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& Industrial Strategy

NATIONAL NUCLEAR
LABORATORY



The United Kingdom Support Programme to IAEA Safeguards: 2016-2021



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UK SUPPORT PROGRAMME TO IAEA SAFEGUARDS 2016-2021

40 YEARS OF UK SUPPORT TO IAEA SAFEGUARDS

2021 marked 40 years of the United Kingdom's active contribution in the Member State Support Programmes for International Atomic Energy Agency (IAEA) Safeguards. The UK Support Programme to IAEA Safeguards (UKSP) was established in 1981, to provide technical support to the Department of Safeguards of the IAEA in verifying the peaceful use of nuclear technology.



UK Ambassador David Hall collecting a certificate of appreciation for 40 years of UK Support Programme assistance to IAEA Safeguards from IAEA's Director General Rafael Grossi, and Deputy Directors General and Head of Department of Safeguards Massimo Aparo in Vienna, January 2020

The UK Support Programme to IAEA Safeguards contributes:

- expertise and advice for the further development of safeguards strategies in new and existing activities and plants 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 2016 to 31 March 2021, the UK Support Programme contributed to over 35 tasks within the IAEA Department of Safeguards Development and Implementation Support Programme. This report provides a summary of progress against tasks active during 2016-2021 within the framework of the UK Support Programme, including:

- routine analysis of safeguards inspection samples through two IAEA accredited Network of Analytical Laboratories;
- provision of open source information from two Regional Information Collection Centres and support to improving the analysis of trade data for safeguards-relevant proliferation activities;
- delivery of training events to IAEA inspectors, analysts and senior staff, including an expansion of support in the areas of negotiation skills and leadership training, whilst retaining a portfolio of courses utilising UK expertise and facilities of the nuclear fuel cycle;
- provision of expertise and software relevant to the assessment of data available to the Department of Safeguards, including the provision of two cost-free expert positions;
- promotion of UK technology solutions to meet current and future safeguards challenges identified in the Department of Safeguards' Instrumentation Technology Foresight project;
- extra-budgetary financial contributions to key IAEA Safeguards projects, including:
 - Modernization of Safeguards Information Technology (MOSAIC) and Keeping Safeguards IT Updated;
 - replacement of analytical instrumentation within the IAEA Nuclear Material and Environmental Sample Laboratories;
 - IAEA Safeguards Traineeship Programme;
 - Marie Skłodowska Curie Fellowship Programme;
 - COMPASS to build State capacity on safeguards implementation;
 - creation of e-learning modules, supporting the preparation of State declared information;
- financial and in-kind support to key IAEA safeguards events including the 2018 Safeguards Symposium and IAEA Emerging Technology Workshops.

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UK SAFEGUARDS SUPPORT PROGRAMME

INTRODUCTION

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

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

The UKSP is funded by the UK Department for Business, Energy and Industrial Strategy (BEIS), which was established in July 2016 and took responsibility for the Programme from the former Department of Energy and Climate Change. The Programme is administered on behalf of BEIS by the National Nuclear Laboratory (NNL). A range of contractors undertake work on behalf of the UKSP, which was initiated by the UK Government in 1981 with the following formal objectives:

- to assist the IAEA in the provision of efficient and effective solutions to identified safeguards needs as set out in the 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.

UK SUPPORT PROGRAMME TO IAEA SAFEGUARDS 2016-2021

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

The specification of long-term capabilities provides a framework to assist Member State Support Programmes (MSSPs), including the UKSP, in deciding where their resources can best be used, and also helps the Department of Safeguards formulate the projects that make up a biennial programme and monitor progress towards the strategic objectives.

The IAEA's biennial Development and Implementation Support (D&IS) Programmes for Nuclear Verification are composed of approximately 25 projects. These projects are themselves composed of over 300 'tasks'. Each project contains objectives, targets and activities that are defined for the relevant two-year period. Both internal tasks, carried out by IAEA staff and consultants, and external tasks, carried out under MSSPs, are included in the projects; some of which are aimed at meeting shorter-term needs and others that are part of longer-term R&D efforts.

The UKSP is one of 21 MSSPs (plus the European Commission) that provide support to the Department of Safeguards. The MSSPs work singly and in collaboration to fulfil the priority needs of the Department of Safeguards, taking into account their individual expertise, resources, national and international priorities.

The IAEA hold biennial Member State Support Programme Coordinators' Meetings which are multi-day events for the Department of Safeguards and Member State Support Programmes to focus on the future, highlight specific ideas and plans for next steps, and discuss how collaboration can help IAEA chart a successful course. The UKSP participated in the 2018 Coordinators' Meeting 13–15 February 2018, and chaired the 2020 Coordinators' Meeting 29–31 January 2020.



IAEA Member State Support Programme Coordinators Meeting held in Vienna, 29–31 January 2020

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

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

- Area A, Safeguards Strategies;
- Area B, Support for IAEA Analytical Services;
- Area C, Training Courses;
- Area D, Safeguards Procedures;
- Area E, Instrument Development and Assessment; and
- Area F, Consultants and Cost-Free Experts.

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

This report provides a summary of the progress against specific tasks in each of these six areas during the period 1 April 2016 to 31 March 2021.

AREA A – SAFEGUARDS STRATEGIES

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

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.

Special Analyses of Environmental Samples Supplied by IAEA (UK X 1045)

Current implementation of environmental sampling for safeguards focuses primarily on the collection of swipe samples inside enrichment plants and hot cell facilities. Samples are analysed by either bulk or particle analysis techniques, depending on the sampling objectives and the activity levels of the swipes. A Network of Analytical Laboratories (NWAL) for environmental samples has been set up by the IAEA, consisting of Member States' laboratories with particular expertise in techniques suited to

environmental sampling. These laboratories complement the Agency's own in-house capabilities, and ensure sufficient analytical capacity to service the diversity of samples and analytical requirements received from inspectors. The NWAL also fulfils an important role by enabling routine inter-laboratory comparisons and cross checks on analytical results. This is of particular importance given the sensitivity of analytical techniques deployed and the need to eliminate the potential for false results due to cross contamination.

During the review period, the UKSP provided the services of AWE Aldermaston within the IAEA NWAL for environmental samples. AWE Aldermaston supported the Department of Safeguards' environmental sampling programme, through the provision of Fission Track Thermal Ionisation Mass Spectrometry (FT-TIMS), Large Geometry Secondary Ion Mass Spectrometry (LG-SIMS) capabilities, and the application of other microanalysis techniques, including Scanning Electron Microscopy (SEM) combined with energy-dispersive X-ray microanalysis.



SIMS instrumentation at UK accredited IAEA NWAL member AWE Aldermaston

The Use of Commercial Satellite Imagery in Support of Safeguards

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

Support for SGIM Analysis (UK D 1329)

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 UKSP assisted in the procurement of commercially available satellite images and equipment, whilst further support from imagery analysts was provided under separate taskings.

For each year of the review period, the UKSP made a voluntary contribution to the Department of Safeguards: for the procurement of satellite images and equipment; or to support UKSP open source information collection tasks.

Strengthening/Integration of Safeguards

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

IAEA safeguards implementation is now evolving to an approach that makes greater use of the IAEA's ability to consider the State as a whole. It involves a comprehensive evaluation of all safeguards-relevant information regarding a State, and the use of objective State-specific factors to draw up a State-level approach (SLA) for each State. The implementation of SLAs will enable the IAEA to make best use of its resources and focus effort on areas of greater safeguards significance. The use of generic objectives common to all states with the same type of safeguards

agreement (and, where applicable, Additional Protocol) enables differentiation without discrimination.

Update of the Physical Model (UK C 2297)

A Physical Model was developed by the Department of Safeguards to identify, describe and characterise various components of the nuclear fuel cycle, providing a technical tool to aid enhanced information analysis. The Physical Model is used in analysing information on a State's nuclear and nuclear-related activities, and in developing integrated safeguards approaches. The Physical Model is subject to periodic review and update based on technical advances in nuclear fuel cycle activities, experience gained through its application practice and new requirements for implementing strengthened safeguards.

During the review period, the UKSP provided subject matter experts to IAEA consultancy meetings to update and enhance the IAEA's Physical Model in the areas of Spent Fuel Management, Reactors, and Reprocessing.

Creation of a Repository of Nuclear Fuel Cycle Signature Reference Materials (UK A 2215)

This task requested provision of a variety of well-characterised dual-use substances to support the evaluation of related instrumentation. The IAEA is evaluating handheld instrumentation for use in prompt on-site identification of various radioactive and non-radioactive materials and compounds, which are indicators of nuclear fuel cycle (NFC) activities. The intended applications for these instruments are during Complementary Access (CA), Design Information Verification (DIV), technical visits and routine inspections. The technologies under evaluation include Raman spectroscopy, Fourier Transform Infra-Red Absorption Spectroscopy (FTIR), and Laser Induced BreakDown Spectroscopy (LIBS).

In March 2018, the UKSP completed its commitment to procure selected metal samples from a list of prioritised materials and a UKSP Subject Matter Expert contributed to the preparation of the Safeguards Technical Report STR-394 "Comprehensive Prioritized List of Nuclear Fuel Cycle Related Metals" which was published in April 2020.

Support to Instrumentation Technology Foresight (UK A 1599)

The Technology Foresight effort works to identify and evaluate technologies in various stages of development, focusing on commercially available technologies and those from non-traditional safeguards fields. The review is coordinated with stakeholders, both internally and externally, to identify and develop technologies with possible safeguards application in support of improving the efficiency and effectiveness of IAEA safeguards activities.

MSSPs are encouraged to continue the provision of scientific and technical information regarding methods and instruments of potential use for the effective and efficient implementation of nuclear safeguards. The IAEA encourages MSSPs to evaluate diverse advanced technologies for potential safeguards use and share their results with the IAEA.

The UKSP provides a contact point within the UK for the identification of appropriate expertise and resources, with the acceptance of individual sub-tasks considered on a case-by-case basis. The task has enabled UK expert participation in a number of technical meetings associated with novel technologies, together with preliminary evaluation of such technologies.

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.

Regional Information Collection Centres (UK D 1728, UK D 1730)

The UKSP continued to operate two Regional Information Collection Centres (RICC) throughout the review period.

The RICCs established methodologies for the collection of information to support the production of detailed surveys of States' industrial and nuclear research infrastructures extending the Agency's ability to identify relevant information, without which the Agency's confidence in safeguards conclusions would be reduced.

The RICCs supported the IAEA through provision of open source information, including 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.

Improving the Analysis of Trade Data for Safeguards-Relevant Proliferation Activities (UK D 1916)

This task supports the development of methods and skills for finding indications of non-declared safeguards-relevant proliferation activities. Through this task, work takes place on investigating the availability and feasibility of predictive analytical approaches, developing capabilities to improve the recognition of non-declared activities through the assessment of trade-related technical indicators, and discussing methods for improving the acquisition of information.

Management Support

The UKSP may provide expertise to enhance the implementation of safeguards through advice on planning, implementing and performance monitoring procedures and best practice.

Knowledge Management Assessment and Review (UK C 2433)

In November 2018, the UKSP provided a two-week consultancy at IAEA headquarters for the review, assessment, and refinement of the IAEA Safeguards Knowledge Management (KM) framework. A report was provided with a diagnosis of current IAEA practices and a benchmark for improvement.

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 UKSP 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. In more recent years, support focussed primarily on the Agency project "Enhancing Capabilities of the Safeguards Analytical Services" (ECAS), and has now turned to assisting both the Nuclear Material Laboratory and continuing environmental sampling capabilities.

Analytical Services

As bulk handling plants become larger, and material throughput increases 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.

The UKSP has two active tasks providing operational and implementation support to the IAEA Environmental Sample Laboratory (UK A 1776) and Nuclear Material Laboratory (UK C 1742).

Implementation Support to Nuclear Material Laboratory (UK C 1742)

NNL's Preston Laboratory continued to provide support through specialised analysis of samples against the relevant standards in response to analysis requests from the Department of Safeguards. In 2019, the IAEA completed its final assessment of the qualification of the NNL Preston Laboratory as a new member of the IAEA Network of Analytical Laboratories (NWAL).



IAEA Accredited Network of Analytical Laboratories (NWAL) Members

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 expertise and nuclear facilities, which can only be made available by Member States.

Inspectors' Training Courses

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

Design Information Verification at Bulk Handling Facilities Training Course (UK B 1990)

Courses on safeguards at bulk-handling facilities have been run for the benefit of IAEA inspectors by the UKSP since 1992. The current tasking supports an on-site training course in which inspectors will acquire relevant skills for performing Design Information Verification (DIV) at Bulk Handling Facilities

(BHF). Inspectors are exposed to the technology applied at conversion, fuel fabrication and reprocessing plants to understand the functions of these facilities in order to assess that facilities are designed and operated as declared. Upon course completion, inspectors are able to perform the necessary safeguards verification activities at similar bulk handling facilities. The UKSP successfully delivered the course on an annual basis between 2016 and 2019. Due to the COVID-19 pandemic it was not possible to deliver the course in 2020.

Training on the Nuclear Fuel Cycle, Indicators and Proliferation Pathways (UK B 1991)

The main objective of the IAEA strengthened safeguards system is to provide assurance of the absence of undeclared nuclear activities in Member States. Under an 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.

The current task provides a training course on indicators of nuclear activities, covering each step of the nuclear fuel cycle, including R&D, with learning objectives for participants to be able to: identify indicators of nuclear activities, assess the significance of those indicators as related to safeguards implementation and evaluation; and identify key indicators for basic steps of acquisition paths, such that they could more effectively define technical objectives for further definition of implementation plans.

The course involves presentations to the Agency participants by a team of UK experts and specialists in the nuclear fuel cycle and proliferation indicators.

The course was delivered twice a year between 2016 – 2019, and once in 2020 by UK nationals in the Department of Safeguards due

to COVID-19 pandemic travel restrictions preventing travel by UK based experts.

Implementation of Safeguards at Enrichment Facilities (UK B 1797)

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. The current task covers a training course on the preparation and implementation of LFUA activities at centrifuge enrichment plants. The course rotates between Urenco's European gas centrifuge enrichment facilities in Gronau, Almelo, and Capenhurst. The course rotation led to delivery at Capenhurst by the UKSP in 2019.

Training in Negotiation Skills (UK B 1874)

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.

During the review period, the UKSP provided training to senior inspectors in diplomatic negotiation skills, utilising a team of former diplomats with high-level experience in negotiation and professional mediation.

The portfolio of courses delivered was expanded to include both in-person and virtual (due to COVID-19 pandemic travel restrictions) skills training in Negotiation, Leadership, Communication, Being Effective and Effective Meetings.

Advanced Training on NFC Facilities to Assist State Evaluation (UK B 1903)

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.

This task supports an advanced training course on nuclear fuel cycle facilities for IAEA safeguards staff, in particular inspectors and analysts, who hold significant responsibilities in the State Evaluation Process.

The course focuses on application of the field knowledge gained and competencies acquired during the "Nuclear Fuel Cycle and Indicators" training course. This course includes physical access to conversion and fuel fabrication plants, reactors and reprocessing plants.

The objective of the course is to enable safeguards staff to analyse advanced nuclear sites in a complete and correct manner by making full use of nuclear fuel cycle related indicators.

The UKSP successfully delivered the course on a twice-yearly basis between 2016-2019. It was not possible to deliver a course in 2020 due to the COVID-19 pandemic.



Participants on the 2017 UKSP Advanced Nuclear Fuel Cycle Training Course

Specialised Training and Visits to Nuclear Facilities (UK B 1936)

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 Department's internal committee, which oversees the overall training programme, to ensure consistency with the programme. A new

course may then be designed at short notice, possibly requiring support from experts or access to nuclear facilities, laboratories or sites from Member States.

This task, functioning as an umbrella task, aims to give the required flexibility, reactivity and capacity for the Training Section to organise such courses under a formal arrangement with the UKSP 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.

Development of 3D Models for Critical Nuclear Facilities (17/OA3-001)

The UKSP has significant technical knowledge and capabilities with advanced state-of-the-art 3D modelling technology. Within the framework of current decommissioning activities across many areas of the nuclear fuel cycle, it has developed a strong technical expertise in the development and use of 3D modelling and visualisation techniques. Much of this experience and knowledge is of direct relevance and has been utilised to support the requirements of IAEA.

UKSP support has provided the opportunity to enhance the IAEA's ability to effectively and efficiently capture and integrate safeguards relevant information related to selected facilities, to prevent loss of critical knowledge due to staff turn-over, and to maintain its preparedness to respond to future changes in safeguards implementation.

Creation of e-learning modules, supporting the preparation of State declared information (UK D 2352)

In order to complement classroom training courses, the IAEA needs to introduce business-relevant e-learning for the State or regional authorities responsible for safeguards implementation (SRAs), for the stakeholders in-house involved in nuclear material accountancy and the preparation of reports and declarations to the IAEA. The UKSP has provided financial support to create interactive e-Learning exercises that lay the foundation for a better understanding of the IAEA reporting obligations, to enable States to make better use of relevant IAEA guidance documents, as well as to develop their knowledge base in this specific area.

Safeguards Traineeship Programme (UK B 2584)

The UKSP provided financial support to the 2020 Safeguards Traineeship Programme which seeks to increase the number of candidates, from States with limited or no nuclear fuel cycle, who are qualified for a position in their national nuclear organisation or the IAEA. The objective of the 10-month programme which takes places in Vienna, Austria at the IAEA headquarters is to provide the trainees with the opportunity to strengthen their knowledge in nuclear energy, and applications as well as in nuclear safeguards, safety and security in order that they may, upon return to their state, help to strengthen the capacity of the State.

Marie Sklodowska-Curie Fellowship Programme (MSCFP)

The Marie Sklodowska-Curie Fellowship Programme (MSCFP) aims to help grow the number of women in the nuclear field, supporting an inclusive workforce of both men and women who contribute to and drive global scientific and technological innovation.

In 2020, the UKSP provided a financial contribution to the MSCFP supporting two eligible female candidates to complete a Masters degree in a course related to nuclear science, technology or non-proliferation, and undertake an internship at the IAEA Safeguards Department.

COMPASS: Comprehensive Capacity Building Initiative for SSACs and SRAs (UK X 2595)

To help States carry out their safeguards obligations more efficiently and effectively, the IAEA launched an initiative called COMPASS to help them strengthen and sustain the effectiveness and efficiency of their State systems of accounting for and control of nuclear material (SSACs) and State and regional authorities responsible for safeguards implementation (SRAs).

In 2020, the UKSP provided a financial contribution to support COMPASS with provision of assistance and services tailored to a State's needs, while also contributing to the greater efficiency and effectiveness of IAEA verification work.

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.

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.

NRTA system documentation and requirements gathering (UK D 2308)

This task supports the writing of comprehensive documentation of the statistical methods underlying the NRTA systems which is required for maintenance and future enhancements. The future NRTA systems will be used in the Rokkasho Reprocessing Plant (RRP) and Japan Nuclear Fuel Limited (JNFL) MOX fuel fabrication plant (JMOX). The final version of the document is to be published as a Safeguards Technical Report (STR).

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.

Technical Manuals and Procedures for Safeguards Instrumentation (UK A 1729)

The Agency requires documentation to a standard format for safeguards instrumentation, including a Reference Manual for Instrumentation and a Checklist Procedure. The UKSP has provided assistance to the Department of Safeguards through the preparation of technical manuals and procedures for NDA instrumentation used by safeguards inspectors.

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.

Developing Business Capabilities for the Modernisation of Safeguards Information Technology (MOSAIC) (JNT D 2171 UK)

The IAEA Modernisation of Safeguards Information Technology (MOSAIC) programme developed applications and software to improve the structure and integration of all safeguards information within a modernised IT system, to allow better planning, conducting, reporting and quality assessment of safeguards activities within the Department of Safeguards.

The UKSP provided support for the enhancement of existing capabilities and the development of new capabilities, through

provision of financial contributions to support software development.

Safeguards Disaster Recovery and Business Continuity (UK X 2464)

The Safeguards Disaster Recovery and Business Continuity project is aimed at strengthening the continuity and recovery capabilities of the Department of Safeguards to allow for continuation of critical services linked to Safeguards legal obligations during emergency situations. In 2020, the UKSP provided a financial contribution to support with travel associated with related event attendance.

Keeping Safeguards IT Updated (UK D 2465)

The objective of the task "Keeping Safeguards IT Updated" is to improve existing IT products supporting IAEA Safeguards businesses, and identify opportunities for new software capabilities to be developed in support of Safeguards' strategic priorities. In 2020, the UKSP provided financial support to this task contributing to a regularly updated IT platform that supports Safeguards effectively, efficiently, and securely.

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.

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.

Nuclear Fuel Cycle Specialist Assistance (UK D 1819)

During the review period, the UKSP has provided a range of expert assistance through nuclear fuel cycle technical studies and modelling developments in support of safeguards. The task has provided a framework for the UKSP to provide technical support in response to urgent and ad-hoc requests from the Agency during the review period.

Expert – Nuclear Fuel Cycle Technology Expert (UK D 2013)

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

An experienced NFC technology expert, to provide technical analysis in support of nuclear sites and activities was requested to support the Safeguards Division of Information Management (SGIM). Following selection by the Department of Safeguards, a NFC technology expert commenced a two-year term as a cost-free expert within the IAEA Department of Safeguards in June 2015. The research and assessments conducted by the expert were used as input to the State Evaluation Process, contributing to the Department's annual conclusions on Safeguards Implementation in States.

Expert – Satellite Imagery Analyst (UK C 2005)

In response to the demands for imagery-derived products and services from the Operations Divisions within Department of Safeguards, the State Infrastructure Analysis Section (ISI) needs to maintain and grow its current analytical capabilities. An experienced satellite imagery analyst CFE, with a

demonstrated familiarity of the nuclear fuel cycle, was requested to support SGIM-ISI.

Following selection by the Department of Safeguards, a Satellite Imagery Analysts commenced an initial two-year term as a cost-free expert within the IAEA Department of Safeguards in January 2020. The expert has contributed to the collection and analysis of commercial satellite imagery and related geospatial information, and work to enhance the analytical processes within the Section.

Expert - D&IS Technical Editing Consultancy (UK X 2479)

The biennial Development & implementation Support (D&IS) Programme describes the IAEA Department of Safeguards development activities and needs for additional support for the implementation of safeguards. It details development tasks and tasks that cannot be implemented without support from Member State Support Programmes.

The UKSP provided a technical editor for the "D&IS Programme for Nuclear Verification 2020–2021" providing a review of the 25 D&IS project plans for technical soundness, consistency, clarity, and completeness.

ADDITIONAL MEETINGS AND ACTIVITIES

The UKSP 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 2016-2021, the UKSP facilitated expert participation in a number of Technical Meetings including:

- Technical Guidelines on Termination of Safeguards on Nuclear Material 29 August - 2 September 2016;
- Particle Analysis of Environmental Samples for Safeguards Purposes, 17 – 20 October 2017;
- Statistical Methodologies for Safeguards 10-12 October, 2017;
- Consultancy Meeting on Quality Control Materials for Particle Analysis 23-24 October 2017;
- Particle Analysis of Environmental Samples for Safeguards Purposes 19 – 22 November 2019; and
- Statistical Methodologies for Safeguards 2-6 November 2020.

UK SUPPORT PROGRAMME TO IAEA SAFEGUARDS 2016-2021

The UKSP continued to provide funds to enable staff from the Department of Safeguards to undertake approved visits in connection with activities associated with the UKSP, including participation in training events.

IAEA Emerging Technologies Workshop (JNT X 2458 UK)

Approximately every two years, the Department of Safeguards holds a departmental workshop that explores emerging scientific and technological capabilities, trends, interdependencies, applications, and the challenges and opportunities that they may impact on the nuclear safeguards mission. This internal workshop allows SG staff to learn from outside experts about emerging scientific and technological advancements and explore their implications. These discussions, takeaways, and subsequent reports then inform the SG's Research & Development Plan that communicate priority research and development needs for safeguards to Member States.

The UKSP made contributions to the IAEA Emerging Technology Workshops in 13-16 February 2017 and 27-29 January 2020 by sponsoring: participation of an expert speaker on recent trends in additive manufacturing; data visualisation work which provided ideas for enhancements for the Safeguards Implementation Report (SIR); and live scribe and animation videos capturing and communicating key insights from the workshops.

2018 IAEA Safeguards Symposium (UK C 2295)

The IAEA holds a Symposium on International Safeguards every four years in order to engage the broader safeguards community in addressing challenges and seizing opportunities to strengthen the effectiveness of safeguards implementation.

The UKSP provided extrabudgetary financial support and in-kind assistance for the IAEA Safeguards Symposium, 5 – 8 November 2018. A UK safeguards expert provided assistance in the preparation for the Symposium including design of its technical programme, and contributing to the development of the Symposium Report which was released in July 2019 as Safeguards Technical Report (STR 392). The report

includes a set of ideas for potential action around innovation, partnering and improving communication as well as collaboration among States, industry, academia, non-governmental organisations and the IAEA.



2018 IAEA Safeguards Symposium, Vienna, Austria, 5 – 8 November 2018

UKSP DELIVERY DURING THE COVID-19 PANDEMIC

Despite the COVID-19 pandemic, the UKSP continued to provide assistance to IAEA Safeguards across all areas of the technical support programme. Areas impacted most included training requiring access to UK facilities, and in-person technical consultancy meetings. To mitigate the risks of COVID-19 transmission and to adhere to travel restrictions, parts of the UKSP training portfolio were re-designed to integrate remote learning and enable delivery from in-house IAEA experts. The UKSP held regular virtual review meetings with the IAEA during the pandemic.