REPORT OF WORKING GROUP 2

- SECURING THE USE, STORAGE AND TRANSPORT OF RADIOLOGICAL AND STRATEGIC NUCLEAR MATERIALS -

The 2016 Nuclear Industry Summit

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1. ELEMENTS OF CONTEXT FOR WORKING GROUP 2

1.1 Introductory Comments

Responsible civilian use of high-activity radiological and strategic nuclear materials requires care be taken to adequately safeguard and secure the materials during its use, transport and storage to protect against a potential malicious use. International organizations, national governments, their responsible agents, and the nuclear industry have long recognized this potential threat and have robust security protocols to secure these materials and the facilities where they are utilized. These measures have been largely effective. However, during the last decade, international organizations and national governments have recognized that we are only as secure as our most vulnerable facility and that the nature of threats can change. Thus, international organizations, national governments and industry have come together in a variety of forums (including the Nuclear Security Summits and Nuclear Industry Summits) to work cooperatively on these nuclear material security issues.

This report focuses on high-activity radiological material and strategic nuclear material, and expands the list of these materials discussed in the Report of Working Group 3 to the 2014 Nuclear Industry Summit (NIS). The 2014 NIS Working Group 3 report focused on the civilian use of High Enriched Uranium (HEU) as potentially attractive strategic nuclear material at civilian facilities and described the excellent progress made by governments and industry to secure and minimize the use of HEU. The 2014 NIS Working Group 3 report also focused on high-activity radiological sources as an attractive materials for potential malicious use.

This 2016 report has been expanded to include high purity plutonium at civilian research facilities as another category of strategic nuclear materials. The report has also been expanded to include used nuclear fuel at all civilian facilities as another category of high-activity radiological materials, and also expands the focus of the previous report to include security of all radiological and strategic nuclear materials during transportation. The inclusion of high purity plutonium provides a focus on securing the relatively limited quantities of this strategic nuclear material. The inclusion of used nuclear fuel is in recognition of the relatively large volumes of this material, which might be attractive for potential malicious use if it can be dispersed.

The major civilian uses of HEU are as fuel for research and test reactors and as targets for the production of the medical isotope Molybdenum-99 (Mo-99). As such, it is widely accepted that civilian use of HEU has been and can be further reduced in the following ways:

1. Replacement of the HEU fuel in existing research, test and medical isotope production reactors (more generally called “research reactors” or “RR” hereinafter) with Low Enriched Uranium (LEU) fuel, where technically and economically feasible.

2. The design, development and deployment of new research reactors that operate on LEU fuel.

3. The use of LEU targets for Mo-99 production.

The major civilian use of high purity plutonium is for research associated with the development of new reactor technology, such as fast neutron reactors. The organizations involved in this research are predominantly State owned and conduct research and development in support of national energy policies and commitments. All organizations involved in such activities are rigorously licensed and monitored by national regulators.

Companies which manufacture, transport, use or dispose of high-activity radioactive sources are aware of the associated security and safety risks and take measures to minimize those risks. Furthermore these companies are regulated and licensed by national regulators, whose regulations reflect international best practice as documented in the International Atomic Energy Agency (IAEA) Code of Conduct on the Safety and Security of Radioactive Sources and associated guidance.

Companies that use nuclear fuel to generate electricity or run research reactors are fully aware of the associated security and safety risks, and take measures to manage the material to minimize the risk. They are also rigorously licensed and monitored by national regulators.

1.2 Statements made at the 2014 Amsterdam Nuclear Industry Summit

Concerning managing materials of concern, the Joint Statement of the 2014 Amsterdam Nuclear Industry Summit includes the following recommendations:

- *Endeavoring to further minimize the use of HEU through the conversion from HEU to LEU fuel in research reactors, where technically and economically feasible, and by switching from HEU to LEU targets in radioisotope production, while assuring a continuous and stable supply of Mo-99,*

- *Fostering the development of high-density fuel both by enhancing the existing scientific coordination and by addressing the industrialization issues, at the worldwide level,*

- *Engaging with states and relevant organizations to ensure that there is a diversification of supply sources of 19.75% enriched uranium and a viable disposition route for LEU research and test reactor fuels,*

- *Accepting return of disused sources which they supplied, and assisting holders of those sources in making logistical and financial arrangements for their return, and engaging with states regarding the provision of central facilities for the management of disused sources which cannot be returned to the supplier.*

1.3 Recent Activities of Other Groups

1.3.1 The themes of the 2016 Nuclear Security Summit

There is a clear connection between the topic of this working group "Securing the Use, Storage and Transport of High-Activity Radiological and Strategic Nuclear Materials" and the themes of the 2016 Nuclear Security Summit (2016 NSS).

1.3.2 The IAEA International Conferences on Nuclear Security

The topic of this working group was reflected in the outcomes of the IAEA International Conference on Nuclear Security: Enhancing Global Efforts held in Vienna, 1-5 July 2013 and is expected to be reflected in the outcomes of the IAEA International Conference on Nuclear Security to be held in Vienna, Austria on 5–9 December 2016. Both the previous and future IAEA nuclear security conferences include a Ministerial Level component to ensure that nuclear security remains at the forefront of the minds of policy and decision makers.

1.3.3 Newly-issued IAEA Nuclear Security Series Documents

The IAEA has issued a number of documents supporting the strengthening of nuclear security. These include: NSS-2 (Revision 1): Implementing Guide – *Nuclear Forensics in Support of Investigations;* NSS-20: Nuclear Security Fundamentals – *Objectives and Essential Elements of a State's Nuclear Security Regime;* NSS-21: Implementing Guide – *Nuclear Security Systems and Measures for the Detection of Nuclear and Other Radioactive Material out of Regulatory Control*; NSS-22: Implementing Guide-*Radiological Crime Scene Management*; NSS-23: Implementing Guide – *Security of Nuclear Information*; NSS-24: Implementing Guide – *Risk Informed Approach for Nuclear Security Measures for Nuclear and Other Radioactive Material out of Regulatory Control*; and NSS-26: Implementing Guide – *Security of Nuclear Material in Transport*.

1.3.4 OECD NEA (HLG-MR) Joint Declaration on the Security of Medical Radioisotopes

In mid-2009, the OECD Nuclear Energy Agency (OECD/NEA) established the High-level Group on the Security of Supply of Medical Radioisotopes (HLG-MR). The OECD/NEA Steering Committee for Nuclear Energy has adopted the policy approach suggested by the HLG-MR, which is based on six principles, including:

> *Principle 4: Given their political commitments to non-proliferation and nuclear security, governments should provide support, as appropriate, to reactors and processors to facilitate the conversion of their facilities to low enriched uranium or to transition away from the use of highly enriched uranium, wherever technically and economically feasible.*

A Joint Declaration on the Security of Supply of Medical Radioisotopes was issued on 17 December 2014 in Paris, which included:

> *WE, the Ministers and representatives of Australia, Canada, France, Germany, Japan, the Republic of Korea, the Netherlands, Poland, the Russian Federation, South Africa, Spain, the United Kingdom and the United States of America, SHARE a common interest in ensuring the security of supply of the most widely used medical radioisotope, molybdenum-99 (99Mo) and its decay product, technetium-99m (99mTc), which is used in approximately 40 million medical diagnostic imaging procedures per year worldwide enabling precise and accurate, early detection and management of diseases such as heart conditions and cancer, in a non-invasive manner*
>
> *WE CONFIRM our acceptance of the principles set forth in the policy approach released in June 2011 by the High-Level Group on the Security of Supply of Medical Radioisotopes (the HLG-MR principles) to ensure the long-term secure supply of medical radioisotopes*

Switzerland has recently joined this joint declaration.

1.3.5 World Institute for Nuclear Security (WINS)

As of 31 December 2015, WINS reported over 3,155 members in 114 countries. Through the use of the WINS Academy, publications and roundtables/workshops, WINS addresses the need to improve security of nuclear and other radioactive material worldwide. Coincident with the 2014 Nuclear Security Summit, WINS launched the WINS Academy Nuclear Security Management Certification Program, which is centered on a core philosophy that security is a strategic activity to be implemented across the organization and as a fundamental aspect of risk management and corporate reputation. As of 31 January 2016, WINS has over 611 Academy participants from 72 countries, with 146 Academy graduates, and has issued 236 Academy certificates.

1.4 Scope

This report will review the progress since 2014 of various initiatives aimed at reducing the civilian use of strategic nuclear materials, most significantly HEU, discuss Industry’s role in securing strategic nuclear material at research facilities, and in securely managing radiological sources and used nuclear fuel at civilian facilities. The report acknowledges that industry has a vital, but limited role in nuclear material security because it is national governments that set policies, ratify treaties and set regulations related to the security of nuclear materials, and typically provide money to support implementation of their policies and regulations. Finally, the report will make recommendations for industry adoption and action.

1.5 Structure

The Elements of Context section of this document includes contextual information and outlines the scope of the discussion. The remaining sections discuss progress since the

2014 NIS in securing the use, storage and transport of the four categories of strategic nuclear and radiological materials throughout their life-cycle; and suggest recommendations for the nuclear industry to consider.

2. MEMBERSHIP

Membership of Working Group 2 on “Securing the Use, Storage and Transport of High-Activity Radiological and Strategic Nuclear Materials”

Name	Title	Organization	Country
Rick Didsbury	Director, Nuclear Science	Canadian Nuclear Laboratories	Canada
Jean Michel Romary	SVP Radioactive Material & Waste Mgmt.	AREVA	France
Michel Pays	Director of Strategy & Risk	EDF	France
Jack Edlow	President & CEO	Edlow International	USA
Matt Fox	Head of Security & Resilience	INS	United Kingdom
Jong-Kyung Kim	President	Korea Atomic Energy Research Institute (KAERI)	Republic of Korea
Kwang-Seok Lee	Director, Center for ROK-US Cooperation	KAERI	Republic of Korea
Kent Cole	President & CEO	NAC International	USA
Sun Qin	Chairman	China National Nuclear Corporation (CNNC)	China
Phumzile Tshelane	CEO	South African Nuclear Energy Corporation (NECSA)	South Africa

3. ACTIVITIES AND ACHIEVEMENTS IN MINIMIZING CIVILIAN USE OF STRATEGIC NUCLEAR MATERIALS SINCE THE 2014 NIS

3.1 Progress on Conversion of Reactors from HEU to LEU Fuel

Governments and industry have continued to work towards minimizing the need for HEU fuel. This has included efforts to overcome technical and economic issues that continue to prevent conversion of high performance research reactors to LEU fuel. Strong collaborations between the United States (US Department of Energy - US DOE), the Russian Federation (Rosatom), China (CNNC), the Republic of Korea (KAERI) and Europe (European fuel manufacturers and operators of high performance RRs) are achieving promising results.

Reduced Enrichment for Research and Test Reactor (RERTR) Meetings and the Topical Meeting on Mo-99 Technological Development, both hosted by the US DOE National Nuclear Security Administration (NNSA), and the Topical Meeting on Research Reactor Fuel Management (RRFM), hosted by the European Nuclear Society, have provided channels for communication and collaboration across government and industry.

The civilian uses of HEU also include important research and medical isotope production which benefits civil society, so a key to HEU elimination is to convert both HEU reactor fuel and HEU targets for medical isotope production to LEU alternatives.

In 2004 [beginning of the U.S. Global Threat Reduction Initiative (GTRI)], 39 research reactors had converted from HEU to LEU fuel. As of March 2016, 95 research reactors have been converted to LEU fuel or verified shutdown. Thus, in just 12 years, 56 facilities have converted from HEU to LEU use or been shut down, a noteworthy accomplishment.

However, there remain 105 civilian facilities that continue to use HEU, the majority of which are located in the Russian Federation.

The objective of the international HEU fuel conversion programs includes:

- Developing alternative LEU fuel with a service lifetime similar to that of the HEU fuel being replaced
- Ensuring that conversion can be achieved without requiring major changes in reactor structures or equipment
- Striving that the overall costs associated with the conversion do not increase significantly the annual operating costs

Conversion of the remaining research reactors is more challenging than earlier ones, because of the use of higher density fuels, the uniqueness of the fuel design, and possible significant reactor modifications for some facilities. Substantial and ongoing efforts to develop Uranium – Molybdenum (U-Mo) alloy fuels continue in the United States, Canada, Europe, the Russian Federation, the Republic of Korea, and Argentina.

Since the last meeting of NIS there have been positive developments related to qualification of U-Mo for use in research reactors. Those developments include the upcoming irradiations of U-Mo lead test assemblies (LTA) in the US ATR and Russian MIR reactors.

However, there are issues that remain to be resolved for its qualification for use in high-flux high-power research reactors, and they relate to both U-Mo fuel forms, that is the dispersion and monolithic forms.

Dispersion fuel performance at bounding conditions of targeted high power reactors (BR2 and JHR) remains an issue. In this case, a combination of fuel meat interaction with the surrounding matrix and recrystallization at high burnups are believed to have limited the fuel performance. Ongoing activities within the European HERACLES group, with support from the US-DOE, seek to mitigate those issues, mainly through a combination of U-Mo powder coating and heat treatment. Upcoming experiments in the US and Europe seek to confirm those mitigation strategies. In the Republic of Korea, KAERI has installed a fabrication facility for U-Mo dispersion fuel, and has successfully fabricated two U-Mo LTAs to be irradiated in the ATR reactor in support of their qualification program of U-Mo fuel for their KJRR reactor. The LTAs were shipped to Idaho National Laboratory in September 2014, and the irradiation test of the LTAs in the ATR began in November 2015 to demonstrate stable irradiation performance under KJRR conditions.

The issues associated with monolithic fuel qualification are related to fabrication rather than irradiation performance (monolithic fuel irradiation performance is acceptable). Manufacturing of bare foils in the US is challenging, and even more challenging is manufacturing with co-rolled zirconium (Zr), which passes through lengthy and expensive processes to reach the final product. Very significant losses of material are currently present in the preliminary process due to casting, machining of ingots, and cold-rolling scrap material (due to presence of Zr in scrap foils that require separate recycling processing). There are on-going process improvement activities and investigations of alternate Zr coating processes to help mitigate those issues.

Reactor conversions have continued to be a focus for industry. Most of the U.S. domestic research reactors and U.S. supplied foreign research reactors have been converted to LEU, but a suitable LEU fuel design has yet to be developed for five high performance reactors in the U.S. Four high performance reactors in Europe fall into the same category. Two reactors in Japan and one in Jamaica that are US origin reactors have detailed plans for conversion.

Most Russian-Federation-supplied research reactors outside of Russia have been converted to LEU except for those in Kazakhstan. Conversion of the WWR-K reactor in Kazakhstan proceeds with the successful completion of the irradiation of three LEU lead test assemblies. Its operator, INP, is currently planning for the reactor to be converted from HEU to low-enriched uranium in 2016. Conversion work also continues on IGR and IVG--1 Reactors at the Institute of Atomic Energy (IAE) in Kazakhstan.

Rosatom and the U.S. reached agreement in 2010 to initiate feasibility studies on the conversion of six Russian HEU-fueled domestic research reactors. These studies were completed and concluded that conversion to LEU was feasible with the qualification of LEU fuel. The ARGUS research reactor in Russia is a 20 kW solution reactor, which converted to an LEU fuel solution and achieved first criticality with LEU in July 2014. This is the first Russian domestic research reactor converted to LEU. With the current political environment, cooperative work has been suspended, with only ARGUS research reactor completing conversion to LEU.

The SLOWPOKE (US fuel supplied) and Chinese-supplied Miniature Neutron Source Research Reactor (MNSR) are very similar designed reactors. In China, CNNC has cooperated with the US DOE to conduct a joint project for converting the MNSR HEU cores (total of seven worldwide) to LEU cores. Preparations have been made to perform the first zero power test, which will take place in the near future. Analysis has been performed and plans are to convert the MNSR in Nigeria from HEU to LEU fuel. Recently completed and planned conversions from HEU to LEU include the Jamaican Slowpoke reactor (completed in September 2015) and MNSRs in China and Ghana.

After completion of the research reactor used fuel management programs created under the Global Treat Reduction Initiative (GTRI) umbrella, research reactors operating with highly enriched fuel and with low enriched fuel will still have to manage their used HEU and LEU fuel. The take-back option of GTRI programs will cease for fuel irradiated after May 2016, leaving no sustainable back-end option to research reactor operators who previously only planned to benefit from GTRI programs until shutting down of their facilities.

However, other back-end options are already available for research reactor used fuel management, such as reprocessing which has been a proven solution for many years for uranium-aluminum (UAl) type of used fuel. The French industry presented during RRFM 2015 the status on uranium silicide fuel (U_3Si_2) reprocessing at La Hague plant, with the industrial operations to start by 2017. This back-end option enables the research reactor operating countries to sustainably manage their used fuel through adapted final waste management (e.g. Belgian or Australian final waste management plans).

Looking ahead, the use of U-Mo fuels may start in the future, once an Internationally-shared system of fuel is identified (dispersed vs. monolithic, coated, etc.). Reprocessing studies and R&D will then be conducted to provide research reactor operators with this sustainable solution for the corresponding used fuel.

3.2 Increasing Use of LEU Targets in Radioisotope Production

Technetium-99m, the daughter product of Molybdenum-99 (Mo-99), is the most commonly utilized medical radioisotope in the world, accounting for approximately 25 million medical diagnostic procedures annually, roughly 80% of all diagnostic nuclear medicine procedures. Two major technical approaches are currently being pursued to supersede HEU use for the supply of Mo-99/Tc-99m radio-isotopes.

i) Direct production of Tc-99m by accelerator-driven activation of Mo-100.
ii) Replacement of HEU targets by LEU targets in research reactors.

In the accelerator-driven activation process, no uranium is used in this process. However, this technique currently faces severe challenges in terms of availability and expense of enriched Mo-100 and of limitations in the quantity of Tc-99m which can be produced. Tc-99m produced in this way has also not yet been approved by regulators for use in clinical applications. However, this technique might be suited for local solutions. Canada is most advanced in research and development of this technique.

The industry remains highly concentrated with 8 major reactor facilities, 6 major Mo-99 processor facilities and 2 major producers of Mo-99/Tc-99m generators. The graphic below shows the basic process flow starting with fresh U-235 targets.

Eight reactors now provide the bulk of irradiation services to meet the global estimated demand of about 10,000 six-day curies per week. All of these reactors can produce 1000 or more six-day curies per week of Mo-99 and all except for one of the reactors (BR-2) have converted from HEU to LEU reactor fuel.

In contrast, the conversion from HEU targets to LEU targets for Mo-99 production has lagged the reactor conversions, although most are in the process of converting to LEU targets. An exception is the CNL NRU reactor in Canada supplying Nordian, which is not expecting to convert to LEU before it shuts down in 2018. Today, the industry is able to manufacture LEU targets with increased uranium densities. However, the increase in density does not fully compensate the loss in enrichment. Some major Mo-99 irradiation reactors already irradiate increased uranium density LEU targets:

- OPAL (Australia) and RA-03 (Argentina) use only LEU targets;

- SAFARI (South Africa) has partially replaced HEU targets with LEU targets (as a result of slow LEU Mo-99 take up).

In Europe, target manufacturers and processors are moving to qualify LEU targets for irradiation in European reactors as well as for processing facilities.

The processor market noted in the table below is more concentrated with five firms capable of processing 1000 or more six-day curies per week.

Processor	Targets	Capacity per week (6-d Ci)	Available annual capacity (6-d Ci)	Expected date of conversion to LEU targets
CNL/NORDION (Canada)	HEU	7,200	374,400	Not expected
ANSTO HEALTH (Australia)	LEU	1,000	52,000	Started as LEU
CNEA (Argentina)	LEU	900	46,800	Converted
Mallinckrodt (Netherlands)	HEU	3,500	182,000	2017
IRE (Belgium)	HEU	2,500	130,000	2016
NTP (South Africa)	HEU/LEU	3,500	156,000	2013

All processors worldwide are testing modified processes for extracting Mo-99 from irradiated LEU targets in order to increase yield and minimize nuclear waste. Most new irradiation reactor projects or major upgrades of existing research reactors or production facilities (Europe, North America, South America, Asia & Australia) rely on LEU targets for Mo-99 production. All processors involved in these new projects have identified waste minimization and waste storage as major issues to be addressed for a sustainable and economically viable supply of medical radioisotopes for nuclear medicine world-wide. In this connection, it is noted that the new Mo-99 production facility being constructed in Australia will be augmented with a new waste treatment facility which will demonstrate Synroc waste management technology on an industrial scale. This waste treatment technology could also be used to immobilize HEU-bearing wastes. While these efforts continue to make progress towards eliminating the use of

HEU in radioisotope production, technological challenges remain, including the chemical processing techniques required for dissolution of high density foil targets.

The Tc-99m generator market is dominated by two firms: Mallinckrodt, with operations in the Netherlands, and U.S-based Lantheus Medical Imaging who together control more than 80 percent of the global Tc-99m generator market.

As a consequence of the 2009/2010 supply crisis for Mo-99/Tc-99m, the OECD Nuclear Energy Agency (NEA) created the High-level Group on the Security of Supply of Medical Radioisotopes (HLG-MR). The main objective of the HLG-MR is to strengthen the reliability of Mo-99/Tc-99m supply in the short, medium and long term.

Under its first mandate, the HLG MR examined the major issues that affect the reliability of Mo-99/Tc-99m supply and determined that the fundamental issue was the unsustainable economic model, since reactor operators originally required payment for direct or marginal costs only, not covering any part of capital costs; even as Mo-99 became a more important part of their activities, its “by-product” status and price structure remained unchanged.

As such, the HLG-MR identified six principles for sustainable Tc-99m production which remain relevant today:

- Principle 1: All Tc-99m supply chain participants should implement full-cost recovery, including costs related to capital replacement.
- Principle 2: Reserve capacity should be sourced and paid for by the supply chain.
- Principle 3: Recognizing and encouraging the role of the market, governments should: establish the proper environment for infrastructure investment; set the rules and establish the regulatory environment for safe and efficient market operation; ensure that all market-ready technologies implement full-cost recovery methodology; and refrain from direct intervention in day-to-day market operations.
- Principle 4: Governments should provide support to reactors and processors to facilitate the conversion of their facilities to LEU.
- Principle 5: International collaboration should be continued through a policy and information sharing forum.
- Principle 6: Need for periodic review of the supply chain.

The HLG-MR will start its fourth mandate from 2016. This international response has provided a positive impetus for States to construct policies that promote these principles. An example is the governmental and industry response to the planned shutdown of the NRU reactor in Canada.

The NRU reactor in Canada, which produces up to 40 percent of the worldwide Mo-99 and supplies the large majority of Mo-99 to the U.S., is scheduled to shut down in 2018. Promptly replacing NRU’s capacity is an imperative to the stable supply of Mo-99 medical isotopes.

To promote the production of Mo-99 in the United States for medical isotope production, and to condition and phase out the export of highly enriched uranium for the production of medical isotopes, the U.S. Congress passed The American Medical Isotopes Production Act (AMIPA). It requires conversion from HEU to non-HEU Mo-99 production by 2020, and further requires a domestic source of Mo-99 be developed. DOE has partnered with US commercial industry to accelerate development of non-HEU technologies to produce US based Mo-99, and there are several projects in various phases of development. The leaders of these rival projects to produce Mo-99 commercially in the US are united in their goal to reinvigorate the country's domestic supply of the lifesaving radioisotope. A brief summary of several leading projects are provided below:

- In March of 2016, the U.S. Nuclear Regulatory Commission (NRC) provided notice of the issuance of a Construction Permit to SHINE Medical Technologies, Inc. (SHINE) for the SHINE Medical Isotope Facility in Janesville, Wisconsin. SHINE’s facility is based on a new method for producing molybdenum-99 (Mo-99) using accelerator-driven neutron sources to induce fission in low-enriched uranium (LEU) within a subcritical operating assembly, creating Mo-99 as a byproduct.
- Northwest Medical Isotopes (NWMI) submitted to the NRC a two-part construction permit application [Environmental Report (February 2015) and Preliminary Safety Analysis Report (July 2015)]. NWMI proposes to manufacture at a facility in Columbia, Missouri LEU targets for irradiation at existing research reactors [University of Missouri – Columbia (MURR) and Oregon State University (OSU)] and to recover Mo-99 through processing of irradiated targets.
- In the area of Material Licenses and License amendments, the NRC reports the following activity:
    - Oregon State University has received a license amendment to demonstrate Mo-99 production in the OSU TRIGA® reactor (OSTR) with experimental LEU targets.
    - Niowave received a materials license for the production of small amounts of Mo-99 through uranium fission using a superconducting linear particle accelerator for proof of concept.
    - MURR is planning a license amendment request to NRC to utilize General Atomics gaseous extraction technology to be used following uranium target irradiation. This project is a partnership where sterilization specialist Sterigenics and radioisotope supplier Nordion will be supplied with Mo-99 produced in a 10 MW MURR using LEU targets. The partners involved in the

project expect to start commercial production by late-2017. The selective gaseous extraction technology, if successful, offers the opportunity for significant reduction in process waste.

- Several other companies are developing technology and making plans to participate in the Mo-99 medical isotope market, including but not limited to Coquí RadioPharmaceuticals, Eden Radioisotopes, Filbe Energy, NuView and PermaFix.

3.3 Progress on the Security and Removal of HEU from Civilian Facilities

Removal of stored HEU is another important step towards reducing risks with HEU, and the list of countries which have removed all HEU continues to grow. Through the end of 2014, the National Nuclear Security Administration’s Office of Material Management and Minimization removed or confirmed the disposition of 5,190 kilograms of fresh and irradiated HEU through approximately 150 shipments from 38 countries and Taiwan. This includes 1,264 kilograms under the U.S.-origin Removal Program, 2,158 kilograms under the Russian-origin Removal Program and 1,768 kilograms under the Gap Material Removal program, which encompasses material ineligible under the U.S.- or Russian-origin Removal Programs. To date worldwide, HEU has been completely removed from 29 countries plus Taiwan, with plans in place for repatriating even more material. However, much work remains to be done, since, today, approximately 61 metric tons of civilian HEU are spread across more than 100 facilities in 25 countries.

Since the last NIS in 2014, HEU inventory has been eliminated from 3 countries, specifically Uzbekistan, Switzerland and Jamaica. A brief summary of those and other HEU removal accomplishments and activities follows.

3.3.1 Japan – Japan Atomic Energy Association (JAEA) FCA Material Removal

In March 2014, Japanese and U.S. leaders agreed to remove and dispose all highly enriched uranium and weapons-grade plutonium from the Fast Critical Assembly (FCA) at the Japan Atomic Energy Agency (JAEA) in Tokai Mura, Ibaraki Prefecture in Japan. In consideration of the NSS 2016, Japanese and U.S. leaders pledged to remove all highly enriched uranium and plutonium fuel from the FCA in Japan in 2016.

3.3.2 Canada – NRU / NRX HEU Removal

Canadian Nuclear Laboratories (CNL) has established a program to repatriate material containing US-origin HEU to the Savannah River Site (SRS) in the United States. Repatriation and processing at the U.S. DOE facilities will reduce proliferation risks by consolidating HEU inventories in fewer locations around the world. The U.S. DOE has the technology and capability to do this work safely and securely. The U.S. Department of Energy (DOE) will convert or manage the HEU so that it permanently eliminates proliferation risks.

Currently, CNL is entering the operational stage of the NRU/NRX HEU Fuel Repatriation Project which will see approximately 1000 irradiated HEU fuel rods from these two reactors repatriated to the US over the next four years. Repatriation of this inventory will require less than 60 cask shipments.

3.3.3 Canada – FISST HEU Material Removal

In addition, CNL has initiated a program to repatriate US-origin HEU solution contained in the Fissile Solution Storage Tank (FISST), also to the SRS. The FISST contains a significant quantity of HEU in a solution which is a by-product of extracting Mo-99 from HEU targets. Repatriating this solution to the SRS has been proposed as a viable disposition path.

3.3.4 Kazakhstan – Fresh HEU from the WWR-K Critical Assembly

Plans are developed for removal of fresh HEU from the WWR-K reactor in Kazakhstan.

3.3.5 Uzbekistan – IIN-3M FOTON HEU Removal

Uzbekistan became a country free from HEU on September 24, 2015, with the removal of irradiated liquid HEU fuel from a research reactor located near Tashkent. This shipment from the IIN-3M FOTON reactor to the Mayak reprocessing center in Russia was the first removal operation of irradiated HEU, enabling subsequent decommissioning of the reactor and research facility.

3.3.6 Jamaica – Irradiated HEU from the SLOWPOKE Reactor at ICENS

Just less than 1 kilogram of irradiated HEU was removed from Jamaica’s SLOWPOKE reactor and returned to SRS in the United States in September 2015, making the Caribbean free of HEU.

3.3.7 Switzerland – Irradiated HEU from Basel

Approximately 2.2 kilogram of U.S.-origin highly enriched uranium (HEU) has been returned from the University of Basel in Switzerland to SRS in the United States. The HEU is from AGN-211-P research reactor, which commenced operation in 1961 using U.S.-origin HEU Material Test Reactor (MTR)-type fuel. Switzerland is now HEU free.

3.3.8 Germany – Irradiated HEU

In January 2016, a draft Environmental Report was published for comment, which will evaluate the potential environmental impacts of a DOE proposal to accept spent nuclear fuel from the Federal Republic of Germany at DOE’s Savannah River Site for processing and disposition. This spent nuclear fuel is composed of kernels containing thorium and U.S.-origin highly enriched uranium (HEU) embedded in small graphite spheres that were irradiated in nuclear reactors used for research and development purposes

3.4 Progress on the Security and Removal of High Purity Plutonium from Civilian Research Facilities

The major civilian uses of high purity plutonium for research are associated with the development of new reactor technology, such as fast neutron reactors. The organizations involved in this research are predominantly State-owned and conduct research and development in support of national energy policies and commitments.

Governments and industry have continued to work towards securing strategic nuclear materials at civilian research facilities and in securely transporting and storing the material to more secure government facilities, sometimes in other countries.

Initiatives are underway to address high purity plutonium at civilian research facilities as part of the Gap Material program that was initiated by the United States under NNSA’s Global Threat Reduction Initiative.

3.4.1 Japan – Japan Atomic Energy Association (JAEA) FCA Material Removal

Following the announcement at the 2014 NSS, the Governments of Japan and the United States of America (USA) have continued to progress the removal of all separated plutonium (and some HEU) currently in commercial use by the Japan Atomic Energy Agency (JAEA). The intention is that the material (approximately 331 kilograms) will be transported from the Fast Critical Assembly reactor (FCA) at JAEA’s Tokai Research and Development Centre to a secure site in the USA in 2016. The removal will form part of the National Nuclear Security Administration’s Material Management and Minimization (M3) program and will be supported by International Nuclear Services (INS) from the United Kingdom (UK).

3.4.2 Switzerland – Separated Plutonium from the Paul Scherrer Institute

Approximately 20 kilograms of separated plutonium have been transported from Switzerland to the United States in March 2016. With this removal, Switzerland is now free of all separated plutonium, which supports international goals of consolidating and minimizing inventories of nuclear material. The plutonium, which originally was intended for research and development of new-generation fuel elements for nuclear reactor plants, belonged to the Swiss Confederation. This material will be stored at a secure facility in the United States pending final disposition.

4. ACTIVITIES AND ACHIEVEMENTS IN RADIOACTIVE SOURCE SECURITY THROUGHOUT THEIR LIFE-CYCLE SINCE THE 2014 NIS

Initiatives to enhance the technical and operational capacity and capabilities of government organizations and industry have continued to improve the physical protection and security management of high activity radioactive sources and associated facilities throughout their life-cycle. Radioactive sources can present unique challenges for implementing additional security measures due to their variety, location and circumstances of use, transport, storage and notably their management when disused.

Significant achievements by governments and intergovernmental agencies in radioactive source security include the IAEA’s work to structure its source security program. Since the 2014 NIS, the IAEA has updated the Code of Conduct and related Guidance and focused effort to increase the number of countries who sign onto the Code.

Amongst industry and non-governmental organizations, several domestic professional associations have included security of sources within their scope of activities, and international associations such as the International Radiation Protection Association (IRPA) are now including security of sources as part of their regular calendar of activities. Additionally, organizations such as the World Institute for Nuclear Security (WINS) have continued to implement significant programs for sources, including a series of workshops and best practices publications, in concert with government organizations and with various industry associations such as ISSPA (International Source Suppliers and Producers Association).

Other work to mitigate the security risk as early as possible in the life cycle of sources has included the development of “security by design” of devices containing sources, more robust physical and chemical forms, possible replacement of certain isotopes by others of lesser security concern, and alternatives to radioactive sources. Efforts to identify required skills and competencies for staff in charge of security of sources, and to offer proper education and training opportunities, including professional certification, are also ongoing. All major producers of radioactive sources now accept the return of disused high activity sources, although in many cases there are challenges in terms of cost and practicality of return. To evaluate and discuss this latter point more fully, the IAEA has established a Working Group on Radioactive Source Security.

Return of disused sources to the supplier for recycling or re-use is the preferred management option. Practically however, many sources still will end as waste and security measures have to be continued. An achievement in this respect is the legal obligation for all member States in the European Union to implement in 2013 the EU Council Directive establishing a Community framework for the responsible and safe management of used fuel and radioactive waste (Council Directive 2011/70/EURATOM). In the field of radioactive source security, the World Institute for Nuclear Security (WINS) has established a comprehensive program of activities to facilitate the exchange of experiences amongst governments, suppliers, transporters, users, relevant NGOs and other stakeholders. In partnership with industry, professional associations and competent authorities, WINS has conducted numerous international, regional and national workshops and has prepared several International Best Practice Guides consolidating lessons learnt from across the medical, industrial and research sectors.

WINS has also launched the WINS Academy that aims to transform security management by introducing a certification program, including elective modules for the management of radioactive sources that will result in personnel with security accountabilities being demonstrably competent. As of 31 January 2016, WINS has over 611 Academy participants from 72 countries, with 146 Academy graduates, and has issued 236 Academy certificates.

A particular example of a government/industry initiative to address source security is the South East Asia Regional Radiological Security Partnership (RRSP). The RRSP is a collaborative effort to address technical and operational capabilities and capacity to deal with the challenges of radioactive source security amongst South East Asian states.

The International Conference on the Safety and Security of Radioactive Sources: Maintaining the Continuous Global Control of Sources throughout their Life Cycle, organized by the International Atomic Energy Agency (IAEA) and held in Abu Dhabi, United Arab Emirates from 27–31 October 2013, identified a number of issues related to the security of radioactive sources on which further work was needed. Of particular interest to the industry were the call for the development of further guidance on the management of disused sources and the request for further consideration of financial provision for liabilities arising from safety or security incidents involving disused sources. Subsequent meetings and discussions have occurred since this meeting to further the actions and conclusions derived, including

- Third Meeting of the Working Group on Radioactive Source Security in May 2014
- Fourth Meeting of the Working Group on Radioactive Source Security in April 2015
- Sixth Consultancy Meeting on the Revision of NSS 11 (The Implementing Guidance on the Security of Radioactive Sources) in January 2015.
- Technical Meeting on the Revision of Security of Radioactive Sources (IAEA Nuclear Security Series No. 11) in March 2015.
- Meeting to Guidance on Management of Disused Sources in Vienna in June 2015.
- Trilateral Kick-off Meeting of the Radioactive Source Location Tracking Project (RADLOT) in July 2014.

Additionally, IAEA conducted numerous national and regional training courses on the security of radioactive sources in Mauritania (August 2014), Burkina Faso (August 2014), Japan (September 2014), Pakistan (December 2014), Cambodia (March 2015), Zimbabwe (July 2015), Pakistan (November 2015), and the Russian Federation (December 2015).

5. ACTIVITIES AND ACHIEVEMENTS IN THE SECURITY OF USED NUCLEAR FUEL THROUGHOUT ITS LIFE-CYCLE

The total cumulative amount of used nuclear fuel that has been discharged worldwide is more than 400 000 tons Heavy Metal (t HM), of which more than 100 000 t HM have already been reprocessed. Thus, about 300 000 t HM are stored at-reactor (AR) or away-from-reactor (AFR) in wet and dry storage facilities, awaiting recycling or disposal in repository.

One of the conditions of public acceptance of the civilian use of nuclear energy is the capability of the States and the Operators to ensure the physical protection of the nuclear materials at the different stages of the nuclear cycle. The global objective is to protect persons, property, society and the environment from “malicious acts” involving these materials.

The Amendment to the Convention on the Physical Protection of Nuclear Material (CPPNM) has received significant attention since NIS 2014, where 18 new state parties are now signatory to the amendment. Only 11 more are needed for the amendment to enter into force. To support the future application of the requirements set forth in the Amendment, the IAEA worked with its Member States and the nuclear industry to develop and issue the “Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities” (INFCIRC/225/Revision 5). These recommendations include several objectives that should be taken into account:

- To protect against unauthorized removal. Protecting against theft and other unlawful taking of nuclear material.
- To locate and recover missing nuclear material. Ensuring the implementation of rapid and comprehensive measures to locate and, where appropriate, recover missing or stolen nuclear material.
- To protect against sabotage. Protecting nuclear material and nuclear facilities (including the NPP) against sabotage.
- To mitigate or minimize effects of sabotage. Mitigating or minimizing the radiological consequences of sabotage.

In order to reach these objectives, the States and the Operators define and implement regulations and requirements designed according to a precise threat assessment and risk management. A reassessment of the regulations and requirements may be performed, depending on the geopolitical situation or conditions in the field. A graded safety and security approach, defense in depth, quality assurance, security culture and confidentiality are the guiding principles of the standard international approach.

The main requirements implemented by the States and the Operators in order to manage these risks and threats can be summarized as follows (the level of these requirements follow a graded approach depending on the nature and risk related of the nuclear materials):

- Definition of realistic threat scenarios and related security studies providing appropriate security measures (for the facilities, NPP, transport operations, etc.)
- Organizational procedures (confidentiality of the sensitive data, quality assurance, staff training, guarding service and responses forces if needed, crisis exercises, etc.)
- Technical means (location and accounting of the nuclear materials, physical protection of the facilities, detection of possible intrusion and or attack, use of the more secured transport modalities, etc.)
- International, national and internal periodic controls by competent and independent authorities.

An important consideration in the physical protection of nuclear material is the radiation level. This leads to the use of a graded approach to security. In general, this approach places more stringent measures on materials that are deemed to be attractive for weapons use (i.e., easy to prepare). One attractive physical protection feature is a characteristic called self-protection; that is, fuel is considered “self-protecting” if it is sufficiently radioactive that those who might seek to divert it would not be able to handle it directly without suffering acute radiation exposure. When the used fuel is not reprocessed and there is no direct disposal option available, Operators must store the used fuel for increasing durations, accumulating large inventories. Typical commercial nuclear power plant used nuclear fuel assemblies remain above the (100 REM/hr) threshold for self-protection for more than 100 years after discharge from the reactor. Even if the used nuclear fuel is viewed as self-protecting, there remains a potential threat that an adversary could try to detonate an explosive near the used nuclear fuel in an attempt to disperse radioactive material. Further, the emergence of suicidal terrorists challenge the traditional notions of self-protection.

Facilities storing used nuclear fuel are robustly designed, have layers of physical protection, and multiple means, including video surveillance, to detect activity to gain access to used nuclear fuel. The radiological dose emitted from used nuclear fuel, even when it eventually drops below self-protecting thresholds, makes it extremely difficult to access this material without the awareness of the Operators.

Many States have national regulators that are active in studying emerging threats and potential vulnerabilities of nuclear facilities to these threats, including threats from insiders and suicidal terrorists. These studies are often the impetus for new regulatory requirements that must be implemented by industry.

Following the tragedy of 9/11/2001 in the United States, the U.S. Nuclear Regulatory Commission issued a series of Orders to its major licensees. These Orders include measures to protect against an insider terrorist attack; waterborne, airborne, and landbased assaults; as well as threats from a vehicle bomb. The specific security measures generally include increased patrols, augmented security forces and capabilities, additional security posts, installation of additional physical barriers, vehicle checks at greater stand-off distances, enhanced coordination with law enforcement and military authorities, and more restrictive site access controls. Similar enhancements in security have been implemented at nuclear facilities worldwide, and provide further assurance that used nuclear fuel is well secured.

The IAEA International Conference on Management of Spent Fuel from Nuclear Power Reactors - An Integrated Approach to the Back-End of the Fuel Cycle was convened in Vienna, Austria from 15 – 19 June 2015. In general, the conference was focused on the importance of spent fuel management to the sustainability of nuclear energy, and the lagging progress and missed opportunity for better integration in the backend of the fuel cycle in most IAEA member states. The gaps in integration in the national programs for spent fuel reprocessing, storage, transportation and the ultimate disposal were noted and openly discussed. While nuclear security was not a highlighted area of focus for the conference, the security benefits of an integrated life cycle used fuel management program with ultimate disposition / disposal facilities in operation were noted. We recognize that used fuel require special precautions in recognition of the relatively large volumes of this material. When the used fuel is not reprocessed and there is no direct disposal option available, we are encouraged by States to store the used fuel for increasing durations, accumulating large inventories, and to provide further assurance that used fuel is well secured.

The international field record shows that a policy strictly and appropriately applied and based on the nuclear security rules such as those underpinning “Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities” (INFCIRC/225/Revision 5) produces very satisfactory results. No significant security deficiencies were noted in this area for many years.

6. ACTIVITIES AND ACHIEVEMENTS IN TRANSPORTATION SECURITY

6.1 Background on Transportation Security Framework

As of January, 2015 the IAEA had 44 signatures to the Convention on the Physical Protection of Nuclear Material (CPPNM). Entering into force in February, 1987 the CPPNM and the associated amendments, is the only legally binding international instrument in the area of physical protection of nuclear material and one of the 13 international counter-terrorism instruments. The CPPNM establishes measures related to the prevention, detection and punishment of offenses related to nuclear material.

The IAEA Nuclear Security Recommendation on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225) is now at revision five and the text of Revision 5 underpins the amendment to the CPPNM. For many years section six of INFCIRC/225 has been dedicated to the Requirements for Measures Against Unauthorized Removal and Sabotage of Nuclear Material During Transport

The vast majority of member states and certainly those who are party to the Nuclear Security Summits, base their domestic transport security regulations and requirements on the recommendations from INFCIRC/225, for example:

Country	**Domestic Security Regulator**	**Domestic Security Regulations**
Canada	Canadian Nuclear Safety Commission	Nuclear Safety and Control Act, 2000
France	Ministry of Ecology, Energy, Sustainable Development and the Sea	Ministerial Order related to the protection and control of nuclear materials during transportation – JORF n°204 – August 1, 2010
Republic of China	National Nuclear Safety Administration	Rules on Physical Protection for Nuclear Materials International Transport, 1994
Republic of Korea	Nuclear Safety and Security Commission	Act on Physical Protection and Radiological Emergency
United Kingdom	Office for Nuclear Regulation	Nuclear Industry Security Regulations, 2003
United States of America	Nuclear Regulatory Commission	Atomic Energy Act, 1954

The common requirements from INFCIRC/225/Revision 5 and the majority, if not all of the above regulations are based upon the physical protection against unauthorized removal during transport. This includes a graded approach to:

- minimizing the total time during which the nuclear material remains in transport;

- minimizing the number and duration of nuclear material transfers;
- protecting nuclear material during transport and in temporary storage in a manner consistent with the category of that nuclear material;
- avoiding the use of predictable movement schedules by varying times and routes;
- requiring predetermination of the trustworthiness of individuals involved;
- limiting advance knowledge of transport information to the minimum number of persons;
- using a material transport system with passive and/or active physical protection measures appropriate for the threat assessment or design basis threat;
- using routes which avoid areas of natural disaster, civil disorder or with a known threat; and
- ensuring that packages and/or conveyances are not left unattended for any longer than is absolutely necessary.

Whilst these general principles form a good foundation for a graded approach to transportation security member states, regulators, consignors and carriers still have a moral obligation to learn from one another, share good practices and learn from events and near misses.

Industry pays extreme attention to the security regulatory framework. The World Nuclear Transport Institute (WNTI), as the international transport industry organization, strongly promotes the strict application of the security regulation and provides the Industry with a clear understanding of what is required for international transport of nuclear and other radioactive materials. In the same spirit, to make the regulation efficient and practicable, the WNTI takes advantage of its observer status to the IAEA, the IMO and the ICAO with the Industry feedback and lessons learned.

6.2 Activities and Achievements in Transportation Security

The main activities and achievements in transportation security since the 2014 NSS are summarized as follows:

6.2.1 US Department of Energy Transport Security Training Course – Argonne, December, 2014 and June, 2015.

The US Department of Energy sponsored a two-element training course on Security of Nuclear and Other Radioactive Material during Transport. The first course element focuses on international transport security, whereas the second course element focuses on the U.S. domestic transport security. Both were held at Argonne National Laboratory, Argonne from 8th to 12th December 2014 and from 22nd to 26th June 2015. The WNTI provided lectures to the participants covering the industry practical implementation of security regulations and lessons learned from the transport operations. Each element covered:

a) relevant security requirements, recommendations, and guidance related to transport of nuclear and other radioactive material;

b) the basis for establishing security measures following a graded approach; and

c) how to develop and implement transport security plans, assess the readiness of the transport system, and ensure all necessary security measures are satisfied through appropriate actions.

6.2.2 IAEA Pilot Transport Security Table Top Exercise – Stockholm, February, 2015.

The IAEA with the support of the Government of Sweden held a Pilot Transport Security Table Top Exercise in Stockholm on 11th February, 2015. The exercise was hosted by the Swedish Radiation Authority and included players from government, police, regulators and industry. The objectives were to a) support the IAEA in work on the transport security exercise handbook; and b) to support development of the Swedish system for countering malicious acts against transports of nuclear material. Transport Industry organization (WNTI) and nuclear industry companies have attended as Observers to take advantage of the lessons learned.

6.2.3 IAEA National Transport Security Field Exercise – Stockholm, May, 2015.

The IAEA with the support of the Government of Sweden held a National Transport Security Table Top Field Exercise in Stockholm on 5th to 7th May, 2015. The exercise was hosted by the Swedish Radiation Authority and included players from government, police, special forces, regulators and industry. The objectives were to test and evaluate the draft transport security exercise guide developed by the IAEA with the support of experts from member states. The players from Sweden also had the opportunity to test and evaluate national arrangements for security on nuclear material in transit, including contingency response to a malicious event against a maritime shipment of spent nuclear fuel. Transport Industry organization (WNTI) and nuclear industry companies have attended as Observers to take advantage of the lessons learned.

6.2.4 IAEA Table Top Exercise – Vienna, June, 2015.

The IAEA with support from the Governments of France, Japan and the United Kingdom held a Table Top Exercise in Vienna on 17th June, 2015. The exercise was hosted by the IAEA . The objectives of the exercise were:

a) to review the implementation of the Best practices for Government to Government voluntary and confidential Government to Government Communications on the Transport of MOX Fuel, High Level Radioactive Waste and, as appropriate, Irradiated Nuclear Fuel by Sea identified in the “roadmap 2013-2014” agreed upon between States participating in the informal dialogue between Coastal and Shipping States;

b) to review the effectiveness of Government to Government communication channels in the case of an event occurring during a transport of Mixed Oxide Fuel (MOX), High Level Radioactive Waste (HLW) and, as appropriate, Irradiated Nuclear Fuel by Sea; and

c) to review to what extent the information made available during the duration of the exercise allows Governments to deliver appropriate information to the public.

Whilst the exercise was primarily focused on maritime and radiological safety, there were a number of key security implications and issues to be considered and addressed.

6.2.5 IAEA 7th Nuclear Security Guidance Committee - Vienna, June, 2015.

The 7th Meeting of the IAEA Nuclear Security Guidance Committee (NSGC) was held in Vienna between 22nd and 26th June, 2015. The main points discussed included:

- IAEA believes that the Amendment to the CPPNM could enter into force in 2017;
- IAEA intends to increase support to member states for Nuclear Security and will conduct more peer assessment activities;
- Feedback from the NSGC;
- NST023 – Implementing Guide for INFCIRC/225/Rev5; and
- NST053 – Security of nuclear and other radioactive material in transport (Technical Guidance).

6.2.6 2016 NSS ‘Gift Basket’ Transport Security Exercise RAIL – Astana, 24th August, 2015

On the 24th August, 2015 Kazakh Government was represented by the competent authorities of the Ministry of Energy (Committee of Atomic and Power Oversight and Compliance Monitoring), Ministry of Internal Affairs (Committee for Emergency Situations), Ministry for Investments and Development (Committees for transport, industrial development and industrial security), National Security Committee (Counterterrorism Center) as well as representatives of the national companies, “Kazakhstan Temir Zholy” (main railway company) and “KazAtomProm” (main atomic company). They were supported but competent experts in the field of transport security of nuclear and radioactive materials from the United States of America.

Together they ran a Command and Staff Exercise on the Security in Transport of Nuclear and Radioactive Materials by Railroads.

The Exercise concluded that it is important to enhance cooperation between different structures of governmental bodies during emergency situations, which can appear while transporting special cargo.

6.2.7 2016 NSS ‘Gift Basket’ Transport Security Exercise SEA – Warrington, September, 2015

The UK Department of Energy and Climate Change hosted the ‘Maritime Gift Basket’ exercises in Warrington on 21st September, 2015.

The exercise was organized by International Nuclear Services (INS) with support from Pacific Nuclear Transport Limited (PNTL) and the UK Civil Nuclear Constabulary (CNC). It was witnessed by representatives from the Office of Nuclear Regulation (ONR) and Department of Energy and tested the multi-agency response and command arrangements for security incidents during the maritime transport of Category I nuclear material.

The lessons learnt from the exercise were reviewed by DECC and ONR and included in the UK Transport Gift Basket Practical Guide to Safe and Secure Maritime Transport of Category I and II Nuclear Material.

6.2.8 2016 NSS ‘Gift Basket’ Transport Security Working Group Meeting – Tokyo, December, 2015

The five participating countries of France, the Republic of Korea, the United Kingdom, the United States, and Japan along with Canada, Hungary, India and Kazakhstan, conducted a meeting in Tokyo, Japan, from 1st to 3rd December, 2015. In light of the result of the meeting, each of the participating countries committed to continuing the implementation of the Joint Statement issued at The Hague Nuclear Security Summit. Furthermore, the participating states drafted practical security guides for four transport modes. Each guide was drafted by the participating states with experience and knowledge of the respective transport mode, and will be shared with other countries at the 2016 Summit and through international organizations or initiatives such as the IAEA or the Global Initiative to Combat Nuclear Terrorism. In addition, the participating countries recommend that international organizations such as these host future activities to strengthen nuclear transport security after the 2016 Summit.

6.2.9 World Nuclear Transport Institute, Transport Security Working Group –London, 9th & 10th December, 2015

The WNTI hosts twice a year a Security Working Group for its members. The latest meeting was in London on 9th and 10th December, 2015 and focused on the implementation of the INFCIRC/225/Revision 5. Representatives of the Security Competent Authorities from the UK and France have exchanged with the WNTI Members on the importance of the implementation of security regulations. The WINS was invited to promote the adequate training in support of secured transport operations.

6.2.10 World Institute for Nuclear Security (WINS) Update

WINS has joined with the World Nuclear Transport Institute (WNTI) and Argonne National Laboratory to develop a WINS Academy certification course on Transport Security Management. The course addresses the roles that operational and response personnel have in properly preparing for and undertaking secure transport of all categories of nuclear and other radioactive material. WINS and WNTI have also released a joint International Best Practice Guide on Nuclear Transport Security. The Guide has been produced to identify best practices and the lessons learned from the operational experience of transporting nuclear material classified by the IAEA as Category I and II, and for transport arrangements involving road and maritime shipments.

6.2.11 IAEA Security Training and Field Exercises

WNTI has lectured and facilitated exercises with nuclear industry companies participating. Some examples are:

- *Security Training in Jakarta (Indonesia) October 13-24, 2014*
- *Joint Spain-Morocco Security Field Exercise – Madrid (Spain) October 27-29, 2015*

7. AGREED PRINCIPLES

The following principles, as in the NIS 2014, have guided the preparation of the Conclusions and Recommendations set forth in this document:

- The threat of malicious use of radiological and nuclear materials is of concern to the public, and therefore affects public support for the nuclear industry.
- The minimization of civilian use of HEU and high purity plutonium and the responsible management of radiological sources and used nuclear fuel are important and worthwhile missions for all industry stakeholders.
- The minimization of civilian use of HEU and high purity plutonium and the responsible management of radiological sources and used nuclear fuel should be undertaken in a manner that is economically sound and responsible.
- Progress towards the minimization of civilian use of HEU should not come at the expense of patient outcomes.
- Responsible management of disused radioactive sources should include their management as waste when recycling or re-use is not (practically) possible.
- Responsible management of used nuclear fuel should include tangible progress by States and Operators in siting, developing and operating long term disposal facilities to support the use of nuclear power, the world’s largest carbon free generation alternative.
- The Working Group recognizes the importance of the beneficial uses of radioactive sources in industry, medicine, research and other fields, including the vital role that radiopharmaceuticals play in achieving positive human health outcomes.

8. CONCLUSIONS AND RECOMMENDATIONS

The Working Group on "Securing the Use, Storage and Transport of Strategic Nuclear and Radiological Materials ":

- acknowledges the accomplishments of international programs for minimizing the civilian use of strategic nuclear materials, developing new LEU fuels and securely managing radioactive sources and used nuclear fuel in which the nuclear industry has participated and will continue to do so; and
- acknowledges the progress made in fuel development in the two years since the 2014 NIS, but emphasize the need for perseverance. To this end, the participation of new organizations in the international U-Mo qualification scheme, which may lead to the qualification and first use of U-Mo fuel is welcomed.

To continue this progress, we reconfirm the following recommendations to the nuclear industry made by the NIS 2014 Working Group 3:

1. To continue to endeavor to fulfill the recommendations contained within the 2012 NIS statement.
2. To endeavor further to minimize the use of HEU through the conversion from HEU to LEU fuel in research reactors, where technically and economically feasible, and through the switch from HEU to LEU targets in radioisotope production, while assuring a continuous and stable supply of Mo-99.
3. To foster the development of high density fuel both by enhancing the existing scientific coordination and by addressing in parallel the industrialization issues, at the worldwide level.
4. To readily share, within appropriate conditions, their experience and technologies regarding the minimization of use of HEU.
5. To continue to collaborate on international programs to research and develop new technologies that require neither HEU fuels for reactor operation nor HEU targets for radioisotope production.
6. To recognize the importance of States' roles for introducing institutional measures to promote the use of LEU-based technologies, including the implementation of appropriate financial and other incentives to encourage greater use of non-HEU based medical isotopes.
7. To endeavor to work with their governments and the medical isotope supply chain for the application and implementation of the HLG-MR’s policy recommendations, in particular full cost recovery, in order to ensure a reliable and sustainable supply of medical radioisotopes. In this regard, we also recommend that all entities engage with health care authorities, including government-supported health care systems and private payers, to work toward

sufficient reimbursement of medical procedures involving Tc-99m, in order to assist in the transition to full cost recovery and conversion to full LEU-based production.

8. To engage with states and relevant organizations to ensure that there is a diversity of suppliers of 19.75% enriched uranium and a viable disposition route for LEU research and test reactor fuels after the end of the FRRSNFA.

9. To continue the development of technically and financially viable methods for reprocessing LEU fuels, or otherwise providing for their long term management and disposal.

10. To accept return of disused sources which they supplied, and to assist holders of those sources in making logistical and financial arrangements for their return. When return is (practically) not possible, safe and secure management as waste should be guaranteed.

11. To develop substitutes and more secure designs for particularly vulnerable or dispersible radioactive sources.

12. To continue to work with states, international organizations and NGOs to ensure that the management of materials of concern is done in practical, efficient and cost effective ways.

In addition, we propose the following additional recommendations to the nuclear industry:

13. To endeavor to fulfill the recommendations contained within the 2016 NIS Joint Statement.

14. To continue to minimize stocks of HEU and to keep stockpiles of separated plutonium to the minimum level, both as consistent with national requirements and nuclear fuel cycle policy.

15. To continue to cooperate with government efforts to repatriate HEU stocks to their countries of origin.

16. To cooperate with government efforts to repatriate quantities of high purity plutonium currently held at research and testing facilities that no longer are required.

17. To continue to safely and securely manage inventories of used nuclear fuel in facilities that are robustly designed with multiple layers of physical protection and detection capability in accordance with national regulations, including implementing new regulations and requirements pursuant to emerging threats.

18. To continue to safely and securely transport radioactive materials in accordance with national and international regulations, including implementing new regulations and requirements pursuant to emerging threats.

To facilitate the implementation of the above recommendations, we recommend that the nuclear industry utilize existing forums (like RERTR, RRFM, WNTI and WINS) to address these issues in dedicated working groups and meeting sessions and in cooperation with national and international regulators.