Department of Energy & Climate Change

SRDP-PR34

UK SAFEGUARDS SUPPORT PROGRAMME

Report on Activities and Progress during the period 1 April 2013 to 31 March 2014

J W A Tushingham

October 2014

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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EXECUTIVE SUMMARY

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 2013 to 31 March 2014, the UK Support Programme contributed to 30 active tasks within the IAEA Department of Safeguards Technical Support Programme, completing work on 3 of these. 13 task proposals were considered during the year, of which 5 were accepted and 5 remained pending at the year-end. Activities undertaken included:

- continuing support to environmental sampling: with the analysis of 22 inspection samples; and the preparation of modelling specifications for six reactor types;
- contributions to guidance documents: on consideration of safeguards in the design of new nuclear facilities; and the implementation of safeguards, including input to the Agency's development of acquisition path analysis;
- provision of open source information, with eight State Profiles updated and two ad-hoc reports issued, and studies related to trade analysis;
- further support to the new IAEA nuclear material laboratory, through an extrabudgetary contribution of €400k to the project 'Enhancing Capabilities of the Safeguards Analytical Services' (ECAS);

- delivery of nine training courses to IAEA inspectors and analysts, including an expansion of support in the areas of analytical and negotiation skills whilst retaining a portfolio of courses utilising UK expertise and facilities of the nuclear fuel cycle;
- assistance through the updating of technical manuals and forms used by inspectors and other personnel within the Department of Safeguards;
- further development of an advanced neutron measurement technology within a plant-scale integrated system for IAEA application; and
- provision of expertise relevant to the assessment of data available to the Department of Safeguards, including from imagery analysts and specialists in different components of the nuclear fuel cycle.

This report provides a summary of the progress on those tasks active during 2013/2014 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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National Nuclear Laboratory, Harwell, UK

INTRODUCTION

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

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

The UK Support Programme is funded by the UK Department of Energy and Climate Change (DECC) and is administered on its behalf by the National Nuclear Laboratory (NNL). A range of contractors undertake work on behalf of the 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.

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

- Area A, Safeguards Strategies;
- Area B, Support for IAEA Analytical Services;
- Area C, Training Courses;
- Area D, Safeguards Procedures;

- Area E, Instrument Development and Assessment; and
- Area F, Consultants and Cost-Free Experts.

This report provides a summary of the progress against specific tasks in each of these six areas during the period 1 April 2013 to 31 March 2014.

AREA A – SAFEGUARDS STRATEGIES

Many of the requests for support to the IAEA are concerned with novel methods and techniques aimed at improving the effectiveness and efficiency of nuclear safeguards. 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. Environmental swipes are taken by inspectors using 10x10cm cotton or round cellulose wipes of around 2.5cm diameter, the latter designed for use with remote manipulators and used within hot cells. In either case, the inspector wipes surfaces that may have been exposed to nuclear material, removing a portion of any surface contamination on the wipe for subsequent analysis. Samples may also be taken by special particulate sampling using installed sample filters (Koshelev filters). 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, with the aim to ensure

sufficient analytical capacity to service the diversity of samples and analytical requirements. The NWAL also fulfils an important role by enabling routine inter-laboratory comparisons and cross checks on analytical results.

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 2013/2014

AWE Aldermaston continued to provide an FT-TIMS capability during 2013/2014, completing the analysis of 10 samples. 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 12 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 was lower than was historically the case, as AWE continued to consolidate and refurbish its analytical facilities. AWE commenced the installation and commissioning of its own LG-SIMS instrument during 2013/2014, expected in the long-term to enhance UK support to environmental sample analysis but with a short-term impact upon the resources available to support the IAEA.

The IAEA will continue to require the analysis of environmental swipe samples by both FT-TIMS and SIMS in 2014/2015, 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 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.

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

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modelling specification for each of the ten reactor types. Modelling specifications for the first four reactors were completed by end-March 2013.

Summary Report on Activities in 2013/2014

Modelling specifications for the remaining six reactors were 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 one reactor as a finite core model with critical rod positions. A WIMS model was produced, generating irradiation-dependent cross-section data for use in the PANTHER whole core code. A PANTHER model was established, employing cluster geometry fuel assemblies within a hexagonal lattice. Suitable data and dependencies for the treatment of control rods and core reflector materials in PANTHER were developed, and verified against a standalone MONK model of the reactor. PANTHER whole-core fluxes, dependent upon core axial and radial location as well as irradiation and control rod insertion, were then fed back to WIMS in order to generate appropriate data for the FISPIN fuel inventory calculation. This study was completed during December 2013, with the conclusion that the WIMS-PANTHER-FISPIN combination provided a feasible route for whole core fuel burnup modelling of the reactor.

The Agency's priority within this task is now for further modelling of the reactor, to accommodate different fuel types and core locations, with two other reactor types also of interest. Work commenced on a definitive and verified WIMS-PANTHER-FISPIN model of the first reactor type, and is expected to be completed by September 2014.

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, 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 measurement 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 Proposal 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.

Summary Report on Activities in 2013/2014

Task Proposal 12/IFC-002 was accepted by the three Member State Support Programmes (MSSPs), as a collaborative effort between the EC, US and UK laboratories. Within the UK, AWE liaised with the other laboratories, 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 material and compiled current analytical data. Arrangements commenced for a coordination meeting between the parties, to progress the task to a conclusion.

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.

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In October 2013, the UK Support Programme offered a voluntary contribution to the Department of Safeguards for the procurement of satellite images and equipment, or to support other open source information collection through tasks placed with King's College London (KCL). The Agency responded by requesting that the funds be retained by the UK and directed towards maintaining support from KCL in the collection of open source information under Tasks A8(e) and A8(f). Funds were duly utilised for this purpose during 2014. The UK Support Programme anticipates that a further contribution to open source information collection/satellite imagery will be offered in 2014/2015.

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. Once under Integrated Safeguards, IAEA safeguards can evolve further to a State Level Approach, where safeguards implementation includes comprehensive evaluation of all safeguards-relevant information taking account of State-specific factors within a process that is consistent and non-discriminatory.

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

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

Background to Task

Strengthened and integrated safeguards 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

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

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In October 2013, the Task Manager completed a third four-week period at IAEA Headquarters: progressing the Commentary to the extent where only two chapters remained outstanding. These would address in detail the implementation of Comprehensive Safeguards Agreements and Additional Protocols, and were framed by the Task Manager but required detailed input from OLA. Completion of the Commentary is now dependent upon the continued availability of staff within OLA.

Task A7(h) - Support for Novel Technologies (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 Whichello/J Kocjan		

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.

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In 2006, the UK Support Programme agreed to contribute to the project through an umbrella task, initially to provide a contact point for the identification of appropriate expertise and resources. Since then, the task has enabled UK expert participation in a number of technical meetings associated with novel technologies, together with preliminary evaluation of such technologies.

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The UK Support Programme engaged the 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.

The UKSP Coordinator liaised with the Agency and potential UK contributors to a workshop on "Scanning the Horizon: Novel Techniques and Methods for Safeguards", subsequently held from 21-24 January 2014 at IAEA Headquarters. The UK Support Programme funded the participation of an expert, from Cranfield University, to talk on the subject of "A systematic approach to realise phenomena for enhanced sensing of nuclear materials and radiation". Additional participation was provided from AWE Aldermaston and the University of Newcastle.

The UK Support Programme also assisted in seeking contributions from UK commercial companies to an Agency technology evaluation of core components of an autonomous indoor positioning system for safeguards. UK suppliers of associated technology were encouraged to consider participation, with three companies expressing interest. Selected participation in a workshop on the subject, to be held in April 2014, will be funded through the UK Support Programme.

The Agency continues to encourage MSSPs to provide scientific and technical information concerning techniques and instruments of potential application to the effective and efficient implementation of nuclear safeguards. Equally, the Agency requests that the provision of diverse advanced technologies undergo a preliminary evaluation for potential safeguards use by the MSSPs as a prerequisite for sharing technologies with the IAEA. The UK Support Programme will continue to provide a point of contact with the Agency, to liaise with the Task Officer to identify appropriate UK expertise and to consider specific requests for support within the framework of this task.

Task A7(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 Tushingham, NNL
IAEA Task Officer:	J Sprinkle		

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 the UK Safeguards Office 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.

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During May 2013, a draft of the document "International Safeguards in the Design of Fuel Fabrication Plants" was reviewed by Mr S Johnson, Springfields Fuels Ltd, who provided additional illustrations for use by the Agency. A second document, "International Safeguards in the Design of Conversion Plants", was reviewed by Mr S Johnson and Mr S Francis, NNL, during the following month, with feedback provided to the IAEA Task Officer.

Mr A Homer, Sellafield Site Ltd, participated in a workshop, convened by the Agency to draft guidance for reprocessing plants, in September 2013. 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".

At the beginning of 2014, the MSSPs input to the three facility-specific guidance documents dealing with long-term spent fuel management, reprocessing and enrichment, was being assembled by the Agency with the intention that they be made available for peer review by summer-2014.

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 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. A meeting was held with the Agency the following month, during which the Task Manager gave a presentation on the contents of the draft report and conducted a workshop to illustrate the recommended techniques, using some example scenarios provided by the IAEA.

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Feedback from the Agency was incorporated into a revised report, which was submitted for final review by the Task Officer in April 2013.

From 24-25 February 2014, the lead author of the UK report, Mr T Pattenden, participated in an Agency workshop on the subject of acquisition path analysis. The purpose of the workshop was to:

- Promote better understanding of the process of acquisition path analysis as it is performed within the Department of Safeguards;
- Share the outcomes of the various studies performed under the joint MSSP task;
- Identify how methodologies developed under the joint task could be applied to or help improve the Department's acquisition path analysis process; and
- Discuss and identify directions of future work under the task.

Mr Pattenden provided an overview of the work done on the subject by Tessella and outlined potential further work including trial sessions with larger focus groups at the IAEA. He also suggested the potential to assist in defining user needs for possible software to support acquisition path analysis. These suggestions were under consideration within the Department of Safeguards at the year-end.

Further support may be provided during 2014/2015, to assist the Agency in reconciling views, training and roll-out of techniques.

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

IAEA SP-1 No:	12/CPC-001	**UK Sub-Contractor:**	Sellafield Site Ltd UK Safeguards Office
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.

Summary Report on Activities in 2013/2014

Mr N Edmonds, Sellafield Safeguards Department, participated in a workshop convened by the Agency from 16-19 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 from 5-8 November 2013. Subsequently, Mr Edmonds assisted in editing the draft guide, prior to its review within the Agency, with publication anticipated for the second half of 2014.

Two additional SIP Guides were proposed for 2014, following the format of the previous work and covering:

- Provision of information to the IAEA (nuclear material reports, Additional Protocol declarations, design information, import/export information etc); and
- Collaborative approaches to safeguards implementation.

Experts from within the UK Safeguards Office were identified as being most able to give an effective UK contribution on these subjects. Consequently, Mr L Johnson participated in the first meeting on provision of information, from 25-28 February 2014, with Mr M Beaman participating in the first meeting on collaborative approaches, from 25-28 March 2014. The Agency hopes that the same two experts will be available to participate in the second meeting on each subject, to be held in November 2014, and that their continued availability will result in a further substantive and relevant contribution from the UK to the joint task.

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 useful material including the European Safeguards Research and Development Association (ESARDA) textbook. However, clarity was still lacking regarding the specific contributions envisioned by each MSSP and no lead author/editor was identified.

Summary Report on Activities in 2013/2014

During 2013, the Agency identified a potential 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 to the Task Officer that the lead author would be unlikely to be able to support the project as originally envisaged. 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 is expected to be given over the coming months, with close involvement of the Department of Safeguards' Training Section.

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		

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 2013/2014

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 2013/2014.

Four State Profiles were updated, covering specific subjects requested by the Agency. In addition, an ad-hoc report on the subject of research on nuclear technology development was prepared. Updates on political issues in the region were researched and sent to the Agency on six occasions during the year.

Activity will continue through 2014/2015, including expansion of existing information collection capabilities; the update of a further four State Profiles; the continued provision of abstracts and political updates; and an ad-hoc report on a subject to be specified by the Agency.

Task A8(f) – Regional Information Collection Centre – 2

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

Background to Task

From 2003 to 2008, a 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 2013/2014

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 2013/2014.

Three State Profiles were updated, together with a first edition of a new State Profile. In addition, an ad-hoc report was prepared that provided an open source assessment from English language sources of indigenous capabilities associated with nuclear technology. 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 2014/2015, 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.

Summary Report on Activities in 2013/2014

The Agency has a need for trade and manufacturing data on both proliferation-sensitive materials and technologies. In particular, the Agency has an interest in knowing which firms manufacture the specific grades of materials or supply the technologies that are sought by proliferators. In January 2014, agreement was reached to provide the first eight Manufacturing Base Reports (MBRs) from a list of 25 proposed technologies. Each MBR would involve analysis, conducted by technical experts, to provide detailed and comprehensive reports on the global manufacturing bases of the most sensitive materials and technologies.

Six MBRs were completed by the end of the financial 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. Four illicit procurement case studies were also prepared, whilst good progress was made on a report on the topic of "Open Source and the State Evaluation Process".

Work is expected to continue in 2014/2015, including the completion of additional MBRs on priority subjects and a report on trends in illicit procurement.

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 SGAS

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

Background to Task

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

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

and future requirements for analytical services, and provided further input to the Agency in respect of advice on the draft plans for a new 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. Meanwhile, the scope of the task was broadened during 2012, to enable the provision of ad-hoc implementation support to the Safeguards Office of Analytical Services (SGAS) and to facilitate technical exchanges between UK experts and SGAS analytical laboratories.

Summary Report on Activities in 2013/2014

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.

Following discussions between SGAS, the UKSP Coordinator and staff from the UK's National Physical Laboratory (NPL), the Agency requested by letter that the UK Support Programme enable the production of the following certified reference materials by NPL:

- 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.

The letter request for the above materials, plus a set of five mixed Np/Pu isotopic reference materials, was accepted by the UK Support Programme. However, commencement of work was delayed beyond the financial year-end, pending agreement of contractual terms and conditions between the UK parties involved.

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

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

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

Background to Task

The Agency requires 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. 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 Dr A Simons under a Special Service Agreement, running from December 2011 to February 2012 inclusive. During this period, Dr 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 SGAS. This enabled presentation of the results from AWE's SIMS re-validation exercise and provided the opportunity to discuss AWE's capabilities and visit laboratories utilised in support of low-level analyses.

Summary Report on Activities in 2013/2014

The Agency's LG-SIMS instrument is now in routine operation, and AWE has procured its own LG-SIMS instrument, delivered in November 2013. It is hoped that this can be utilised, in part, in support of Agency environmental sample analysis. Meanwhile, AWE's activity under this task was limited to participation in a technical meeting on particle analysis, convened by the Agency and held in November 2013.

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The Agency wishes to continue to utilise the expertise of AWE staff, as it continues the development of its in-house LG-SIMS capability, whilst AWE will validate its own LG-SIMS instrument for safeguards work during 2014/2015.

AREA C - TRAINING COURSES

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

Task Area C1 - Inspectors' Training Courses

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

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

IAEA SP-1 No:	06/TTR-003	**UK Sub-Contractor:**	NNL
IAEA SPRICS No:	UK B01618	**UK Task Manager:**	S M Francis
IAEA Task Officer:	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 360 inspectors (usually recent recruits) have received general training and familiarisation aimed at providing an enhanced understanding of operations at a variety of bulk handling facilities.

Prior to 2001, the course included a simulated Physical Inventory Verification (PIV) exercise, using Non-Destructive Analysis (NDA) instrumentation at Springfields. In 2001, the course was reviewed and, at the request of the IAEA, the focus changed to performing a Design Information Verification (DIV) exercise. The course was of three weeks duration, the first week being conducted by the IAEA in-house; the second and third weeks being hosted by BNFL, at Springfields and Sellafield in the UK, and including one day at Capenhurst hosted by Urenco (Capenhurst) Ltd. Consolidation over subsequent years led to the visit to the Urenco enrichment plant being removed and the overall duration of the course being reduced to two weeks.

Summary Report on Activities in 2013/2014

The course on safeguards and design verification at bulk handling facilities was successfully delivered to eleven IAEA inspectors from 29 April – 9 May 2013. Some changes were made from the 2012 course, to provide additional time for training in the understanding and use of engineering drawings and to consolidate some of the course exercises. Introductory days at both Springfields and Sellafield included lectures and practical exercises, but were dominated by preparation time for the plant exercises. The approach was to allow the participants to be more independent and responsible for the preparation and conducting of the exercises, with the UK

site staff requested to be "less helpful" than on previous courses, to require the participants to drive the exercises more as a real inspection would be carried out. To support the exercises, training materials were distributed that included: a general description of the main processes relating to conversion, fuel fabrication and reprocessing operations; notes relating to Design Information Evaluation/Verification (DIE/V) concepts; and a large collection of plant drawings, layouts and schematics. The participants were asked to check the accuracy and completeness of design information and to look for possible routes for the diversion of nuclear material. They were expected to identify inconsistencies and omissions in the information.

At Springfields, a new day-long exercise in the Oxide Fuels Complex targeted an initial DIV visit to a "newly-declared facility" whilst the second exercise, in the Enriched Uranium Residues Recovery Plant, concentrated on the verification of detailed process flow diagrams across a diverse and complex facility. At Sellafield, exercises based in the Thermal Oxide Reprocessing Plant (THORP) allowed the participants to use their own initiative in identifying where they wished to go, with site guides instructed not to volunteer advice but only to provide information when requested. Finally, a Design Information Questionnaire (DIQ) exercise was held within NNL's Central Laboratory, providing a balance between large and small-scale facilities. Based upon the participants' presentations that followed the exercises, each group demonstrated an understanding of the facilities and successfully completed each exercise.

In January 2014, following a periodic review of the courses offered under the UK Support Programme, the Agency submitted a new Task Proposal seeking the continued provision of a DIV training course. The intention was to build upon the training offered under the existing task, but to expand the participant base and to maximise in-field practical activities. In addition to the training of safeguards inspectors, the replacement course would target members of State Evaluation Groups (SEGs) whose performance within such groups requires them to make full use of DIV at bulk handling facilities when performing State evaluation and preparing safeguards implementation plans. The Task Proposal was accepted in February 2014 and preparations commenced for the first course, to be held in May 2014.

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

IAEA SP-1 No:	07/CTR-004	**UK Sub-contractor:**	NNL
IAEA SPRICS No:	UK B01698	**UK Task Manager:**	S M Francis
IAEA Task Officer:	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 nuclear weaponisation processes and 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 eighteen years, the course was run on 31 occasions by the UK Support Programme.

Summary Report on Activities in 2013/2014

Two Nuclear Fuel Cycle and Proliferation Pathways Courses were run in 2013, in June and November. These concentrated on the safeguards-relevant elements of the nuclear fuel cycle and on the nuclear proliferation pathways associated with its more 'sensitive' activities, such as enrichment, fuel reprocessing, MOX fuel fabrication and power generation from reactors capable of unreported plutonium production.

The 32nd Proliferation Pathways Course was delivered to 13 participants from Operations and Support Divisions, with introductory lectures at IAEA Headquarters followed by a week-long residential course at Puchberg. The introductory lectures covered an introduction to proliferation indicators and the nuclear fuel cycle, and integrated safeguards and information review. The course that followed provided for one day of presentations and exercises per fuel cycle stage, with the UK Support Programme providing five experts who gave lectures on subjects including conversion, enrichment, reprocessing and reactors. For the June course, modified reactor and reprocessing modules were introduced, together with a final exercise intended to support development of a consistent fuel cycle scenario through the week's exercises.

A further 16 participants attended the 33rd Proliferation Pathways Course in November 2013. The course followed the same format as the previous one, with the UK Support Programme providing four experts supplemented by one expert from within the Agency.

In January 2014, the Agency submitted a new Task Proposal, incorporating experience and lessons learned from the earlier courses but with the aim to increase interactivity in the course and enable a more effective evaluation of the participants' performance. The course would continue to consist of lectures, individual and group exercises, addressing:

- 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, with arrangements commencing for the first course to be held under the new task in June 2014.

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.

Individual Member State Support Programmes were expected to take responsibility for preparation of the different manuals, with the UK Support Programme agreeing to provide the revised Fuel Fabrication and Power Reactor volumes. Work was subsequently undertaken on both manuals, with the Fuel Fabrication manual completed during 2010 and published the following year. However, the Power Reactor manual required further work, to broaden the scope to a worldwide focus, and this was subsequently undertaken together with the revision of sections that dealt with gas-cooled and boiling water reactors. Input from the Agency's Department of Nuclear Energy provided additional detail, with the UK Support Programme completing further revision to ensure a safeguards focus.

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.

Meanwhile, the Task Manager was requested to review and provide comments on the Australian-authored Mining, Milling and Conversion manual, initially with emphasis on the conversion section but later expanded to consideration of the whole manual. This activity was also completed in March 2013.

Summary Report on Activities in 2013/2014

Additional support was provided to development of the Reprocessing and Power Reactor volumes during the year. Input to the Power Reactors volume was provided by two UK experts, taking the opportunity of their presence in Vienna prior to the June and November 2013 Proliferation Pathways courses to facilitate detailed review and discussions. This was followed by further input and review from the UK. By the end of the financial year, the Power Reactor manual was considered to be well-advanced, but with further illustrations required. This need can be met through use of material already collected to support existing UKSP training activities.

As with the Power Reactor volume, the opportunity was taken for a reprocessing expert from Sellafield to support development of the Reprocessing volume immediately before the June 2013 training course. He reviewed the manual with the Task Officer, selecting the most appropriate images from a range of material provided by the Agency and advising on the revision of flow diagrams and plant layouts.

It is anticipated that the Power Reactor manual will be finalised during the first quarter of 2014/2015, with the UK Support Programme then providing further input to the Mining and Milling manual.

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:**	D Williams/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.

Summary Report on Activities in 2013/2014

No training in practical safeguards at gas centrifuge enrichment plants was conducted during 2013/2014.

The next training course is provisionally scheduled for October 2014, at Urenco Deutschland Gronau. The UK Support Programme anticipates continuing to facilitate support from Urenco (Capenhurst) staff to this and future courses.

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 ‘spoilers’ and ‘bad leaders’.

Late in 2010, the UK Support Programme was requested to provide training to senior inspectors in diplomatic negotiation skills, utilising a team of former diplomats with high-level experience in negotiation and professional mediation. 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 course was extremely positive, and the Agency proposed that the course be held on an annual basis.

Summary Report on Activities in 2013/2014

A Diplomatic Negotiation Skills course was held from 1 – 4 October 2013 at IAEA Headquarters. The course was successfully delivered by two UK ex-diplomats, with a third participating as an observer and sharing his additional experiences with the group. Through a combination of presentations, discussion and role play, the participants learnt about and practised a range of negotiation techniques intended to enable them to prepare and conduct negotiations with regional or State authorities. The course was well-received, with the Agency requesting that it be repeated in the same format in September 2014.

A priority was identified early-2014, to provide training in negotiation skills in the context of managed access to a specific group of Agency personnel. The development of appropriate training was completed, with the first three-day course subsequently held in March 2014. A second course was scheduled for April 2014.

The UK Support Programme was also requested to facilitate additional support to the Agency's existing Communication Skills Course. It was subsequently agreed that the UK would assist the Agency with the negotiation skills component of the course through:

- Revising four existing role plays and developing two new scenarios;
- Presenting a lecture on basic negotiation techniques; and
- Facilitating course exercises.

Two UK trainers are expected to contribute to the Communication Skills Course in May 2014, following a period of research that commenced during 2013/2014.

The UK Support Programme expects to continue to provide training in negotiation skills and related topics during 2014/2015.

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 2012 and March 2013, but with nine participants on each course.

Summary Report on Activities in 2013/2014

The fifth course 'Advanced Training on NFC Facilities to Assist State Evaluation' was held during October 2013, 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 that included presentations on the sites to be visited, imagery analysis techniques and open source analysis, followed by more detailed study of site imagery and schematics and examination of a package of open source information related to the two sites. There followed a week of detailed technical visits to sites, plant and equipment at Sellafield and Springfields.

At Sellafield, detailed tours over a three-day period included: Calder Hall; the Fuel Handling Plant; MAGNOX and THORP Reprocessing Facilities; older facilities including the Windscale Piles and separation plants; laboratory areas; and a satellite imagery and open source analysis exercise based at the low-level waste facility at Drigg. At Springfields, a similarly detailed level of visits encompassed: main line chemical plants; the Oxide Fuels Complex; Enriched Uranium Residues Recovery Plant; and fuel fabrication areas.

A sixth course was held to a similar format during March 2014, again for nine course participants, but with some changes enforced by plant availability. Feedback from both courses was very positive, and will be used to fine-tune further courses anticipated for October 2014 and March 2015.

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 focussed on a nuclear issue. 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 specialised analytical skills and appreciation within the Agency.

Summary Report on Activities in 2013/2014

The first full analytical skills training course was successfully delivered to selected Department of Safeguards inspectors and analysts by three UK experts from 6 - 10 May 2013. The course provided participants with a range of techniques for hypothesis generation and testing, scenario generation and evaluation, data organisation, communicating uncertainty and capturing expert judgement.

Although the course was extremely well received, a small number of adjustments to the training material were sought, together with a request by the Agency to include information on audit trails. These revisions were implemented prior to the second course, held from 28 October – 1 November 2013. A more focused approach to selecting the course attendees was implemented, with 15 inspectors and analysts from two SEGs participating in the course. This assisted in building a more complete understanding of a structural analytical approach; and in resolving some of the issues in terms of inspectors driving the assessment process over the analysts who have the wider picture.

In a continuation of agreed transition arrangements, some modules of the second course were presented by an Agency training team, with UK participation reduced to two trainers. The training material was transferred to the Agency's format, to further strengthen Agency ownership of the course. The opportunity was also taken to facilitate participation of two SEG

members, identified to assist in further courses, in a December 2013 'Train the Trainers' course within theUK.

The Task Manager has accepted a commitment to provide two more weeks' training in 2014, with courses to run during July and November. The Agency is then expected to provide course trainers from in-house by 2015, although further support may be provided in terms of consultancy from the UK.

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

IAEA SP-1 No:	12/CTR-006	**UK Sub-contractor:**	-
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 overseas 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.

Summary Report on Activities in 2013/2014

Discussions were held over the possibility to hold a bespoke training event, to provide four imagery analysts and two inspectors with a detailed knowledge of particular plants and their associated infrastructure. An itinerary was developed for September 2013 but, subsequently, resource issues within both the IAEA and UK lead to the conclusion that training on this schedule was impractical. The site visits are now expected to take place during September 2014.

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

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

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.

Summary Report on Activities in 2013/2014

A report on the SimMOX software tool was completed, incorporating revisions identified during a visit to the Agency in March 2013. The report was issued to the Agency and an international distribution list on 2 July 2013.

In order to complete the task, the assumptions underlying the software tool must be analysed, and if necessary modified, and a series of simulation test cases must be defined and run. 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. However, it was foreseen that, by late-2014, the necessary support from the side of the Agency could resume. In light of the importance of the task with regard to designing an effective safeguards approach for the J-MOX plant in the future, it was agreed that the task should be placed on standby, to resume in September 2014.

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.

Summary Report on Activities in 2013/2014

During 2013, the Task Officer requested assistance in the updating of a set of documents for measurement applications, including uranium enrichment and attribute verification, that

currently used an ageing miniature multichannel analyser. A new instrument, the mMCA-527, was under test and evaluation by the Agency and nine documents required updating, by end-2013, to reflect use of the mMCA-527. During a familiarisation visit to the Agency in September 2013, the equipment was demonstrated, existing documentation was reviewed and examples of the equipment and software were handed over to Canberra's technical author, for use during preparation of the documentation.

The first draft reference manual was completed during September 2013. This manual contained all of the technical reference material relating to the hardware and software, and was used as a reference for the preparation of the other eight manuals. The complete set of draft documents was submitted to the Task Officer for review late-November 2013. Further work, to prepare additional documentation associated with use of the multi-channel analyser for criticality testing, remained pending at the year-end, awaiting feedback from the Agency on the earlier manuals.

In a separate initiative on the part of the Agency, to achieve quality improvements for safeguards forms and working papers used throughout the Department of Safeguards, the Agency sought an appropriate expert to:

- Review the importance and frequency of use of all forms and working papers within the Department of Safeguards;
- Select the most important and frequently used, and review their correctness and completeness;
- Select a common graphical design and rewrite selected forms and working papers; and
- Draft a guide on form and working paper 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 within protected cells and selection from menus. The forms were circulated to all stakeholders for comment on usability and validity of the fields, and the process of revising forms according to feedback commenced. This activity will continue into 2014/2015, with completion of the revised forms and a procedure for the preparation of future forms.

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 Tushingham, NNL
IAEA Task Officer:	E Smith/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 ^{235}U material balance in large-scale enrichment plants. The intention would be to install OLEM at Gas Centrifuge Enrichment Plants, to monitor permanently and accurately the uranium enrichment of uranium hexafluoride in unit header pipes through application of passive gamma spectrometric measurements.

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

Following extensive discussions between Urenco, the US Department of Energy (USDoE), Los Alamos National Laboratory and the IAEA, Urenco agreed to allow a field test of an OLEM of US origin at its Capenhurst enrichment plant. Contractual arrangements were agreed late in 2010 and USDoE and Agency parties subsequently met at Urenco Capenhurst in January 2011, to enable the US side to gather preliminary analysis data at a product header pipe location and to discuss the preliminary results with meeting participants. An on-site field trial progressed through 2012/2013 without call on the resources of the UK Support Programme. Urenco (Capenhurst) worked directly with the IAEA and US parties to facilitate testing.

Summary Report on Activities in 2013/2014

Urenco continued to facilitate the sharing of information and lessons learned from the collaborative Urenco/USDoE testing of enrichment technologies at Capenhurst, without call on the resources of the UK Support Programme. In addition, discussions were facilitated with Urenco LES 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.

SRDP-PR34

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:	A Lavietes/N Mascarenhas		

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 JNFL's MOX Fuel Fabrication Plant (J-MOX). ^{3}He is widely used in neutron detectors due to its outstanding γ-ray rejection properties. Recently, a world-shortage of ^{3}He has led to renewed interest in systems based upon ^{10}B and even ^{6}Li. However, what all these systems lack is an ability to detect fast neutrons: the neutrons emitted by plutonium must be slowed down to energies in thermal equilibrium with their surroundings.

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 ^{3}He-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.

Summary Report on Activities in 2013/2014

Work focussed on completion of the 16-channel mixed-field analyser (MFA) instrument, and its integration to detectors supplied under the Netherlands Support Programme, with 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 LEU in gadolinium-doped VVER fuel assemblies.

Further testing at ITU Karlsruhe, utilising a variety of sample materials, raised some additional issues associated with user interfaces and data presentation. Hybrid Instruments reviewed the required enhancements and developed a strategy for their implementation. Work on the necessary further developments was agreed, to commence in April 2014.

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 Tushingham, 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.

Summary Report on Activities in 2013/2014

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, and the system is expected to be deployed to the MSSPs during 2014/2015.

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

Cartwright supported the work of the Agency in the periodic training of both imagery analysts and safeguards inspectors. In 2012/2013, discussions were held between staff of the SIAU, Mr Cartwright and the UKSP Coordinator on the subject of additional activities that might be undertaken, in anticipation of a time when Mr Cartwright was no longer available to train imagery analysts. The preparation of three audio/visual narrated tutorials was identified as a priority, and Mr Cartwright began to research the three projects during the remainder of the year.

Summary Report of Activities in 2013/2014

Mr Cartwright conducted specialist satellite imagery training at IAEA Headquarters in November 2013. Two, back-to-back, Satellite Awareness Courses were run for the benefit of up to 24 safeguards inspectors and other operations staff. Instructors from the UK and Swedish Support Programmes delivered the core subjects of the course, with additional support provided by four Agency staff from the SIAU.

Whilst this proved to be Mr Cartwright's final activity under this task, the Agency has requested that the task remain open, with the UK Support Programme to identify an appropriate expert to continue Mr Cartwright's work.

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

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

Background to Task

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

During 2008, the Agency approached a number of Member State Support Programmes, seeking the nomination of imagery experts for initial two-year posts within the SIAU. The Agency accepted the UK Support Programme's nomination of a candidate for the position of satellite imagery cost-free expert in January 2009, and an extrabudgetary voluntary contribution, equivalent to the costs associated with the first year of employment of the expert by the Agency, was made the following month. The nominated CFE commenced work with the Agency in September 2009, in a position that was subsequently extended to September 2014.

Summary Report of Activities in 2013/2014

The UKSP-sponsored imagery analyst completed his fourth year with the Agency, and commenced a fifth year working within the SIAU. During this period, he continued the

production of imagery analysis reports in support of safeguards monitoring and verification activities, participated in a number of workshops and continued to develop training materials. In particular, he continued collaboration with country and facility officers to provide analytical products.

He worked with GIS staff in the creation of site plans for nuclear facilities, for uploading to the new Geospatial Exploitation System (GES), and continued detailed consistency checks of GES data. He acted as facilitator to a number of UK Support Programme training events, and also liaised with other MSSPs to support and promote specific tasks.

During the third quarter of 2013/2014, in recognition of his continuing value to the SIAU and the fixed-term nature of his CFE position, the Agency offered Mr Flory direct employment within the Department of Safeguards. He subsequently transferred to the Department of Safeguards staff and his CFE contract was terminated.

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 2013/2014

During the year, the UK Support Programme provided expert assistance in a number of areas in response to requests under this task, including:

- An expert in process monitoring continuing to support technical evaluation;
- Further support to a nuclear fuel cycle technical study;
- In-depth discussions with UK experts on current safeguards issues; and
- Modelling development 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 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 non-proliferation issues. The previous such event, the Symposium on International Safeguards: Preparing for Future Verification Challenges, was held in Vienna in November 2010.

The 2014 Safeguards Symposium is 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 will be focussed around the Department's Long-Term R&D Plan, 2012-2023.

Summary Report of Activities in 2013/2014

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.

The UKSP Coordinator, will contribute to the review and selection of abstracts and development of the symposium programme during 2014/2015.

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 2013/2014, the UK Support Programme facilitated expert participation in three meetings not directly associated with active tasks but convened by the Department of Safeguards. These were:

- "Statistical Methodologies for Safeguards", October 2013;
- "Particle Analysis of Environmental Samples for Safeguards", November 2013; and
- "Scanning the Horizon: Novel Techniques and Methods for Safeguards", January 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 2013/2014

A5(b) **SRDP-R312** "Revalidation of Cameca 4f SIMS Instrument for the Isotopic Analysis of Uranium Particles Extracted from Environmental Swipe Samples", A J Simons, A J Pidduck, N J Montgomery and J W Cairns. (Issued May 2013)

A7(k) **SRDP-R311** "Review of Objective Techniques for Combining Different Sources of Information", T Pattenden and C Mistry. (Draft issued April 2013)

A8(h) **SRDP-R313/1-6** "Manufacturing Base Reports", I J Stewart (Drafts)

SRDP-R314 "Open Source and the State Evaluation Process", I J Stewart. (In preparation)

D2(h) **SRDP-R310** "SimMOX: A Computer Simulation to Examine Implications of Applying NRTA to a MOX Facility", J Howell and G T Cowell. (Issued July 2013)

SRDP-PR33 "Report on the Activities and Progress during the Period 1 April 2012 to 31 March 2013", J W A Tushingham. (Issued September 2013)

ABBREVIATIONS

Abbreviation	Term
Am	Americium
AWE	Atomic Weapons Establishment
Be	Beryllium
BNFL	British Nuclear Fuels Ltd
CANDU	Canadian Deuterium Uranium Reactor
CFE	Cost-Free Expert
Cm	Curium
DA	Destructive Analysis
DECC	Department of Energy and Climate Change
DG-TrEn	Directorate General for Transport and Energy of the European Commission
DIE/V	Design Information Evaluation/Verification
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
FBR	Fast Breeder Reactor
FISPIN	A Fuel Inventory Code
FT-TIMS	Fission Track-Thermal Ionisation Mass Spectrometry
GES	Geospatial Exploitation System
HEU	High-Enriched Uranium
IAEA	International Atomic Energy Agency
INFCIRC	IAEA Information Circular
ITU	Institute for Transuranium Elements, EC Joint Research Centre
J-MOX	Japan Mixed Oxide plant
JNFL	Japan Nuclear Fuels Ltd
KCL	King's College, London
LEU	Low-Enriched Uranium
LFUA	Limited Frequency Unannounced Access
LG-SIMS	Large Geometry-Secondary Ion Mass Spectrometer
MAGNOX	A graphite-moderated, gas-cooled reactor (originally with MAGnesium Non-OXidising fuel cladding)
MBR	Manufacturing Base Report
MFA	Mixed Field Analyser
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
NWAL	Network of Analytical Laboratories
OLA	IAEA Office of Legal Affairs
OLEM	On-Line Enrichment Monitor
ONR	Office for Nuclear Regulation
PANTHER	A neutron diffusion and thermal hydraulics code
PIV	Physical Inventory Verification
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
SIAU	IAEA Satellite Imagery Analysis Unit
SIMS	Secondary Ion Mass Spectrometry
SIP	Safeguards Implementation Practices
Th	Thorium
THORP	Thermal Oxide Reprocessing Plant, Sellafield
TIMS	Thermal Ionisation Mass Spectrometry
U	Uranium
UK	United Kingdom
UKSO	UK Safeguards Office
UKSP	United Kingdom Support Programme to the IAEA
UOC	Uranium Ore Concentrate
US	United States of America
USDoE	US Department of Energy
VVER	A Pressurised Water Reactor, of Russian design
WIMS	Winfrith Improved Multigroup Scheme, a neutronics code

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