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Ten Years of IAEA Cooperation with the Russian Research Reactor Fuel Return Programme

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ABSTRACT

The Russian Research Reactor Fuel Return (RRRFR) programme was launched in 2001. Until today, the programme has successfully completed 43 safe shipments of 1.6 tons of fresh and spent HEU fuel to the country of origin using Russian fuelled research reactors. The IAEA has been a very active supporter of the RRRFR programme since its inception. Under the auspices of the RRRFR programme, the Agency has ensured a broad range of technical advice and organizational support to the HEU fuel repatriation, and provided training in RR-conversion from HEU to LEU since core conversion is mandatory for reactors to participate in the RRRFR programme.

This presentation gives an overview of the achievements made by the RRRFR programme with special emphasis on the IAEA's contribution. This will include the shipments' history in terms of fresh and spent fuel, as well as a summary of experiences gained during preparation and termination. The presentation discusses the consolidated knowledge of the unique international programme and shares the most important lessons learned.

The IAEA has been involved for almost 30 years in international nuclear non-proliferation efforts associated with reducing the amount of highly enriched uranium (HEU) in international commerce. IAEA projects and activities have directly supported the Reduced Enrichment for Research and Test Reactors (RERTR) programme, and have been directly associated with the efforts to return research reactor (RR) fuel to the country of origin where it was enriched. The IAEA is a primary partner in the Global Threat Reduction Initiative (GTRI) and carries out many projects and activities supported by GTRI.

1. Introduction

The preparation for the Russian Research Reactor Fuel Return (RRRFR) programme started in December 1999 [1], when (on the basis of the successful implementation of the US initiated HEU Research Reactor Fuel Take-back Programs) at the IAEA General Conference in September 1999, U.S. Energy Secretary, Bill Richardson announced that the US was prepared to work with Russia and the IAEA to manage and dispose of Russian-origin HEU RR fuel remaining in a number of countries. Between 1999 and 2000, this then led to a series of tripartite meetings organised by the IAEA to review the situation regarding fresh and spent Russian origin RR fuel in various locations around the world; Russian experience with regard

to spent fuel transport, and financial issues. The primary goal was to advance nuclear non-proliferation objectives by eliminating stockpiles of HEU and encouraging eligible countries to convert their research reactors from HEU to low enriched uranium (LEU) fuel upon availability, qualification and licensing of suitable LEU fuel. The topics discussed included the IAEA's role in the programme as well as Russian laws, regulations and policies. It was decided that the IAEA should send a letter to targeted member states to assess their interest in participating in a fuel return programme.

Thus, the IAEA took the initiative in the RRRFR programme, when in October 2000 the IAEA's Director General sent a letter to the governments of relevant countries for the elimination of HEU fuel from Soviet RRs. Fourteen out of sixteen responses were favourable, that concerned 20 RRs, which led to the launching of the RRRFR programme in 2001.

Between 2001 and 2004, upon the requests of member states, a series of fact finding missions to nearly all facilities concerned (15 RR sites) in 11 countries were carried out to survey the storage conditions of fuel and existing shipping logistics. The findings were then discussed during further tripartite meetings organised by the IAEA.

A major expansion and strengthening of IAEA activities in support of – among others – HEU fuel take back programmes started in 2004 after three important events in Vienna and Bratislava:

- Announcement of the GTRI by the United States Secretary of Energy Spencer Abraham on May 2004 at the IAEA headquarters. The announcement was followed by several discussions between the IAEA and US officials to clarify cooperative activities;
- A US-RF bilateral agreement was signed by presidents of US and RF in Bratislava (Bratislava Agreement) in May, 2004 following the GTRI's announcement. This agreement helped to facilitate the RRRFR programme. Under this agreement, more than a dozen countries became eligible to receive financial and technical assistance from the US and others to ship their fresh and spent RR fuel to Russia for future safe and secure management.
- The GTRI Partners Conference from September 18-19, 2004, adopted the conference findings supportive of the goal of accelerating and expanding relevant programmes among others such as RRRFR programme.

2. Shipments accomplished

Since the first shipment made in August 2002, the RRRFR programme successfully completed 43 shipments of 1.6 tons of fresh and spent HEU fuel from different countries using Russian fuelled research reactors to the country of origin.

2.1 Fresh RR HEU fuel shipments

In the case of fresh shipments from 2002 to 2010 under contract agreement by the IAEA, 21 shipments representing a total amount of about 600 kilograms of fresh HEU were returned safely to the Russian Federation. The shipments are listed in Table 1 in chronological order. The first actual step in the implementation of the RRRFR programme was in 2002 when the Serbian Government decided to shut down the RA reactor permanently in Vinča [2], and to participate in the international nuclear non-proliferation efforts to minimize HEU in international commerce. Thus the Republic of Serbia was the first IAEA Member State to return fresh HEU fuel to the Russian Federation that followed further twenty shipments.

Table 1. Fresh RR HEU fuel returned to Russia under IAEA contracts

No.	Country	Facility	Container used	Mode of transport	U-mass [kg]	Actual Finish
1	Serbia	RA, Vinča	TK-S16	Air transport	48.0	2002-08-08
2	Romania	WWR-S Magurela	TK-S16	Air transport	14.0	2003-09-30
3	Bulgaria	IRT-2000, Sofia	TK-S16	Air transport	17.0	2003-12-23
4	Libya	IRT-1 Tajura	TK-S16	Air transport	17.0	2004-03-07
5	Uzbekistan	WWR-SM Tashkent	TK-S16	Air transport	3.0	2004-09-09
6	Czech Republic	LWR-15, Rez	TK-S16	Air transport	6.0	2004-12-21
7	Latvia	IRT-M, Salaspils	TK-S16	Air transport	3.0	2005-05-25
8	Czech Republic	CA, CTU Prague	TK-S16	Air transport	14.0	2005-09-27
9	Libya	IRT-1 Tajura	TK-S16	Air transport	3.0	2006-07-25
10	Poland	MARIA	TK-S16	Air transport	39.8	2006-08-10
11	Czech Republic	Rez	TK-S16	Air transport	0.2	2006-10-15
12	Germany	RRR	TK-S16	Air transport	268.0	2006-12-18
13	Poland	MARIA	TK-S16	Air transport	8.8	2007-08-28
14	Vietnam	Dalat	TK-S16	Air transport	4.0	2007-09-17
15	Romania	Pitesti	TK-S16	Air transport	30.0	2009-06-28
16	Hungary	BRR	TK-S16	Air transport	18.6	2009-07-06
17	Czech Republic	Rez	TK-S16	Air transport	12.1	2010-06-18
18	Belarus	Minsk. Pamir fuel	TK-S16	Air transport	46.7	2010.11.29
19	Ukraine	Sevastopol	TK-S16	Air transport	25.1	2010.12.29
20	Ukraine	KINR	TK-S16	Air transport	9.8	2010.12.29
21	Ukraine	Kharkov 1st	TK-S16	Air transport	15.7	2010.12.29
Last update: 2011-09-20				**TOTAL**	**603.6**	

After the first couple of shipments a "standard" preparatory shipment scenario was applied in each case that included a fission material verification made by IAEA safeguards inspector(s), and a combined fuel characterisation and visual inspection procedure accomplished jointly by facility operators and experts representing the contractors. After this painstaking inventory and fuel condition survey, the fuel is packed in TK-16S Russian type containers under the IAEA's vigilance, to be transported by trucks to the nearest airport and later sent by commercial cargo aircraft to its final destination in the Russian Federation (see Fig. 1). The licensing procedures as well as the radiation-, emergency preparedness- and physical protection measures are routinely applied after the first couple of shipments.

The features of fresh shipments can be summarised as follows:

- Shipments were accomplished under IAEA contracts (tripartite contracts where the Agency was the customer for the benefit of the consignor's country under the Technical Cooperation Project of "Repatriation, Management and Disposition of Fresh and/or Spent Nuclear Fuel from Research Reactors").
- The transport mode at each shipment was air-transport (AT);
- TUK 16S, Russian type containers were used; and
- Nearly the same preparatory and licensing procedures (including tripartite contract conditions), as well as shipment scenario was applied at each shipment.

Fig. 1 Fresh HEU fuel preparation and transport in Serbia (August 2002)

2.2 Spent RR HEU fuel shipments

In contrast to the relatively simple and "standardised" fresh fuel shipments, shipment of the spent nuclear fuel (SNF) assemblies requires a more extensive preparation, including package design approvals, site preparation to be able to serve the transport containers, circumspect transport route and mode selection, trans-boundary shipment approvals (if the facility country don't have common border with the RF) to transport SNF through the territory of a third country.

Table 2 shows shipments carried out under the RRRFR programme in chronological order. Since 2006, altogether 22 shipments from RR sites to RF were safely and successfully accomplished that mean a total amount of about 987 kg HEU SNF removal. The first, so called "pilot shipment" was accomplished in January 2006 followed by three other SNF transports from Uzbekistan. Russian type TUK-19 casks were used for the first four shipments, while later the newly developed Skoda type VPVR/M casks were also used for the shipments.

As it can be seen from Table 2 the transport modes show also a kind of "developments". In the beginning the railway mode was licensed only, later (due to transit difficulties in a third country) in 2008, the sea transport than finally the air transport was applied in 2009. Now it can say that RR SNF assemblies can be transported by all modes. However it should be noticed that the TUK-19 type package still have only license for air shipment (Type "B" package according to the IAEA TS-R-1 [3]), while the VPVR/M package is under an air shipment licensing procedure in RF to get, as the first in the world the Type "C" package design certificate [4].

Regarding SNF shipment preparation and termination, it means a very challenging and more painstaking preparation and implementation. Although the mains steps are similar to the fresh HEU fuel, but is much more complex, more expensive and time consuming especially when the SNF should be transported through the territory of one or more transit countries. There is no way to apply a unified preparatory procedure, since each shipment requires special preparation. It should be pointed out that some procedural modules (fuel characterisation, safeguards control, loading procedures, package preparation to transport, etc.) and supplementary equipment (spacers, transport flask) can be applied for future shipments. Figure 2 shows few photographs taken during the preparatory work of Vinča SNF shipment which was the most complex project accomplished in the frame of RRRFR programme.

Table 2. Spent RR HEU fuel returned to Russia

No.	Country	Facility	Container used	Mode of transport	U-mass [kg]	Actual Finish
1	Uzbekistan	WWR-SM Tashkent	TUK-19	RW	10.0	2006-01-10
2	Uzbekistan	WWR-SM Tashkent	TUK-19	RW	13.0	2006-02-14
3	Uzbekistan	WWR-SM Tashkent	TUK-19	RW	14.0	2006-03-20
4	Uzbekistan	WWR-SM Tashkent	TUK-19	RW	26.0	2006-04-15
5(*)	Czech Republic	Rez	VPVR/M	RW	80.0	2007-11-29
6	Latvia	Salaspils	TUK-19	RW	14.4	2008-05-12
7	Bulgaria	Sofia	VPVR/M	RW	6.3	2008-07-04
8	Hungary	BRR	VPVR/M	PR-RW-**SV**-RW	154.5	2008-10-10
9	Kazakhstan	Alatau	TUK-19	RW	17.3	2008-12-25
10	Kazakhstan	Alatau	TUK-19	RW	16.6	2009-03-01
11	Kazakhstan	Alatau	TUK-19	RW	18.8	2009-04-01
12	Kazakhstan	Alatau	TUK-19	RW	21.0	2009-05-01
13	Romania	Magurele	TUK-19	AT	23.7	2009-06-29
14(*)	Poland	EWA	VPVR/M	PR-RW-**SV**-RW	190.1	2009-09-13
15	Libya	Tripoli	TUK-19	AT	5.2	2009-12-21
16(*)	Poland	EWA, MARIA	TUK-19, VPVR/M	PR-RW-**SV**-RW	139.2	2010-03-18
17(*)	Poland	MARIA	TUK-19	PR-RW-**SV**-RW	49.5	2010-05-23
18(*)	Ukraine	KINR	VPVR/M	PR-**RW**	55.9	2010-05-25
19(*)	Poland	MARIA	TUK-19	PR-RW-**SV**-RW	38.6	2010-07-24
20(*)	Poland	MARIA	TUK-19	PR-RW-**SV**-RW	37.5	2010-10-10
21	Belarus	Minsk. Pamir	VPVR/M	RW	42.0	2010-10-24
22(*)	Serbia	Vinča RA	TUK-19, VPVR/M	PR-RW-**SV**-RW	13.2	2010-12-17
Last update: 2011-09-20				**TOTAL**	**986.8**	

(*) = IAEA involvement; PR = Public Road (highway, truck); RW = railway; SV = seagoing vessel; AT = air transport


SNF repackaging


VPVR/M container loading


RP control at SR-HU border station

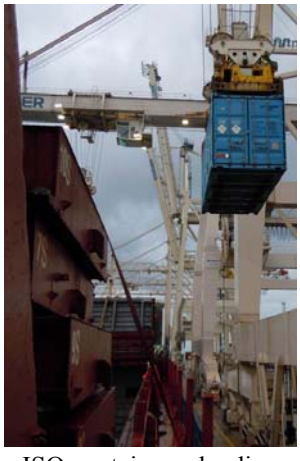
ISO container reloading onto sea-going vessel

Fig 2. Snapshots on Vinča SNF shipment accomplished in 2010

Preparation and termination procedures are beyond the scope of this paper (these matters are well described in IAEA-TECDOC-1632 [5]), but the main features of the SNF shipments can be summarised as follows:

- The legal frameworks as well as the contracting solutions look different from country to country. With the exception of the Vinča RA reactor SNF shipment, the main stakeholder to support and coordinate the shipments as well as the primary contractor was in all cases the US DOE NNSA. In the case of the Vinča SNF removal the coordination and primary contracting role was ensured by the IAEA.
- Each shipment is unique. It is not possible to give one set of general procedural rules (site preparation, licensing, etc.) for all shipments. However some procedural modules and supplementary equipment developed for previous shipments can be applied in future shipments.
- Special attention should be devoted to non-technical issues such as licensing matters, managerial activities, implementation of good communication process among the stakeholders.
- The site and SNF conditions significantly influence the preparatory works, therefore the results of the site survey as well as the fuel characterization play determinative role to define the site modification (upgrading) packing technology and mode (put the fuel assemblies as they are in a container or encapsulate prior to loading in the transport container) as well as application of supplementary equipment (filter system, transport flask, drying and vacuuming systems, etc.).
- The selection of the transport route and the modes of transport, including assigning reloading places from one vehicle onto another (if needed) are based on a case study where all circumstances of the transport with a stressed consideration to the safe and secure transport conditions are evaluated, and the best alternative is selected.
- Preparation entails serious planning and staff training.
- Typically a multinational team from four-five countries have to support the facility's operators at fuel loading (not taking into account possible radiation and physical protection services of transit countries).
- It is typical also that along the entire transport route significant radiation protection and defence forces are mobilised to secure the shipment operation.

3. IAEA contribution and support activities

Under the auspices of the RRRFR programme, the Agency has been ensuring a broad range of technical, advisory and organizational support to the HEU fuel repatriation, as well as training and advice to support RR conversion from HEU to LEU since core conversion is mandatory for rectors to participate in the RRRFR programme. Particularly the Department of Nuclear Energy and the Department of Nuclear Safety and Security as well as the Department of Technical Cooperation and of course the Office of Procurement Services, play a key role in arranging fresh and spent fuel shipments, assisting in the planning of fuel return projects, and providing technological support for member states (MSs) participating in the RRRFR programme. This section provides an overview of the IAEA's contribution in the RRRFR programme and summarises the support it provides to the MSs.

In general, the Agency's role in supporting projects like the RRRFR programme is threefold: (1) verification made by Safeguards; (2) standardization ensured by published IAEA Safety Standards (e.g. Nuclear Safety-, Transport-, Emergency preparedness-, Waste management standards, etc.); and (3) technical cooperation ensuring multidisciplinary backing for MSs throughout technical cooperation mechanisms. The first two supports are a continuous Agency service for the MSs. From RRRFR

programme's viewpoint the third group plays a significant role through which programme specific supports have been provided.

Regarding technical cooperation mechanisms with regard to the RRRFR programme the support activity of the Agency can be divided into four groups:

- Traditional support
- Programme specific technical cooperation
- Advisory support
- Collecting and dissemination practices

3.1 Traditional support

The traditional support is typically an integral part of a TC project launched by the Agency that means in general: outlining a project, organising technical meetings, conducting fact finding missions, equipment and service procurements (issuing call for bids, contracting, procurements and appraisal of deliverables), etc. Some of the most significant IAEA cooperation with regard to RRRFR programme support are as follows:

- Organising bilateral and multilateral meetings (nearly hundred meetings were organised including the organisation of the first serial of the tripartite initiative meetings in 1999 -2000);
- Fact find missions between 2001-2004 (15 RR sites in 11 countries were surveyed);
- Agency is one of the contracting parties in case of fresh HEU shipments (21 contracts with its entire procurement support from the issuing call for bids to the deliverables' evaluations);

3.2 Programme specific technical cooperation

Within the framework of IAEA's Technical Cooperation projects two significant subject specific projects were launched: (1) Skoda VPVR/M cask procurement; (2) Vinča (Serbia) SNF return programme.

3.2.1 Skoda VPVR/M cask procurement

Transporting a large quantity of SNF stored at many of Russian origin RRs required to develop suitable new capacity packages for the RRRFR programme to haul all of the stored SNF with one shipment from some facilities (at the beginning 16 pcs. TUK-19 casks were available), and in addition ensure further transport package alternatives with an improved cask loading technology to meet the needs of the different RR site and SNF conditions stored at a facility. To assist in resolving this demand, the IAEA agreed to use their procurement system to send out a call for bid and procure enough casks to meet the foreseen shipment needs. After the bidding procedure the VPVR/M cask system of Skoda (Czech Republic) was selected from six international cask vendors. The Skoda proposal not only met all of the scope requirements, but also provided additional benefits to the programme: had NRI's offering to provide to the RRRFR programme their six VPVR/M casks after completing the transfer of their SNF to Russia.

The IAEA procured ten high capacity dual purpose (transport/storage) containers under a 4 million Euro contract. The complex procurement and implementation included outlining the technical requirements, evaluations of bids, contracting, quality inspections, evaluation of the results of the so called "dry run" and "wet run" tests [6].

Thus, due to this procurement the programme has now 16 VPVR/M casks and 16 TUK-19 casks. A comparison table of casks' utilisation is presented in Table 3 [7].

Table 3. Comparison table of casks' utilization

Cask	Casks available, since	Total No. of shipment used	Total No. of cask used	Total No. of FAs shipped	Total HEU mass
TUK-19	16 pcs, Jan 2006	16	275	1100	357 kg
VPVR/M	16 pcs., May 2008	8	86	3096	623 kg

3.2.2 Vinča (Serbia) SNF return programme

The first TC project after the re-admittance of the country was started in 2001. This was then followed by three essential specific projects. The strategic objectives of these projects were firstly to survey the Vinča site, identify the real conditions of the SNF as well as stabilize its conditions (prevent as much as possible the escalation of further degradation and achieve a long term safe and stable state) [8].

From 2004 the IAEA, the Nuclear Threat Initiative (NTI), the US-DOE and the European Union provided funds to cover the Vinča RA Reactor SNF removal[1]. With such financial support, upon the invitation of the IAEA, in May 2005 an international consultancy meeting was held in the Vinča Institute. The main goal was to draft the outlines of an international bid for the removal and transportation technology of the seriously corroded and leaking SNF assemblies in the storage pool adjacent to the reactor building. At the conclusion of this meeting an international tender was issued by the IAEA in the summer of 2005. An RF consortium was selected and an international tripartite contract between the IAEA, RF consortium and the Vinča Institute was signed in September 2006 for the safe removal of SNF from the Vinča RA Reactor and return to the RF (Vinča SNF return programme).

For the implementation of the tripartite contract consistently with the TC management principle a special PMO was appointed by the Agency to coordinate the programme implementation in all respect. During the programme performance, 16 technical officers, and two technical experts were assigned to the Project Management Unit at Vinča site. Thus, the Agency not only contracted, but provided a general coordinative managerial support, as well as an overall technical backing for the operating organisation and the officers of the regulatory body [9].

The project was completed as planned in December 2010: 8030 SNF was removed representing more than two-and-half tonnes of highly radioactive spent fuel [10]. This transport was the largest single shipment of SNF made under the RRRFR programme, and also this project became the largest and most complex TC project in the history of the IAEA with a total budget of over USD 55 million.

3.2.3 Advisory support

Advisory support was provided either upon demand by a regulatory body or a stakeholder involved in the shipment preparation:

- **Support provided upon the demand of a regulatory body.** The goal was to assist and advice the regulatory body to review the safety documentation prepared for a shipment, and assist onsite inspection. This support mainly was ensured in the form of a safety mission, as well as follow up missions with the involvement of external experts. During these missions the items reviewed were

[1] In 2004, a so called Vinča Institute Nuclear Decommissioning programme (VIND) was launched objective of which covers not only SNF removal but includes RA Reactor decommissioning, radioactive waste management and on-site radiation protection logistic.

focused on QA/QC, training and education programs, and their implementation in the practice, as well as on applied radiation protection measures, waste- and emergency preparedness programs. The communication mechanism was always an issue in reviewing and implementing the lessons learned. Altogether four missions were conducted three of which concerned the Vinča project [11].

- **Support provided upon demand of a stakeholder.** This technical and advisory support was mostly case specific interactions requested by the operating organisations and/or stakeholders (contractual parties or even authorities). This contribution encompassed mainly the following four activity fields: (1) feasibility consideration and technology selection; (2) documentation preparatory support, (3) licensing support (local and trans-boundary licensing supports), (4) on-site technical review and advisory support to implement equipment [12].

  (1) Feasibility consideration and technology selection: decisive role to survey the site condition, infrastructure availability in order to advise on the technology approach. Or analyse and evaluate transport route and mode considerations. Conclusions of these considerations served later as a guiding principle in the project implementation.

  (2) Documentation of preparatory support: real consultative and advisory help, more over sometimes direct contribution was given to develop SAR, OLCs, as well as licensing, authorization, technical, accompanying, emergency preparedness etc. documentation. The main objective that the Agency intended to implement was the policy of safety awareness. Therefore it was consequently emphasized that the main objective of the mandatory documentation was to guarantee that all activities should be carried out with trained staff, in planned, controlled and documented ways.

  (3) Licensing support: while the onsite work meant a unique technical challenge for the operators, obtaining all authorisation and permits provided a puzzle for the legal entity intending to ship the SNF by means of different transport modes from export country throughout transit countries to the RF. The support encompassed the export country and transit countries as well. This support field together with the documentation preparatory support utilised mostly the experiences gained on previous shipments.

  (4) On-site technical review: it took the form of on-site advisory support of the on-going activities, which covered staff training, equipment commissioning, test operation of newly manufactured or already used accessories, devices and tools, as well as implementation of work procedures (e.g. package maintenance before loading, cask loading and drying, waste management, etc.) and equipment as well. Even while walking down a facility, the Agency's technical officer(s) revised the equipment conformity, assessed the work performed in accordance to the requirement and written procedures. Repeatedly revised and emphasised issues were: applied radiation protection measures, waste management, QA/QC plan implementation.

3.2.4 Collecting and dissemination practices

Regional lessons learned workshops. As the first shipments were completed, experts were brought together to share their experience and knowledge with those who would be dealing with fresh and spent fuel shipments in the future under the umbrella of RRRFR programme. In 2005, the IAEA in cooperation with the US DOE initiated a yearly regional workshop on "Russian Research Reactor Fuel Return Programme Lessons Learned". The primary objective was – and still is – to bring together the core players in the preparation and accomplishment of shipments, and sharing experiences on lessons learned so that others may benefit in the future. Accordingly the invited participants represent facility operators

from 16 countries[2], regulatory bodies, stakeholders ensuring financial and coordination support for the programme, as well as companies actively being involved in the programme completion on a contractual basis.

Table 4 shows the history of the Regional Workshops. Although the meeting indicated in the second row was a workshop on "International Legal Framework Applicable for Shipment of Russian-origin Research Reactor Spent Fuel to the Russian Federation" that replaced the annual regional workshop in 2007, but its main feature was gathering experience. Thus altogether six workshops on lessons learned were organised.

Table 4. History of the Regional Workshops on RRRFR programme Lessons Learned"

No	Place	Date	Participants
1	Belgrade, Serbia	October 2006	75 participants from 15 countries
	Poina-Brasov, Romania(1)	April 2007	43 participants from 10 countries and EU
2	Rez, Czech Republic	May 2008	97 participants form 17 countries
3	Varna, Bulgaria	June 2009	88 participants form 17 countries
4	Poina-Brasov, Romania	May 2010	71 participants from 16 countries
5	Jackson, WY-USA	June 2011	95 participants from 17 countries
6	*Lake Balaton, Hungary*	*Scheduled for 2012*	

(1): It was a Workshop on "International Legal Framework Applicable for Shipment of Russian-origin Research Reactor Spent Fuel to the Russian Federation" organised by the IAEA in cooperation with the European Union.

Regarding the workshop scenario, workshops traditionally consist of a series of review lectures given by the leading experts, followed by status reports from facilities, and round table discussions of relevant problems and tasks. The main benefit of the workshop is to exchange experience and methods for effective performance of RRRFR, to discuss, consider technical, legal, logistical, administrative and other experiences obtained during the programme implementation, as well as draw conclusions and lessons learned for improving safety, radiation protection and physical protection while shipping fresh and spent fuel. Experience shows that the annual workshop on lessons learned is an important tool in collecting and disseminating information. After the first three-four workshops it was a common understanding the Lessons Learned Workshops ensure a stand-alone forum to exchange experiences (applied practices, methods, developed and implemented special auxiliary equipment, tools, etc.) and lessons learned, as well as capturing the consolidated knowledge of this unique international historical programme.

IAEA-TECDOC booklets issued for support RRRFR programme objectives. The IAEA-TECDOC publications mean another effective tool to disseminate practical information and experiences. On the basis of the gathered experience during RRRFR programme's implementation the Agency issued four booklets to support the programme implementation. They are:

- B. Yuldashev and J. Thomas: Technical and Administrative Preparation for Shipment of Russian-origin Research Reactor Spent Fuel to Russian Federation. IAEA Guideline document. Vienna, Austria. February 2007. This guideline document provides key information for the planning and return of Russian-origin SNF or materials containing HEU to the RF.
- IAEA-TECDOC-1593: Return of Research Reactor Spent Fuel to the Country of Origin: Requirements for Technical and Administrative Preparations and National Experiences. July 2008. This IAEA-TECDOC is a proceedings of technical meeting held in Vienna, August 2006

[2] Belarus, Bulgaria, Czech Republic, Germany, Hungary, Kazakhstan, Latvia, Poland, Romania, Russian Federation, Serbia, Slovenia, Ukraine, USA, Uzbekistan, Vietnam

summarising shipment experiences 32 shipment preparation and operation experiences made under the umbrella of USA Foreign Research Reactor Spent Nuclear Fuel (FRRSNF) acceptance programme and RRRFR programme.

- IAEA-TECDOC-1632: Experience of Shipping Russian-origin Research Reactor Spent Fuel to the Russian Federation. November 2009. This IAEA-TECDOC is an extended summary and account of the experience obtained from the completion of international projects on return SNF to the RF from RRs in Uzbekistan, Czech Republic, Latvia, Bulgaria and Hungary;
- Draft of IAEA-TECDOC: Legal Aspects of Spent Nuclear Fuel Repatriation to Russian Federation - Lessons Learned. The need for a multilateral approach to reviewing both national and international legal obligations connected with the international transport of the SNF was first raised in the context of LL workshop held in Belgrade 2006. The TECDOC focuses on the national and international legal aspects of SNF fuel to the RF from RRs located in a number of States in central and Eastern Europe.

4. Look into the Future

The Agency will continue to support RRRFR programme. This support encompasses the core conversion efforts of RRs since core conversion being is mandatory for reactors to participate in the RRFR programme. A status review of the foreseen shipments intending to be accomplished under the umbrella of the RRRFR programme is shown in Table 5.

Table 5. Status review of the foreseen shipments

Location	Facility name	Type	Power	Core conversion		Due shipments
				Start	End	
Due HEU SNF shipments						
Kiev, Ukraine	WWR-M	Tank type	10MW	Jan 2011	2013	Febr 2012
Taschkent, Uzbekistan	WWR-SM	Pool type	10 MW	March 2008	Nov. 2009	May 2012
Rez, Czech Republic	LVR-15	Tank type	10 MW	Febr 2010	Sept 2011	March 2013
Budapest, Hungary	BRR	Tank type	10 MW	Sept 2009	Dec. 2012	Dec 2014
Svierk, Poland	MARIA	Pool type	30 MW	July 2012	Jan 2014	2017
Germany, Rossendorf	–	–	–	–	–	3 postponed SNF shipments (no scheduled date yet)
Dalat, Vietnam	Dalat RR	Pool	500 kW	–	–	2012 (no scheduled date yet)
Due HEU fresh shipments						
Kharkov, Ukraina	–	–	–	–	–	April 2012
Minsk, Belarus	–	–	–	–	–	No scheduled date yet

As it can be seen after the core conversion five RR SNF shipments are still due between 2012-2017. Some postponed shipments from 2010 are hanging (three shipments from Germany and one from Vietnam), shipment dates of which are not scheduled yet. Also two fresh HEU shipments are still due. Service contract for Kharkov (Ukraine) just was signed few days ago (the shipment is due in April 2012), but the fresh HEU from Minsk (Belarus) still not scheduled yet.

5. Summary and conclusions

The RRRFR programme was launched in 2001. The programme has successfully completed 43 shipments of 1.6 tons of fresh and spent HEU fuel from different countries using Russian fuelled research reactors to the country of origin. Since the programme inception the IAEA, in cooperation with US DOE, Russian Federation, European Union, and a number of individual Member States has provided important overall technical support in the effort to return HEU RR fuel to the RF.

In this cooperation, the Agency utilizes all its mechanisms available through its regular Agency programme and Technical Cooperation Programme to advance Member States and the international non-proliferation efforts to eliminate stockpiles of HEU fuel. The Agency's contribution overlaps a broad range of technical, advisory and organizational support from usual Agency services (safeguards, standardization, procurement, meeting organizing) with the programme specific supports. With regard to the RRRFR programme, the following two contributions by the Agency should be emphasised: (1) procurement of ten high capacity of dual purpose (transport/storage) containers; (2) Complex support of Vinča (Serbia) SNF return programme, which resulted (i) the largest single shipment of SNF made under the RRRFR programme, and also (ii) the largest and most complex TC project in IAEA's history total budget over USD 55 million.

The Agency initially contributed in collecting and disseminating practices when, in cooperation with the US DOE, initiated in 2005 to organise annually a Regional Workshop on Lessons Learned. The primary objectives were – and still are - to bring together the core players in the preparation and completion of shipments, and sharing the lessons learned, so that others may benefit in the future. And also, on the basis of that experience the Agency issued four TECDOCs to support proactively the programme implementation. Experience shows that the annual lessons learned workshops as well as the TECDOCs are important tools in collecting and dissemination practices.

The Agency's contribution in implementing the RRRFR programme includes a wide-range of professional support, which is provided almost immediately on the demands of the stakeholders. The continuous advice and expertise contributed greatly to the smooth shipment preparations and operation, and helped to ensure that all the 43 shipments were accomplished safely according to schedule. In summarising, the following may be concluded:

- Special attention should be devoted to „non technical" issues such as managerial activities, licensing matters and implementation of good communication process among the stakeholders. It is important that all activities are well planned, controlled and documented.
- While the fresh shipment operations can be implemented on a more or less standardised way, in case of SNF shipment some procedural modules and supplementary equipment developed at previous shipments can be applied for future shipments. Each SNF shipment preparation and operation is unique.
- While the IAEA fulfilled its advisory and coordination assistance, the Agency unintentionally played the role of a mediator amongst the stakeholders, which consequently yielded additional Agency support: a kind of "charity mission" to resolve conflicts between core actors and strengthen trust issues amongst the contractual parties.

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