)
- SRDP-R313/6** “High-Speed Cameras Manufacturing Base Report” (Issued September 2014)
- SRDP-R313/9** “Aluminium Manufacturing Base Report” (Issued September 2014)
- SRDP-R313/10** “Remote Manipulators Manufacturing Base Report” (Issued September 2014)
- SRDP-R314** “Open Source and the State Evaluation Process”, I J Stewart (Under review)
- SRDP-R316/1** “Maraging Steel Manufacturing Base Report” (Issued March 2015)
- SRDP-R316/2** “Beryllium Manufacturing Base Report” (Issued March 2015)
- SRDP-R316/3** “Radiation Shielding Windows Manufacturing Base Report” (Issued March 2015)
- SRDP-R316/4** “Mass Spectrometers Manufacturing Base Report” (Issued March 2015)
- SRDP-R316/5** “Bellows-Sealed Valves Manufacturing Base Report” (Under review)
- SRDP-R316/6** “Centrifuge Rotor Materials Manufacturing Base Report” (In preparation)
- SRDP-R316/7** “Frequency Converters Manufacturing Base Report” (In preparation)

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SRDP-R317 “Compendium of Nuclear Technologies”, I J Stewart (In preparation)

B1(v) **SRDP-R315** “Sample Preparation for IAEA Safeguards Cameca SIMS 1280 Analysis”, T Nicholls, J Collins and S Crooks. (In preparation – awaiting issue as an SRDP report)

D2(h) **SRDP-R310** “SimMOX: A Computer Simulation to Examine Implications of Applying NRTA to a MOX Facility – Addenda”, J Howell. (Issued March 2015)

SRDP-PR34 “Report on the Activities and Progress during the Period 1 April 2013 to 31 March 2014”, J W A Tushingam. (Issued October 2014)

ABBREVIATIONS

Abbreviation	Term
AGR	Advanced Gas-cooled Reactor
Am	Americium
AVLIS	Atomic Vapour Laser Isotope Separation
AWE	Atomic Weapons Establishment
B	Boron
BHF	Bulk Handling Facility
BN800	Sodium-cooled Fast Breeder Reactor type
BNFL	British Nuclear Fuels Ltd
CANDU	Canadian Deuterium Uranium Reactor
CFE	Cost-Free Expert
Cm	Curium
D&IS	Development and Implementation Support
DA	Destructive Analysis
DECC	Department of Energy and Climate Change
DG-Ener	Directorate General for Energy of the European Commission (split off from DG-TrEn in February 2010)
DG-TrEn	Directorate General for Transport and Energy of the European Commission
DIQ	Design Information Questionnaire
DIV	Design Information Verification
EC	European Commission
ECAS	Enhancing Capabilities of the Safeguards Analytical Services
ESARDA	European Safeguards Research and Development Association
EURRP	Enriched Uranium Residues Recovery Plant
FISPIN	A Fuel Inventory Code
FT-TIMS	Fission Track-Thermal Ionisation Mass Spectrometry
F/WPs	Forms and Working Papers
GCEP	Gas Centrifuge Enrichment Plant
He	Helium
IAEA	International Atomic Energy Agency
INFCIRC	IAEA Information Circular
IR-40	Iranian Heavy Water Reactor
IT	Information Technology
ITU	Institute for Transuranium Elements, EC Joint Research Centre
J-MOX	JNFL MOX Fuel Fabrication Plant
JNFL	Japan Nuclear Fuels Ltd
JRC	European Commission Joint Research Centre
KCL	King's College, London
LANL	Los Alamos National Laboratory
LEU	Low-Enriched Uranium
LFUA	Limited Frequency Unannounced Access
LG-SIMS	Large Geometry-Secondary Ion Mass Spectrometer
Li	Lithium
LLNL	Lawrence Livermore National Laboratory
MAGNOX	A graphite-moderated, gas-cooled reactor (originally with

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	MAGnesium Non-OXidising fuel cladding)
MBR	Manufacturing Base Report
MFA	Mixed Field Analyser
Mo	Molybdenum
MoD	Ministry of Defence
MONK	A Monte Carlo neutronics code
MOX	Mixed Oxide
MSSP	Member State Support Programme
MUF	Material Unaccounted For
NDA	Non-Destructive Analysis
NFC	Nuclear Fuel Cycle
NML	IAEA Nuclear Material Laboratory
NNL	National Nuclear Laboratory
Np	Neptunium
NPL	National Physical Laboratory
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
NRTA	Near Real Time Accountancy
NSP	Nuclear Safeguards Programme
NWAL	Network of Analytical Laboratories
OLA	IAEA Office of Legal Affairs
OLEM	On-Line Enrichment Monitor
ONR	Office for Nuclear Regulation
ORNL	Oak Ridge National Laboratory
PANTHER	A neutron diffusion and thermal hydraulics code
PIV	Physical Inventory Verification
PIWG	Performance Indicators Working Group
PSD	Pulse Shape Discriminator
Pu	Plutonium
PWR	Pressurised Water Reactor
R&D	Research and Development
RAE	Resistive Anode Encoder
RICC	Regional Information Collection Centre
SAGSI	Standing Advisory Group on Safeguards Implementation
SEG	State Evaluation Group
SEM	Scanning Electron Microscopy
SGAS	IAEA Safeguards Office of Analytical Services
SGIM	IAEA Safeguards Division of Information Management
SIAU	IAEA Satellite Imagery Analysis Unit
SILARC	Separation of Isotopes by Laser-Assisted Retardation of Condensation
SIMS	Secondary Ion Mass Spectrometry
SIP	Safeguards Implementation Practices
SPRICS	Support Programme Information and Communication System
Th	Thorium
THORP	Thermal Oxide Reprocessing Plant, Sellafield
TIMS	Thermal Ionisation Mass Spectrometry
U	Uranium
UK	United Kingdom

UKAEA	United Kingdom Atomic Energy Authority
UKSP	United Kingdom Support Programme to the IAEA
UOC	Uranium Ore Concentrate
US	United States of America
USDoE	US Department of Energy
USSP	US Support Programme
VVER	A Pressurised Water Reactor, of Russian design
WIMS	Winfrith Improved Multigroup Scheme, a neutronics code

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