IAEA-TECDOC-1632

Experience of Shipping Russian-origin Research Reactor Spent Fuel to the Russian Federation

IAEA
International Atomic Energy Agency

IAEA-TECDOC-1632

Experience of Shipping Russian-origin Research Reactor Spent Fuel to the Russian Federation

IAEA
International Atomic Energy Agency

The originating Section of this publication in the IAEA was:

Research Reactor Group
International Atomic Energy Agency
Vienna International Centre
P.O. Box 100
1400 Vienna, Austria

EXPERIENCE OF SHIPPING RUSSIAN-ORIGIN RESEARCH REACTOR
SPENT FUEL TO THE RUSSIAN FEDERATION
IAEA, VIENNA, 2009
IAEA-TECDOC-1632
ISBN 978–92–0–110709–1
ISSN 1011-4289

Printed by the IAEA in Austria
November 2009

FOREWORD

The primary goal of the Russian Research Reactor Fuel Return (RRRFR) programme is to advance nuclear non-proliferation objectives by eliminating stockpiles of Russian-origin highly enriched uranium (HEU).

The RRRFR programme was first conceived during trilateral discussions among the USA, the Russian Federation and the IAEA, initiated in 1999, when participants identified more than 20 research reactors in 17 countries having Russian/Soviet supplied fuel. In 2000, the Director General of the IAEA sent a letter to 15 countries asking for their willingness to return HEU spent fuel to the Russian Federation. Fourteen countries responded positively to the Director General's letter.

In 2004, the Russian Federation and the USA signed a Government-to-Government Agreement concerning cooperation to return the Russian produced research reactor nuclear fuel to the Russian Federation. This agreement established the legal framework necessary for the cooperation between the Russian Federation and the USA for the return of Russian supplied research reactor fuel from eligible countries. Under the Bratislava agreements concluded by Presidents George W. Bush and Vladimir Putin in February 2005, both countries committed to completing all shipments of Russian-origin HEU spent fuel currently stored outside research reactors by the end of 2010. Up to the time of writing (May 2009) the programme has completed 19 shipments totalling over 838 kg of Russian-origin HEU spent and fresh fuel which has been returned from Bulgaria, the Czech Republic, Germany, Kazakhstan, Latvia, the Libyan Arab Jamahiriya, Poland, Romania, Serbia, Uzbekistan and Vietnam. During this time, the programme successfully removed all HEU from two countries, Latvia and Bulgaria.

HEU spent fuel shipments have been the most complex shipments under the RRRFR programme, which will be the focus of this publication. The first shipment of HEU spent fuel from Uzbekistan was completed in January 2006, followed by HEU spent fuel shipments from the Czech Republic in 2007, and Latvia, Bulgaria, and Hungary in 2008. The experience obtained from the first shipments generated many new ideas and lessons learned that can inform the execution of upcoming RRRFR shipments. This publication discusses these lessons learned, and describes the key steps necessary for the future successful performance of the RRRFR and similar programmes. Contact points are listed in Appendix VI and contributing organizations are listed in Appendix VII.

The IAEA acknowledges the contributions in the preparation of this report of all the organizations that carried out shipments of research reactor spent nuclear fuel to the Russian Federation.

The IAEA officer responsible for this publication was B. Yuldashev of the Division of Nuclear Fuel Cycle and Waste Technology.

CONTENTS

1. INTRODUCTION ... 1
   - 1.1. Objectives and scope ... 1
   - 1.2. Structure ... 2
   - 1.3. RRRFR programme background information ... 2

2. PREPARATIONS FOR SPENT FUEL IMPORT ... 3
   - 2.1. The RRRFR programme flow chart ... 4
   - 2.2. Baseline schedule ... 4
   - 2.3. Government-to-Government agreements ... 4
     - 2.3.1. United States of America and the Russian Federation ... 5
     - 2.3.2. United States of America and the originating country ... 6
     - 2.3.3. Originating country and the Russian Federation ... 7
     - 2.3.4. Transit countries (if applicable) ... 8
   - 2.4. Contracts ... 8
     - 2.4.1. United States of America and the originating country ... 8
     - 2.4.2. Russian Federation and the originating country ... 9
   - 2.5. Russian Federation preparation activities ... 9
     - 2.5.1. Unified project ... 10
     - 2.5.2. Approval process and shipment authorization ... 13
     - 2.5.3. Fuel characterization ... 13
     - 2.5.4. Mayak facility acceptance requirements ... 18
     - 2.5.5. Cask licensing in the Russian Federation ... 21
     - 2.5.6. Sample documents for the import of SFA to the Russian Federation ... 22
   - 2.6. Originating country preparation activities ... 23
     - 2.6.1. Legislative requirements ... 23
     - 2.6.2. Facility preparations ... 26
     - 2.6.3. Training ... 30
     - 2.6.4. List of documents used during preparatory works at INP ... 30
   - 2.7. Transit country preparation activities (if applicable) ... 32
     - 2.7.1. Kazakhstan experience in transit of spent fuel assemblies ... 32
     - 2.7.2. Transit on the territory of Ukraine ... 34
   - 2.8. European Commission (if applicable) ... 37

3. BRIEF DESCRIPTION AND SPECIFICATIONS OF CASKS ... 38
   - 3.1. Arrangement of SNF in the casks ... 38
   - 3.2. Transport package TUK-19 ... 39
     - 3.2.1. Cask 19 ... 40
     - 3.2.2. Basket for canister TS1 ... 41
   - 3.3. Transport package SKODA VPVR/M ... 41
     - 3.3.1. Description of the SKODA VPVR/M cask and its components ... 42
   - 3.4. ISO container for transport of SKODA VPVR/M packages ... 47
   - 3.5. ISO container for transport of TUK-19 ... 48

4. TRANSPORTATION 50
4.1. Transportation responsibilities 50
4.1.1. Originating country 50
4.1.2. Russian Federation 50
4.1.3. Transit (if applicable) 51
4.2. Transportation modes 51
4.2.1. Rail 51
4.2.2. Sea 51
4.2.3. Air 51

APPENDIX I. RRRFR PROGRAMME FLOW CHART 53

APPENDIX II. CONTRACT – TASK PLAN INSTRUCTIONS 57

APPENDIX III. TUK-19 CASK LICENSE 62

APPENDIX IV. SKODA VPVR/M CASK LICENSE (ENGLISH VERSION) 68

APPENDIX V. SHIPMENT FORMS OF THE RUSSIAN FEDERATION 78

APPENDIX VI. POINTS OF CONTACT 93

APPENDIX VII. CONTRIBUTING ORGANIZATIONS 94

APPENDIX VIII. SUMMARY REPORTS ON SHIPMENTS IN EACH COUNTRY 95

REFERENCES 123

ABBREVIATIONS 125

CONTRIBUTORS TO DRAFTING AND REVIEW 127

1. INTRODUCTION

This IAEA-TECDOC is an extended summary and account of the experience obtained from the completion of international projects on return of spent nuclear fuel to the Russian Federation from research reactors in Uzbekistan, Czech Republic, Latvia, Bulgaria, and Hungary.

1.1. Objectives and scope

With the recent successes in shipping spent fuel to the Russian Federation (RF) from Uzbekistan (2006), Czech Republic (2007), Latvia (2008), Bulgaria (2008) and Hungary (2008) under the Russian Research Reactor Fuel Return (RRRFR) Programme, valuable information on the laws and requirements for the importation of spent nuclear fuel (SNF) has been learned. Since the shipments of spent fuel from research reactors to the Russian Federation were stopped in 1991, the laws in the Russian Federation governing the import of SNF have undergone substantial changes. Through the Uzbekistan and following projects, the preparatory activities required for authorizing the shipments were identified and refined; and the logistics for the transportation phase were negotiated and approved.

This IAEA-TECDOC provides key information for the planning and return of Russian-origin spent nuclear fuel or materials containing highly enriched uranium (HEU) to the Russian Federation (Figure 1). It is intended for use by all parties involved in the planning, preparations, coordination and operations associated with returning SNF to the Russian Federation. It identifies and discusses the basic methods and activities that serve as the preparatory framework for implementing the programme. It further acts as a valuable resource document by providing the needed forms, procedures, and information to conduct a shipment. With this core information, a shipment plan may be developed by the originating country to identify and organize their specific needs.

FIG. 1. Research Reactors with Russian-Origin fuel.

Since the common link between all of the RRRFR shipments is the receipt country and facility, this publication will focus on providing the acceptance requirements for Mayak enterprise in the Russian Federation. For the originating and transit countries, where shipment requirements may vary widely, general recommendations and subject reminders have been provided. Much of the content of the main text has been generalized to apply to all shipments regardless of the originating country. However, because the initial revision of this IAEA-

TECDOC centred on the experiences from Uzbekistan, some data and specific experiences from that shipment have been included as examples to enhance the text. Once countries complete shipments of spent fuel to the Russian Federation, their specific experiences will be included as separate attachments to this IAEA-TECDOC.

1.2. Structure

This publication consists of two main sections. The first consists of chapters describing the legal documents, preparation activities, cask information, and transportation topics. A RRRFR programme flow chart has been developed to assist the originating country (OC) in planning the project. The various items listed in the flow chart are supported by descriptive text in the body of the publication and the appendices. The major preparation activities within the flow chart have been placed on a baseline schedule to aid in schedule development. The second main section includes all of the Appendices that provide the required forms, technical data, sample documents, and other resource information. Additional resources and information will be added to the guideline as they become available. As shipments occur, a summarized account of the shipment along with the specific lessons learned will be added as appendices to this IAEA-TECDOC.

1.3. RRRFR programme background information

Beginning in December 1999, and continuing to the present, representatives from the USA, the Russian Federation, and the International Atomic Energy Agency (IAEA) have been working on a programme to return to the Russian Federation - Sovietor Russian supplied highly enriched uranium fuel currently stored at foreign research reactors. The primary goal of the Russian Research Reactor Fuel Return programme is to advance nuclear non-proliferation objectives by eliminating stockpiles of HEU. A country is eligible to participate on the condition that it agrees to convert its research reactor(s) from HEU to low enriched uranium (LEU) fuel upon availability, qualification, and licensing of suitable LEU fuel, or to shutdown. Additionally, an organization with bulk quantities of fissile material may also participate by either returning the bulk material to the Russian Federation or by blending down the material to LEU.

The trilateral discussions have identified more than 24 research reactors at 17 facilities in 15 countries[1] that have Sovietor Russian supplied fuel. Most of these reactors use at least some HEU fuel, and many have inventories of both fresh and spent fuel that must be carefully stored and managed. The implementation of this programme supports the goal of the Department of Energy (DOE)/National Nuclear Security Administration (NNSA) to help the Russian Federation develop a broad-based HEU minimization policy under which it will accept the return of fresh and spent HEU fuel from Soviet or Russian supplied foreign research reactors. New fuels that will allow conversion of such reactors to LEU are also provided under this policy. The programme closely resembles the successful United States Foreign Research Reactor Spent Nuclear Fuel Acceptance programme and works in conjunction with the Reduced Enrichment for Research and Test Reactors programme, which, among other things, assists the Russian Federation with the development of new LEU fuels as well as reactor conversion feasibility studies.

In October 2000, the Director General of the IAEA sent a letter regarding the management of research reactors of Soviet-/Russian-origin to the relevant Ministers in the following

[1] Official numbers stated by the RRRFR programme. Table 1 includes additional reactors that either no longer have spent fuel or are not participating.

16 countries: Belarus, Bulgaria, China, Czech Republic, Egypt, Germany, Hungary, Kazakhstan, Latvia, the Libyan Arab Jamahiriya, Poland, Romania, Ukraine, Uzbekistan, Vietnam and Yugoslavia (now Serbia). No letter was sent to DPRK. Responses were received (Table 1) from all recipients except China and the Libyan Arab Jamahiriya. All responses were favourable except two. Germany expressed interest in principle but only after the details of the programme had been clarified, and Egypt responded that it only possessed LEU fuel.

TABLE 1. COUNTRIES CONTACTED BY THE IAEA.

Countries	Reactor names	Fuel types	Interested in Programme as expressed to IAEA
Belarus	IRT-M, Pamir	EK-10, Rods, Spheres, Pamir, Bulk Material	YES
Bulgaria	IRT-Sofia (IRT-2000)	EK-10, S-36	YES
China	SPR IAE, HWRR	EK-10, TVR-S	No response
Czech Rep.	LWR-15,VR-1, LR-0	EK-10, IRT-2M	YES
Egypt	ETRR-1	EK-10	Response with reservations
Germany	RFR, RRR, RAKE, AKR, ZLFR	EK-10,WWR-SM, Pellets, Rods, Cylinders and Plates	YES with conditions
Hungary	WWR-S, Training R.	EK-10, WWR-SM, WWR-M2	YES
Kazakhstan	WWR-K, IGR, EWG1	WWR-K, Special Type, Bulk Material	YES
DPR Korea	IRT-DPRK	EK-10, IRT-2M	Not asked
Latvia	IRT, RKS25,	EK-10, IRT-2M, IRT-3M	YES
Libyan Arab Jamahiriya[2]	IRT-1, Critical Assembly	IRT-2M	No initial response, joined 2004
Poland	EWA, MARIA, ANNA, AGATA, MARYLA	EK-10, WWR-SM, MR	YES
Romania	WWR-S	EK-10, S-36	YES
Ukraine	WWR-M, IR-100	WWR-M2, WWR-M5, WWR-M7, Bulk Material	YES
Uzbekistan	WWR-CM	IRT-3M, EK10, S-36, IRT-4M	YES
Vietnam	IVV-9	WWR-SM	YES
Yugoslavia (Serbia)	RA, RB	TVR-S	YES

2. PREPARATIONS FOR SPENT FUEL IMPORT

Importing spent nuclear fuel assemblies into the Russian Federation requires a series of extensive preparation activities. These preparation activities support the requirements listed in the applicable governmental laws of the Russian Federation, originating country and transit countries (TC). Section 2 will describe the activities required to obtain the shipment authorization in the Russian Federation, originating country, and transit countries.

[2] In 2004, the Libyan Arab Jamahiriya declared that it would participate in the RRRFR Programme.

2.1. The RRRFR programme flow chart

The RRRFR Programme Flow Chart is shown in Appendix I for reference. It attempts to provide a graphical representation of the steps needed to ship spent fuel to the RF. Each activity that is supported with descriptive text in this publication contains the corresponding chapter numbers next to it.

The decision by the originating country to return its spent fuel to the RF under the RRRFR Programme starts the shipment project. The flow chart at this point then splits into three parallel paths. The first path focuses on the legal protocol with the RF. A letter from the Ministry of Foreign Affairs (MFA) of the OC is transmitted to the State Atomic Energy Corporation Rosatom (Rosatom) through the MFA of the RF declaring its intent to return the spent fuel. After receiving Rosatom's acceptance, the OC is able to sign a general order agreement (contract) with the Federal Centre for Nuclear and Radiation Safety (FCNRS) for the return activities and also begin the bilateral agreement phase if a current government-to-government agreement (GTGA) does not already exist. The second path identifies the shipment concept, including the scope (number of assemblies), cask selection, route, and, if required, subsequent transit country (or countries). All of this preliminary information is needed as baseline information for future preparation activities. The third path focuses on the legal framework with the USA. It shows the need to identify whether the appropriate bilateral agreements are in place so that the NNSA can enter into a contract with the implementing agent in the OC. Once the governmental agreements are signed, the contract can be developed and approved. The completion of all three paths allows for the initiation of the project tasks which are depicted by the flow chart and described in the publication. Successfully completing all of the items in the flow chart means that all of the authorizations to ship have been obtained from the Russian Federation, the Originating Country, and applicable transit countries. In most cases, the required forms for the shipment are completed during the authorization process, however, additional forms required during transit have been provided in the Appendices.

2.2. Baseline schedule

Figure 2 shows the baseline schedule for authorizing the shipment of SNF to the Russian Federation. It was developed and refined as a result of the many meetings and discussions held during the planning of the shipment from Uzbekistan. It should be used as a guide to develop specific project schedules. Recent experience with shipments from other countries has demonstrated that timing intervals shown in the diagram are approximately the same (plus or minus couple of months) from country to country.

2.3. Government-to-Government agreements

The bases providing the legal framework for performing the shipment of spent fuel to the Russian Federation are the government-to-government agreements that exist between the interested countries, the USA, the Russian Federation, the originating country and the transit country (if applicable). The objectives of the GTGAs are implemented through the use of international contracts. Section 2.2 will discuss the types of agreements and contracts utilized for spent fuel shipments to the Russian Federation.

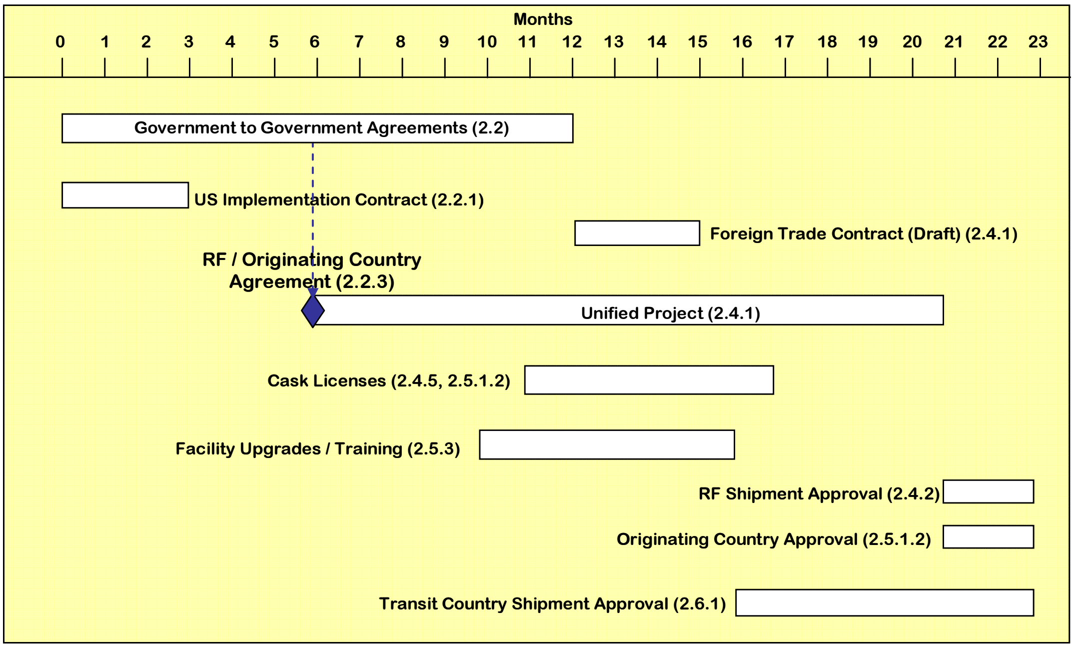


FIG. 2. Preparation activities – baseline schedule.

2.3.1. United States of America and the Russian Federation

In May 2004, the RRRFR programme completed an important milestone with the signing of the Agreement between the Government of the United States of America and the Government of the Russian Federation Concerning Cooperation for the Transfer of Russian-Produced Research Reactor Nuclear Fuel to the Russian Federation (RRRFR Agreement) [1]. This Government-to-Government Agreement between the USA and the Russian Federation provides the legal authority for the RRRFR programme. The RRRFR Agreement establishes the parameters whereby eligible countries may return fresh and spent HEU fuel assemblies and fissile materials to the Russian Federation. The USA, through the RRRFR programme, provides funding for the removal and reprocessing of eligible material. In order to participate in the programme and be eligible for funding, a country or facility must meet the following programme criteria:

- The fuel return programme includes only existing Sovietor Russian produced research/test reactors in eligible countries that possess nuclear fuel and other nuclear material supplied by the Soviet Union or the Russian Federation;
- Eligible material includes stocks of HEU and LEU currently stored outside of reactors and HEU fuel currently being used in reactor cores;
- Any country desiring to return material to the Russian Federation must:
  - Agree to convert its operating research/test reactor(s) using Russian-produced HEU fuel to use LEU as soon as suitable LEU fuel, licensed by the country's national regulatory authority, is available; and the reactor's existing inventory of HEU fuel is exhausted; or
  - Agree to permanently shut down the reactor(s); or
  - Have shut down the reactor(s) at the time of entry into force of the Agreement.
- Whenever possible, all HEU must be made available for return to the Russian Federation before any LEU is returned;

- All nuclear fuel to be delivered to the Russian Federation under the programme must be handled in accordance with IAEA INFCIRC/225/REV.4[3] guidelines on the physical protection of nuclear material.

DOE/NNSA serves as the US Executive Agent for the RRRFR Agreement. As required by the text of the Agreement, a Joint Coordinating Committee has been established to provide oversight of the Agreement. The responsibilities of the JCC include the following activities:

- Determine the priority areas of activity to fulfill the objective of this Agreement;
- Develop a plan of joint actions and implementing mechanisms to facilitate coordination and implementation of activities;
- Review implementation of the Agreement and resolve issues that may arise in the course of its implementation;
- Organize annual and other meetings on the progress of implementation; and
- Discuss and draft, if necessary, recommendations to the USA and the Russian Federation concerning amendments to the Agreement as well as proposals to resolve disputes that are not resolved at the JCC level.

2.3.2. United States of America and the originating country

The USA and the Government of the Originating Country must have an agreement that provides the legal framework allowing the US Government to fund and work directly with the originating country on non-proliferation activities. Often, this agreement is called the Cooperative Threat Reduction (CTR) Agreement or the Weapons of Mass Destruction (WMD) Agreement (e.g. [2]). If such an Agreement is in place, the Implementing Agreement discussed below is used to enter the contract phase of the project.

If a CTR or WMD Agreement is not in place, a diplomatic note between the governments of the USA and the OC can be used to provide the legal mechanism including tax exemption and liability protection for non-proliferation activities. Once signed, the implementing agreement discussed below can be used to implement the project. In some cases, a diplomatic note is not acceptable. In this situation, an RRRFR specific Government-to-Government Agreement can be approved and signed that includes the applicable GTGA provisions and Implementing Agreement in one combined document[4].

This Implementing Agreement allows the Department of Energy to designate an implementing agent to assist the originating country in the return of nuclear fuel to the Russian Federation. It also allows the originating country to do the same. In the RRRFR programme, the Department of Energy will delegate these responsibilities to the National Nuclear Security Administration. The NNSA, in turn, will have the approval to enter into contracts or arrangements with the designated implementing agents to complete fuel removal. This Agreement also commits the appropriate ministries, agencies and organizations of the originating country and the USA to treat all associated work with the highest priority.

With the implementing agreement in place, the NNSA and the implementing agent of the OC sign a basic order contract for the full scope of the return. This contract includes all of the preparation activities as well as the shipment, reprocessing, and interim storage of the high

---

[3] IAEA INFCIRC/225/REV.4 can be accessed via the web at http://www.iaea.org/Publications/Documents/Infcircs/1999/infcirc225r4c/rev4_content.html

[4] Bulgaria, for example.

level waste (HLW) for a period of twenty years[5] [3]. To expedite the project, a limited scope contract for shipment preparations only (no fuel handling) can be signed while the negotiations for the bilateral agreements are in progress. This limited scope contract must be revised prior to any fuel movement.

2.3.3. Originating country and the Russian Federation

The State Atomic Energy Corporation Rosatom is responsible for the export and import of nuclear facilities, equipment, technologies, fissile and radioactive materials, special-non-nuclear materials and services in the field of nuclear energy. Due to this, the proposed Government-to-Government Agreement between the Russian Federation and the OC is submitted to the RF Government by Rosatom together with the Ministry of Foreign Affairs of the RF upon their agreement [4].

The proposal to conclude a Government-to-Government Agreement should contain the draft text of the agreement or its main provisions, justification for the expediency of such an agreement, conformity of the agreement to the RF legislation, and estimation of financial, economical and other consequences of this agreement.

Prior to submission of the proposed Government-to-Government agreement to the RF Government for approval, it should be reviewed and agreed upon by interested federal executive bodies and other state bodies (Rostechnadzor, Ministry of Foreign Affairs and Ministry of Trade and Economical Development).

Following this internal approval, the draft Government-to-Government Agreement is subjected to the State Ecological Expertise Review at Rostechnadzor in accordance with the law governing the ‘Ecological expertise’. In the case of a positive conclusion, the draft is approved by the RF Government or the Head of Rosatom and comes into force according to the order and term provided in the agreement by the Russian and OC Parties.

The GTGA for the transportation of spent fuel assemblies from the OC to the RF should contain the following provisions:

- Scope of the agreement including disposition of the HLW;
- Competent bodies authorized to perform regulation, surveillance and solve disputes;
- Competent bodies authorized to perform regulation and surveillance for nuclear and radiation safety;
- Competent bodies authorized to perform physical protection of special goods;
- Competent bodies authorized to perform the transportation;
- Transport operations on the territories of the transit countries;
- Order of the shipment of special goods;
- Order of the provision of physical protection of special goods;
- Order and conditions of the transfer of responsibility for fissile materials;
- Define responsibility for nuclear damage caused by nuclear incident;
- Procedure for information exchange.

[5] The OC may decide to leave the HLW in the RF but at the expense of the OC.

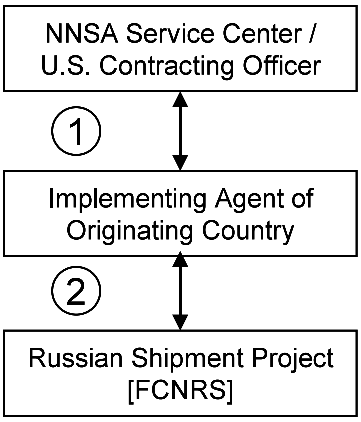
2.3.4. Transit countries (if applicable)

A Transit Agreement is needed between the originating country and those countries along the shipment route (and the Russian Federation in some cases) for the transportation of nuclear materials. If a history of nuclear material shipments exist then it is possible that a transit agreement may already be in place that can be applied to the SNF shipment. However, this should be verified early in the preparations process. The transit agreement should identify the following:

- Define the type of transport for special goods transport.
- List the requirements for the coordination and implementation for the transport of special goods.
- Define the responsibilities for physical protection management.
- Agree to HEU transfer protocol.

2.4. Contracts

2.4.1. United States of America and the originating country



The project to remove, transport, and process the spent fuel and manage the high level waste is implemented through three primary contracts. Each contract is summarized below with the relationships shown in the diagram below.

Contract 1: The contract between the originating country and the DOE/NNSA establishes the originating country as having overall responsibility for the preparation, removal, transportation, processing and final disposition of the spent fuel. This single contract includes all of the activities, broken down by tasks, required to complete the project. Each task has a clearly defined scope of work, activities, deliverables, and cost and schedule. Additional tasks may be added as required, with each task requiring review and approval by the US Contracting Officer (CO).

The contract is a fixed price, indefinite delivery, and indefinite quantity contract. In other words, it is a fixed price contract that uses individual tasks to authorize specific work activities. The parts of the tasks and process for development and approval are listed in the model contract.

Task Description (or also called Statement of Work) **-** The written instrument issued by the US Contracting Officer to the Contractor specifying a certain scope of work to be performed, including task requirements, milestones, period of performance, and reports/deliverables. The task description is prepared (with input from the OC and subcontractors) by the Country

Project Officer (CPO) and is approved and issued by the US Contracting Officer. It is important that the scope of the task is adequately described in the task description. The corresponding contract between the subcontractor and OC should mirror this task description. A sample task description has been included in the publication.

Task Plan **-** The written instrument provided by the Contractor to the US Contracting Officer in response to receiving a Task Description, in which the Contractor identifies any proposed changes to the Task Description, the fixed price for which it will perform the work, and justification of the price. This is a key document and usually requires the most time to prepare (Instructions for completing the worksheets are included in Appendix II). Here, all of the costs associated with the defined scope are broken down into finer detail and justified. The categories of costs that are expected to be included in the task plan are:

- Direct Labour Categories and Labour
- Overhead Costs
- Direct Materials
- Other direct costs
- Subcontracts
- Travel
- Profit
- Taxes

Task Assignment (also known as approved Work Release) **-** The written instrument issued by the Contracting Officer that details individual services to be performed, milestones, deliverables, fixed prices, period of performance, and unique payment provisions, for performance of specific tasks. The task assignment is the final authorization for work and no work should be performed prior to the issuance of the task assignment.

2.4.2. Russian Federation and the originating country

Contract 2: The originating country enters into a contract (General Order Agreement) with the FCNRS for Unified Project activities, the Foreign Trade Contract, and government decrees. For many of the remaining activities required for the return of spent fuel to the Russian Federation, including obtaining regulatory approvals and permits, facility preparations, cask leasing, and processing, the OC directly subcontracts with organizations such as Sosny. If the shipment of the spent fuel requires transit through another country or countries, the originating country will arrange for the contract(s) with the transit country for all transit related activities. This may include regulatory and government approvals, and transportation support.

2.5. Russian Federation preparation activities

In 2007, the Russian government reorganized the nuclear industry structure and, by decree, created the Federal Centre for Nuclear and Radiation Safety (FCNRS). The FCNRS was appointed as the only organization that was authorized to import spent nuclear fuel into the Russian Federation. Previously, Techsnabexport (TENEX) and TVEL were authorized. FCNRS coordinates the import of the spent fuel and Federal State Unitary Enterprise (FSUE) PA Mayak remains as the receipt facility and shipper.

The Federal State Unitary Enterprise PA Mayak belongs to the State Atomic Energy Corporation Rosatom and acts in accordance with Russian Federation legislation as well as the corresponding standard documents and instructions of Rosatom and other organizations pertaining to the security, safety and environmental protection when dealing with nuclear and radioactive materials. Mayak adheres to the firm rules and instructions as well as strict requirements when dealing with the SFA from research reactors to be shipped to the Russian Federation for reprocessing. The enterprise Mayak plays a key role in the return of the spent fuel as the principal facility responsible for performing the 'physical' transportation of the SFA from the originating country to the RF. Moreover, the experts of Mayak, working within the framework of the signed contracts per se, play an important technical role in the SFA shipment performance.

After the signing of a contract with Mayak or one of its agents, one of the first steps for the originating country's facility is to invite the technical experts from Mayak to perform a joint inspection of the SFA to be returned. In parallel, discussions should begin on the coordination of the Unified Project. In the following sections, the Unified Project along with other general requirements determined by the Rosatom, such as document OST 95 10297-95, titled 'Spent Nuclear Fuel Assemblies from Research Reactors, General Requirements to the Shipment', will be described in further detail. Some of the topics to be covered are:

- Requirements to the Spent (irradiated in Russian version) fuel assemblies;
- Requirements to the design and condition of transport vehicles for SFA loading and transportation;
- Requirements for the loading and transport vehicle preparations for the shipment of SFA from a facility;
- Requirements for accompanying documents and shipment preparation;
- The warranties of the Consignor and the Consignee.

This section also includes the SFA specifications for reprocessing and the standard forms for the required documents.

2.5.1. Unified project

A Unified Project (UP) is required for the importation of spent nuclear fuel into the Russian Federation per Russian Law [3]. The Unified Project is a 2001 requirement legislated under the law, 'On Special Ecological Programmes for Remediation of Radio-Contaminated Areas'. The UP is basically an overall assessment of the radiological, economical, social, and environmental impacts to the Russian Federation, particularly the areas surrounding the Mayak Plant (Chelyabinsk Region) [4]. The provisions stipulate that the importation of spent fuel is permitted once a positive decision from the State Ecological Commission of Experts is received. Per RF law [3], the documents that make up the various elements of the Unified Project are:

- Transportation Technological Scheme
- Safety and Environmental Impacts documents
  - Cause-Consequence Analysis
  - Emergency Response Plan
  - Radiation Risks Analysis
  - Technical Requirements Document
  - Environmental Impact Assessment Report
- Foreign Trade Contract (Draft)
- Special Ecological Programmes
- Anti-terrorist Measures
- Public hearing documents
- Transportation and Cask licenses
- Assembled Unified Project package.

An important part of the Unified Project includes the documents that make up the Special Ecological Programmes (SEPs). The requirements for developing the SEPs are defined by RF law [5-8] in the field of nuclear power usage and environmental protection and by the programmes for social and economic development of the RF. The SEPs are used to rehabilitate the radioactive contaminated areas of the territory surrounding Mayak and are financed by the receipt of the SNF from foreign customers. The SEP project covers the following sections:

- Targets/objectives/milestones of programme implementation.
- Description of targeted issue and justification to use SEP to mitigate.
- Programme actions and amounts of funding.
- Anticipated results and social and economic efficiency of the programmes, including health and environmental predictions.
- Programme resources.
- Mechanism for programme implementation and performance monitoring.

The SEPs go through a vigorous review process, with reviews by Rosatom, the Ministry of Economic Development and Commerce, and Medbiokestrem, culminating in a State Environmental Expert Review (SEER) by Rostechnadzor. A positive outcome from Rostechnadzor means that the SEPs can be included in the final Unified Project package.

In the case of the Uzbekistan project, the following timeline was observed Tables 2 and 3.

TABLE 2: TIMELINE OF UZBEKISTAN PROJECT

Date	Actions
January 2004	State Atomic Energy Corporation ‘Rosatom’ of the Russian Federation made a decision on the SEP development agreed with the administration of the Chelyabinsk region.
April 2004	The two SEPs were developed and agreed with the administration of the city of Ozersk and that of the Chelyabinsk region.
July 2004	Public discussion of the SEP projects in Ozersk and Chelyabinsk.
May-October 2004	Consideration of the SEP projects in the RF Ministry of Health.
May-December 2004	Consideration of the SEP projects in the RF Ministry of Economic Development.
January-February 2005	Consideration of the SEP projects in EMERCOM of the Russian Federation.
December 2004 - April 2005	State environmental assessment of the SEP projects.
April-May 2005	Joint approval of the SEPs.

Since each shipment from a different country requires SEPs, the RF has, in order to be more efficient and timely, developed SEPs that covered the shipments from multiple countries. For instance, SEPs were developed and approved for shipments from Bulgaria, Hungary and Kazakhstan. This saves 3 to 5 months minimum from each country's planning process.

Another significant part of the Unified Project is the draft Foreign Trade Contract (FTC) for the processing and storage of the SNF. The draft Foreign Trade Contract contains:

1. The number and type of SNF assemblies to be shipped.
2. The scope and cost of the services provided.
3. Confirmation of the decision by the originating country to accept the return of the high level waste.
4. Total project cost.
5. Durations of temporary and interim storage[6].

FCNRS and the originating country sign the Foreign Trade Contract after the Unified Project is approved by the SEER.

Other documents substantiate an overall radiation risk reduction and environmental safety increase as a result of the Unified Project implementation. These documents also address the storage durations and hazards associated with the products of the reprocessing activities. An additional document titled 'Assessment of Environmental Impact (AEI)', not required at the time of the Uzbekistan shipment Unified Project, is now required by the SEER to be included in Unified Projects. Specifically, the AEI covers:

- Import scope,
- AEI when transporting spent fuel assemblies,
- AEI when managing spent fuel assemblies at Mayak,
- Analysis of the environmental status in the region of Mayak,
    - Temporary technological storage of spent fuel assemblies,
    - Processing of spent fuel assemblies for originating country,
    - Radioactive waste management after reprocessing.

The fourth and final part of the Unified Project is the set of materials used to discuss the SNF importation project with the community members and public organizations in the areas affected by the shipments.

Once all of the required documents are collected into the final Unified Project package, it is submitted by Rosatom to Rostechnadzor for the State Ecological Expert Review. Rostechnadzor prepares and issues an Order to begin the State Environmental Expert Review. This Order defines the SEER's timeline, chair, and members of the expert committee. Once the committee has finished its work and issued an Expert Committee Resolution, Rostechnadzor prepares an Order on the completion of the SEER. This Order is officially forwarded to Rosatom.

For example, in the case of Uzbekistan, the following timeline was observed (Table 3).

---

6 Temporary storage relates to the time between receipt and reprocessing. Interim storage relates to the time period the HLW remains at Mayak before return to the originating country.

TABLE 3. TIMELINE OF UZBEKISTAN PROJECT

Date	Actions
January 2004	Decision was made on preparation of the UP
July 2004	Public discussions on the UP (in the city of Ozersk and the Chelyabinsk region).
June-July 2005	A decision to introduce the SEP into the Unified Project was agreed with the following structures: – Rostechnadzor; – The RF Ministry of Health; – Sanitary and Epidemiological Surveillance; – Administration of the city of Ozersk; – Local authorities of the Chelyabinsk region.
June-July 2005	Consideration/approval by Rosatom of the Russian Federation of the document "*Justification for the Overall Risk Reduction in Radiation Effects as well as for Environmental Safety Increase, When Implementing the Project for Delivery in the Russian Federation of spent fuel assemblies of the research reactor from Uzbekistan's Institute of Nuclear Physics and when performing environmental actions*".
September 2005	Consideration of the Unified Project.
October 2005	State Ecological Expertise of the UP.

Based on the experiences with the RRRFR Programme, the entire Unified Project activity from development to approval requires less than 12 months. This has been somewhat improved with the multi-country SEP discussed in the section above. The cost breakdown of the Foreign Trade Contract is provided in the Table 4 [9]. It is important to note that the costs to manage and handle the SNF in the Russian Federation cannot exceed 70% of the total contract cost. The remaining 30% is devoted to the Special Ecological Programmes.

2.5.2. Approval process and shipment authorization

After the Unified Project is reviewed by the SEER, Rostechnadzor issues a report to Rosatom and FCNRS with the findings. If the Unified Project is approved, Rosatom and FCNRS sign the report agreeing with the findings. Rostechnadzor then prepares the draft decree and submits it along with the Unified Project to the RF Government for approval. The RF Government signs the decree permitting the shipment of the spent fuel and the import license is issued. This allows for the signing of the foreign trade contract, the final step in the RF authorization process.

2.5.3. Fuel characterization

2.5.3.1. Passport data

A technical specification is developed to characterize the spent fuel that is included in the shipment. The technical specification includes the information needed by Mayak to accept and process the fuel and is based on the Russian Industry Standard OST 95-10297-95. The following information must be distributed to Mayak for their review and approval.

TABLE 4. COST BREAKDOWN OF THE FOREIGN TRADE CONTRACT

	Costs	Value, %
1.	**SNF HANDLING**	70.0
1.1	Payments for services of organizations authorized by the Government of the Russian Federation to enter into a foreign trade contact related to the import of spent assemblies into the Russian Federation	1.0
1.2	Customs payments	69.0
1.3	Payments for handling spent assemblies and products of their processing under conditions of the foreign trade contract including the following procedures:	
1.3.1	Shipment of spent fuel assemblies to the Russian Federation for interim technological storage and reprocessing;	
1.3.2	Interim technological storage of spent fuel assemblies;	
1.3.3	Reprocessing of spent assemblies;	
1.3.4	Treatment of radioactive wastes resulted from reprocessing or interim technological storage.	
1.4	Expenses related to implementation of investment programmes (included into the Unified project) aimed at development of production infrastructure of organizations dealing with spent assemblies and products of their processing	
1.5	Payments for services of designing, research and other organizations responsible for development of the Unified project documents	
2.	**SPECIAL ECOLOGICAL PROGRAMMES**	
2.1	Expenses related to realization of special ecological programmes	22.5
2.2	Payments to the budgets of the subjects of the Russian Federation on which the enterprises for SNF processing are located	7.5

Manufacturer data (Passports)

- Reactor type.
- Fuel element types with drawings.
- FA type with drawings. It is necessary to modify drawings in concordance with present condition of SFA in case of deviation of present dimensions from initial.
- Number of FA and fuel element drawing.
- SFA factory number.
- Country and manufacturer of fuel element.
- Country and manufacturer of FA.
- Date of FA manufacturing.
- Mass of FA fuel composition, g.
- FA mass by its passport, g.
- Initial enrichment on U-235, %.
- Initial mass of uranium isotopes sum, g.
- Initial mass of uranium-235, g.
- Material of fuel composition (chemical form).

- Physical form of fuel composition (powder, pellet, etc.).
- Material of fuel element cladding.
- Material of SFA wrapper and other structural components.

Operation data

- Date of loading of FA in reactor.
- Date of unloading of FA from reactor.
- FA nominal power, W.
- Real reactor power, W.
- Minimal quantity of FA in reactor.
- SFA cooling time after unloading from reactor, months.

Data from calculations

- FA burn up, MW(d)/kgU.
- Calculated mass of U-232 in SFA, g.
- Calculated mass of U-233 in SFA, g.
- Calculated mass of U-235 in SFA, g.
- Calculated mass of U-236 in SFA, g.
- Calculated mass of U-238 in SFA, g.
- Total calculated mass of uranium isotopes in SFA, g.
- Calculated mass of Pu-238 in SFA, g.
- Calculated mass of Pu-239 in SFA, g.
- Calculated mass of Pu-240 in SFA, g.
- Calculated mass of Pu-241 in SFA, g.
- Calculated mass of Pu-242 in SFA, g.
- Total weight of plutonium isotopes in SFA, g.
- Calculated mass of Th, g.
- Calculated mass of Np, g.
- Calculated mass of fission products, g.
- Residual decay heat of SFA, W.
- Calculated activity of fission products, Bq.

2.5.3.2. Mayak spent fuel acceptance criteria

The major regulations and documents that regulate the technical aspect of acceptance of RR SNF at PO Mayak are listed below:

- Industry Standard OST 95 10297-95. Spent Nuclear Fuel Assemblies of Nuclear Research Reactors. General Requirements for Delivery.
- Regulations for Process Conditions for Receipt, Storage and Processing of SNF.
- Certificates/Permits for TUK-19 and Skoda VPVR/M for Container Design and Shipment of SNF.

The nomenclature of research SFA subject to removal and processing at RT-1 plant is listed in the Industry Standard, specified in the plant Regulations for Process Conditions and indicated in the Certificates/Permits for the casks to be used.

The following is needed to conduct handling of SFA of other types:

- availability of a process for processing a specific type of SNF;
- applicability of the material handling diagram for handling SNF currently in use at the plant or a possibility to modify it for a specific type of SNF;
- availability of transport equipment.

No technical problems are expected when shipping TVR-S (small units of a heavy-water reactor) SFA in the contained form. However, if this fuel is shipped in its natural form (in the form of small units) or in available aluminium storage containers, serious technical measures shall be taken at RT-1 plant in order to adjust the material handling diagram.

The industry standard determines also major requirements for the physical conditions of the SFA shipped. Spent fuel assemblies shall be checked for air-tightness of fuel element shells by using a procedure concurred by the scientific advisor or chief designer of the reactor installation and processing facility. The procedure shall ensure detection of FAs characterized by defects resulting in a contact of the fuel compound with storage water and heating liquid located in the cask.

SFAs subject to delivery shall not have:

- structural integrity damages, i.e., they shall not be torn, cut-off, melted, etc.;
- significant deviations of geometric shape/dimensions and damages complicating loading/unloading of spent FAs to/from the overpack according to the standard process;
- gripper damages that prevent regular operation of the respective tools;
- loss of fuel element air-tightness resulting in a contact of the fuel compound with SNF storage water and heating fluid in transport packing containers (micro defects of fuel element shells corresponding to shell ‘permeability for gases’ are allowed);
- sludge and other surface contaminants.

SFAs that do not meet the aforementioned requirements may be delivered under individual specifications (the delivery may be accompanied by a modification of the makeup of the material handling equipment used). Upon completing the design, these specifications shall be agreed upon by the concerned parties and approved by Rosatom of the Russian Federation upon completion of the safety analysis for all steps of handling SFAs.

One should also mention two important points (positions) in the above mentioned document of standards (OST):

- Those standards are subject to be applied for SFA from research reactors placed within the territory of Russian Federation;
- The shipment of SFA which are not satisfying the OCT requirements and standards can be done only under specific technical conditions developed and elaborated for given case in accordance with existing regulations in the Russian Federation.

It should be underlined that the discussed OCT standards have very limited nomenclature of SFA to be accepted for shipment and in practice that requires developing separate technical conditions for each particular project, which means that it is almost impossible to have the pattern technical form fitting all cases.

Based on results of the technical specifications review and the design of the transport packing unit, the permissible characteristics are determined for the SFA to be exported. They should be given in form of table referenced in the technical specifications and certificate of the transport packing unit design. An example of the table with permissible characteristics of SFAs exported from Uzbekistan is given below (Table 5).

Table 5. MINIMUM COOLING TIME FOR SFA IRT-2M AND IRT-3M LOADED INTO THE TUK-19 CASK BASED ON BURN-UP

Тип ТВС Type of FA (fuel assembly)	Начальное обогащение топлива по урану-235, % Initial fuel enrichment by U-235, %	При перевозке восьми упаковок в вагоне ТК-5, дооборудованном дополнительной радиационной защитой Shipment of 8 packages in a railroad car TK-5 with additional radiation protection		При перевозке восьми упаковок в вагоне ТК-5, без оборудования дополнительной радиационной защитой Shipment of 8 packages in a railroad car TK-5 without additional radiation protection	
		Глубина выгорания топлива, % Burnup fraction, %	Время выдержки, год, не менее Holdup time, year, not less than	Глубина выгорания топлива, % Burnup fraction, %	Время выдержки, год, не менее Holdup time, year, not less than
ИРТ-2М IRT-2M	36	до 30 up to 30	4	до 30 up to 30	4
ИРТ-3М IRT-3M	36	до 50 up to 50	3.5	до 50 up to 50	9
		от 50 до 60 50 to 60	4.5	от 50 до 60 50 to 60	10
ИРТ-3М IRT-3M	90	до 64 up to 64	6	до 56 up to 56	8
				от 56 до 64 56 to 64	9
		от 64 до 74 64 to 74	8	от 64 до 70 64 to 70	9.5
				от 70 до 74 70 to 74	12

Inspection criteria

Visual inspections are carried out by reactor staff and Mayak experts. The following information is recorded from the visual inspections.

1. SFA identification number (ID);
2. Number of fuel elements;
3. Number of bevels (if applicable);
4. Presence/absence of the gripping head;
5. The condition of the gripping head, damaged or not;
6. The presence/absence of oxides on outer surface;
7. Presence/absence of foreign objects on outer surface (particles, thermocouples, etc);
8. Presence/absence of visible deformations;
9. Pass/not pass through the test stand;
10. Presence of corrosion on outer surface [%];
11. Type of corrosion;
12. SNF suitable for transportation (yes/no) based on the parameters 9 determined above.

Failed fuel considerations

If as a result of the visual inspection, the cladding of a SFA is found to be breached and the assembly is identified as ‘failed’, the SFA is required to be placed into a special canister prior to shipment.

Decision of canister leakage should be made after radiation safety justification as for SFA package transportation and for temporary interim storage of SFA canisters in Mayak storage. Canister design should be agreed with the Mayak specialists. General canister requirements should be formulized as follows:

- The design and technical state of the canister must provide the ability of manual transportation by hook. In upper part of canister should have an ear with a gap not less than 3 cm.
- A canister should be done from stainless steel, wall thickness of 0,5÷2,0 mm, lid and bottom may have nozzles with tighten elements to draining and filling with inert gas Lid and bottom thickness may be not more than 10 mm.
- Canister dimensions should be appropriate to selected basket cell: if canister is to be reprocessed together with SFA, the outer dimension of canister will inscribed in a circle with a diameter of 180 mm. The length of canister - from 0.5 m to 3.5 m.
- Water presence in liquid form in a sealed canister at positive temperature range (in °C) is not allowed. Method of draining quality determination should be agreed with Mayak.
- Sealing of canister should be provided by welding. Canister lid may be closed by rubber or other proper (radiation and chemical resistant) material. Canisters should be tested by leakage method agreed with Mayak.
- Canisters to be loaded into basket should not have:
    - Damages in the design integrity.
    - Geometry, dimensions and damages making the standard loading/unloading procedures more difficult.
    - Deviation from standard geometry (tested by method of passing through a gauge, the size of which is equal to the basket cell).
    - Damages of the gripping device preventing its normal operation.
    - Leakage leading to the contact of fuel composition with the cooling pool water and coolant in the package.
    - Sludge or other contamination on the surface.
- Each canister with SNF in form different from SFA should have passport similar to SFA passport.
- Each canister should have resistant mark, references to canister number and uranium enrichment.
- Failed fuel canisters have been used to package loose intact rods for shipment.

2.5.4. Mayak facility acceptance requirements

2.5.4.1. Mayak facility safety analysis

Currently, the safety analysis of the Mayak facility includes all of the Russian research reactor fuel types in inventory in the RRRFR Programme. Spent fuel assemblies that differ from the standard assembly or assemblies that have been encapsulated may not be included. It is recommended that all fuel characterization data be submitted to Mayak well in advance to verify compliance with the safety analysis and allow sufficient time for safety analysis revisions.

2.5.4.2. Operational readiness

Cask acceptance

Removal of SNF from domestic research reactors shall be conducted by using TUK-19 and Skoda VPVR/M containers that are characterized by limited capacity. If additional cask types are to be used in the programme, they must be licensed in the OC, TC, and RF, as well as, meet the minimum requirements of Mayak.

The following criteria should be formulated as basic technical criteria for using TUKs and transport equipment of foreign manufacture to ship SNF to FGUP PO Mayak:

1. Usually, SNF shall be shipped over the Russian territory by rail.
2. Transport equipment (a special railcar) shall be provided with an option for interchanging wheel pairs of Russian and European standards. It is preferable to use the standard rail trucks.
3. A mass of the transport packing containers designed without overpack and used for item-by-item unloading shall be no more than 15 tonne (shock absorbers are not included). A weight of the loaded overpacked baskets (if any) included to the cask makeup shall be no more than 15 tonne.
4. Overall dimensions of the casks designed without overpack and overpacked baskets unloaded from the casks shall be no more than 3500 mm (height) and 1500 mm (diameter of the horizontal circle surrounding the item).
5. When using heavy containers of enhanced capacity, a provision shall be made for using a loading/unloading process based on use of an interim container that meets the aforementioned requirements. A mass of the heavy container shall be no more than 125 tonne.

In order to develop and implement a material handling diagram for handling casks of foreign manufacture at FGUP PO Mayak, it is needed to provide timely design documents for the cask and transport equipment.

If long-term use of new casks for shipment at/to FGUP PO Mayak is expected, an issue with modification and re-certification of special railcars used by the enterprise may be reviewed.

Currently, there are no dry storage facilities at FGUP PO Mayak. Therefore, a provision shall be made within the scope of this project implementation for timely unloading of the casks and providing regular interim storage of SFAs in the basin/storage followed by processing.

The design and physical condition of the package must ensure the following:

- Its nuclear safety.
- Loading, location and unloading of the basket (empty and loaded).
- SFA protection from external mechanical, thermal and other influence under normal and accidental shipment conditions.
- Radiation safety of the personnel, public and environment.
- Prevention of radioactive content release to the environment above the prescribed limit.
- Capability of sealing.
- Capability of customs examination.
- Capability of identification.

Cask marking is included:

- Proper shipping name
- Labels (Radioactive White I, Radioactive Yellow II, or Radioactive Yellow II, Fissile Material, and Radiation Trefoil)
- Sign of radiation danger.
- Package mass.
- Package type.
- Identification of certificate.
- Serial cask number (given by the manufacturer).
- Cask designation and cask type.

Additional requirements to cask shipment preparation:

- Preparation for package shipment is performed on basis of TS in accordance with the package handling technology elaborated specifically for the given type of the fuel and with the technology of SFA handling at the reactor.
- Before the transport departure from the loading room the package containing SFA must undergo leakage test in accordance with the operating manual. A leakage test report must be filled with the test results.
- Representatives of the reactor facility and IAEA (and Euratom, if appropriate) before the transport departure must seal packages loaded with SFA. The data of the sealing are recorded in the accompanying consignment and shipping permission bill of departure.
- Packages with SFA ready for shipment are provided with removable labels characterizing the degree of the package radiation hazard. The labels are made and positioned in accordance with NP-053-04.

SFA should be cooled within the time period not less than that indicated in the certificate for the package design.

Basket acceptance

The design and technical state of the basket must provide the following:

- Free SFA loading by gravity and allocation from basket.
- Free insertion (and removal) of the basket into the cask.
- Not exceed maximal admissible gross weight – 450 kg.
- Nuclear safety during SFA shipment.
- Positioning of SFA and canisters so as SFA head and cask gripping parts located at one level for visualization during pointing and catching of SFA or cask (if necessary it is required vertical spacers).
- Effective placing of SFA and canisters during normal transportation.
- Simple and safe SFA removal from basket.

The basket should be loaded with SFA of the same design and enrichment (HEU and LEU separate). Their characteristics should correspond to the certificates for package design and transportation. A passport is issued for the basket loaded with SFA and it is accompanied with a cartogram of the basket loading.

Basket marking includes:

- The orientation mark of SFA location according to loading map. The orientation mark is an arrow near one of the basket handling hooks. The mark defines the first cell of the outer row - the beginning of numeration of basket cell. Cell numeration goes from left to right in row and from top to down in columns.
- Serial basket number (given by the manufacturer).

Cask and fuel handing equipment

Currently, Mayak has the equipment and tools to receive, unload and handle the spent fuel that is transported in TUK-19 and SKODA casks. All of the fuel types in inventory can be handled provided that the assembly top bail is in intact and the fuel is not damaged. If an assembly requires encapsulation, Mayak should be notified so that the appropriate handling tool may be fabricated for use in the Mayak facility.

2.5.5. Cask licensing in the Russian Federation

In the Russian Federation, casks transporting radiological materials must be licensed for both design and transportation [5]. The design licenses for the TUK-19 and Skoda VPVR/M casks have already been issued for most of the fuel types in the scope of the RRRFR programme. However, the transportation license is shipment specific and a new or amended license will be required for the shipment to Mayak. The transportation license includes information such as: duration of the shipment; actual radioactive content; mode of transport, vehicle type and route planned; emergency card information; and proposed shipment category to name a few. VNIIEF (Sarov) and VNIPIET (St. Petersburg) are the authorized organizations of Rosatom responsible for the certification of packages for SNF storage and transportation. The time needed to obtain the transportation license is three to six months.

According to the 'Temporary procedure of the issuing of certificates for radioactive materials of special kind, design and transportation of packages with radioactive materials' (Russian regulatory document PVSR-92), the following organizations take part in the preparation of these certificates:

- VNIPIET, VNIIEF that deal with preparation of draft certificates for the package design and SNF transportation;
- IPPE (Nuclear Safety Department) that deals with expertise of means and conditions related to the nuclear safety and preparation of the relative justification to prepare the certificate.

The accredited expert centres within Rosatom mentioned above have the status of system working organizations. Rosatom forwards the applications for certificates of approval to certain organizations, i.e. working organizations, for their expert review. These working organizations, with the appropriate accreditation, organize and perform real tests, design verification and expert analysis of the transport container under the corresponding application.

In the case of a positive expertise result, the working organizations prepare the draft certificates and other documents for Rosatom and for approval by the Regulatory and Technological Review organizations. Certificates on the transport containers are issued for compliance with requirements of both national regulations on radioactive materials transportation and the IAEA safety regulations for radioactive materials transportation (ST-1 and TS-R-1). In the Russian Federation all types of certificates listed in the IAEA safety regulations for radioactive materials transportation are subject to review. In accordance with the regulations in the Russian Federation all transport containers are subject to certification, including foreign packages if used within the territory of the Russian Federation.

The list of documents required for obtaining certificates on the transport containers, their design and transportation are given below. The application shall include the following:

- Detailed description of radioactive material, for transportation of which the specified package is designed for, indicating its chemical composition, physical state and radiation characteristics
- Maintenance and operating manual of the package operation
- Technical project (design documents) of the package, including a list of materials used, data on the testing and calculation results, time of radioactive material encapsulation in the package. Information on construction materials used for the sealing system
- Instructions and justification on assumptions of the SFA characteristics made in the process of the package design and analysis
- Any special location conditions required for the safe heat removal from the package; types of proposed transportation means shall be specified
- Explanatory note with justification of fulfilling each requirement of regulations on the package design
- Quality assurance programme implementation during the package designing and manufacturing
- List of standard technical documentation to be used for the package handling
- Scheme and specification of the package location in the means of transportation
- Description of materials filling the package cavity
- Validity of the certificate
- Proposed route of transportation
- Number of the standard emergency card and category of transportation

The final approval of license requires the positive conclusions of nine organizations.

2.5.6. Sample documents for the import of SFA to the Russian Federation

The main document prepared jointly by Mayak and the facility-origin (exporter) is the Specification of SFA to be imported into Russian Federation – the sample of such a document is shown below.

Examples of the main documents to be prepared by Mayak and the originating facility have been provided in Appendix V.

№ п/п No.	Тип реактора Reactor type	№ чертежа ТВС Drawing No.	№ ТВС IFA No.	Тип ТВС (кол-во ТВЭЛ) IFA type (number of fuel rods)	Начальное обогащение, % Initial enrichment, %	Исходная масса изотопов урана, г Initial mass of U isotopes, g	Исходная масса урана-235, г Initial mass of U-235, g	Дата загрузки в реактор Date of loading into the reactor	Дата выгрузки из реактора Date of unloading from the reactor	Глубина выгорания, % Burn-up fraction, %	Расчетная сумма изотопов урана, г Estimated sum of U isotopes, g	Расчетная сумма урана-235, г Estimated sum of U-235, g	Расчетная масса изотопов плутония, г Estimated mass of Pu isotopes, g	Остаточное тепловыделение ТВС на момент загрузки в ТУК, Вт Residual heat of IFA at the time of loading into the package, W	Вес ТВС, г Weight of IFA, g
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

2.6. Originating country preparation activities

The originating country preparation activities can be divided into two large categories: the legislative and the ‘physical’ performances. The first category includes the preparation and receipt of all legal documents necessary for the shipment (export) of the SFA in accordance with the legislation of that given country; while the second covers the concrete measures on the physical aspects regarding the shipment of SFA. No doubt that the basics of legislation for the shipment of SFA can be (and is!) different from country to country requiring various procedures, e.g. approval by parliament, as in some countries. In this chapter we review the experience gained in Uzbekistan from the shipment of SFA to the Russian Federation and this can be useful in terms of identifying the necessary preparatory works, some of which can not be ignored. On the other hand in addendum one can find description of preparatory works done in Nuclear Research Institute in Rez (Czech Republic), see also [9,10].

2.6.1. Legislative requirements

2.6.1.1. Contracts with foreign organizations

In the framework of the signed agreements between the USA, Russian Federation and IAEA on the return of Russian-origin spent fuel there should be two main documents in place in order to start preparatory works on shipment of SFA to the RF:

- The bilateral agreement between the originating country (exporter of SFA) and the Russian Federation on the cooperation in the field of peaceful use of atomic (nuclear) energy (or equivalent). The responsible Russian organization is Rosatom.
- The bilateral agreement on peaceful use of atomic (nuclear) energy (or equivalent) between the originating country and the USA. The authorized organization in the USA is the Department of Energy.

As the agreements are not a prerequisite, the first step is to send the official letter (diplomatic note) to Rosatom declaring the intent of the originating country to return the spent fuel from the research reactor within the Russian Research Reactor Fuel Return programme.

After receiving the positive response from Rosatom, the OC nominates the official contractor, which can be either facility or another corresponding governmental organization. Once approved by OC officials, the contractor immediately should sign the three following important and necessary contracts:

- The contract with the US DOE, or designated alternate such as a National Laboratory, on the subject of research reactor fuel return programme performance.
- The contract with the FCNRS (or ‘Sosny’) on the preparation of unified project on SFA export from the OC to the Russian Federation, carrying out ecological assessment of that project, obtaining necessary permissions and certificates, and, in case of transit through the third country, the obtaining of license for transit. The important part of that contract is the obligation of the Russian side in preparation of the special Decree of Russian government on the acceptance of SFA from the OC. That decree gives, in fact, the green light for succeeding steps.

The third contract (on export-import operations) should be signed with Rosatom organization FCNRS.

Depending upon the originating country laws and governmental structure, several state ministries, state committees and related organizations, including those which will be providing physical security works, can be involved in the implementation of the RRRFR project. In the case of Uzbekistan, the special decree of the Uzbekistan Cabinet of Ministers was released and that significantly facilitated the solution of local problems and many other formalities.

2.6.1.2. Local authorities

In accordance with the legislation and regulations of given country for the export of spent fuel assemblies the related documents and formalities should be completed. For example in case with Uzbekistan the following document has been prepared:

‘Programme of the Shipment of Spent Fuel Assemblies from Reactor of Institute of Nuclear Physics (Uzbekistan AS) to Russian Federation’

This programme was one of the most important documents and was approved by the State Committee on Safety and Mining (in case of other country it can be corresponding regulatory body nominated by government) as a guidebook which covers all necessary steps to export SFA. In particular, the subjects covered in that programme included:

- Main paragraph, which describes the reason for transportation, programme development, objective and area of action of the programme;
- Information about acting parties;
- Information about contracts, corresponding letters and notes exchanged by parties;
- The list of persons involved in the project and their personal responsibilities;
- Information about possibilities of transportation (rail, air, or highway) and detailed description of how the spent fuel will be transported to the Russian Federation including cargo description, packing (containers), means of transport, content of cargo, the total volume of transportation, transportation survey, physical protection and safety conditions during transportation;
- Information on accident prevention, including provision of nuclear safety and radiation protection as well as common safety during transportation from the Institute to railway station, while loading SFA and containers;
- Physical protection, including facility area, transportation of cargo to railway station and protection of train on the way from the railway station till the border of a country;
- The physical condition of roads, bridges and other constructions along the route of transportation to railway station, e.g. one truck with two TUK-19 containers weighs more than 20 metric tons (in case of using Skoda containers it would be about 30 tons); from the security and safety points of view there should be at least two approved routes to transport SFA from facility to railway station and very limited number of involved people should know which route will be used as well as one must avoid, if possible, transportation through heavily populated areas;
- Measures on possible accident elimination during loading and transportation, and, in case of accident, follow up actions depending on the type of accident;
- The permanent control and provision of radiation and nuclear safety during loading and transportation and follow up actions in case of emergency.

In accordance with the requirements of local authorities the abovementioned programme contained 22 separate documents including the following principal ones:

- ‘Emergency Card #2’
- ‘The Order of Notification in Case of Accident’
- ‘Follow Up Actions in Case of Accident’
- ‘The Order of Communications’ etc.

The Uzbekistan State Inspectorate on Safety in Industry and Mining also required the following documents:

- Approval by the country Inspection Committee of Nuclear Safety ‘Instructions for loading SFA onto trucks’
- Instructions for loading onto train cars
- Timetable of loading containers onto train cars
- Packing instructions providing radiation safety
- Transport index of packages determined by sender
- Loading identification number
- Loading number in accordance with UN classifications
- Number of assemblies in one basket
- Number of baskets in one container
- Number of containers in one car
- Contents ownership information
- Total amount of shipping SFA
- Approved by IAO ‘Instructions for personnel actions in case of accident’
- The list of equipment for radiation control.

And, last but not least, one should obtain on the basis of abovementioned documents the ‘License of the State Inspectorate on Safety in Industry and Mining for the Rights to carry out works on shipment of SFA from the research reactor of facility to Russian Federation for reprocessing’ as well as certificates allowing the use of a given type of containers, namely TUK-19 (which were used in transportation from Uzbekistan).

After receiving official approvals from the relevant governmental organizations, one can start the works on the preparation of sending SFA to the Russian Federation. The facility should also: sign additional contracts and/or agreements with local organizations which will be providing the rail (or air) routes for the transportation of train with SFA on the territory of the originating country; provide physical protection till the border of the originating country; and provide logistics, safety and security while the special train, sent by the Russian side (MAYAK), is parked on the siding.

The special measures should also be taken in order to provide safety and security in case of fire, earthquakes and other disastrous phenomena.

2.6.2. Facility preparations

2.6.2.1. Spent fuel preparations

First of all the facility must have a spent fuel database that contains sufficient data and parameters, in order to characterize the SFA. The data should include:

- SFA factory name, production number and date,
- Physical dimensions: mass,
- Type of fuel, content of isotopes, enrichment, history of use, burn-up coefficient,
- Cooling time used in the isotope calculations and/or absolute numbers of isotope content in the given fuel element or assembly. (See also the chapter on Mayak requirements).

Secondly, each SFA should go through a visual inspection of physical condition (check for scratches, cracks, examine if it is swollen or has mechanical deformations due to heavy radiation etc.). It is also recommended that a joint team formed from representatives of the originating country and Russian experts representing the SFA accepting organization, e.g. Mayak (or 'Sosny') enterprise, examine the condition of each SFA.

Thirdly, the abovementioned joint group after careful examination of each SFA should determine the priorities of shipping SFA and prepare the list of highly enriched SFA or elements to be sent in accordance the shipping plan. One must note that in accordance (see the chapter about requirements of Mayak) with existing instructions undamaged highly enriched SFA should be shipped first. The damaged SFA are the subject for special negotiations and require additional preparatory works.

In fourth, based on the results of examination and shipment plan, all the SFA should be rearranged in the storage pool to facilitate loading efficiency and reduce loading times.

After the SFA shipment plan is finalized, the export and customs procedures should be initiated in accordance with the applicable regulations. In parallel, the passport data for each SFA to be returned must be reviewed and confirmed. It is necessary to have complete data about the content of the isotopes of uranium, plutonium, the level of radiation, the decay heat etc... This data must be based on the results of direct measurements as well as on the calculations in accordance with standard existing software programmes and confirmed by joint Mayak experts. For example, the measurements can be done by use of the gamma-spectrometer consisting of an HPGe detector and multi-channel analyzer provided by Genie-2000 programme package. For local activities the most important document is the detailed plan of preparatory works and tasks confirmed and approved by all contracting sides.

2.6.2.2. Facility area preparations

The spent fuel storage facility should be configured to support container loading with the following considerations:

- The facility must have a crane with sufficient capacity to lift a fully loaded TUK-19 cask (weighs approximately 5.5 tons) or the Skoda VPVR/M cask (weighs 12.4 metric tons). If such a crane is not available at a facility a mobile crane which can lift at least 15 tons of cargo to the height not less than 8 meters should be used (in case of transportation by special train sent by Russian side).
- There should be enough space for safe operation of the crane.

- There should be enough lighting for safe operations during the loading.
- In order to avoid possible unexpected cut in energy supply one must have at facility at least one additional and independent source of energy which automatically turns on in case of the loss of electricity. In the case of the Uzbek shipments a 45 kW•t electric backup generator was used to provide power to all vital elements of loading operation.
- the loading area should be equipped with video cameras (remote if loading in-air) allowing the operator to observe the whole loading operation from different positions; in addition, at least one video camera should be installed onto the crane allowing the operator to control all actions while reloading the SFA from storage pool into container.
- IAEA provide 24-7 coverage of spent fuel pool and loaded casks to provide 100% safeguards during the loading operations.
- The loading/reloading area (the reactor hall in many cases) should have a floor covering which allows for simple decontamination. Some reactors have smooth, removable floor coverings while others have chosen a non-removable epoxy specifically designed for nuclear applications.

FIG. 3. Basket Grapple used in Uzbekistan project

- A special automatic device (grapple) with remote control capability should be designed and manufactured (Figure 3 where the cradle made in Institute of Nuclear Physics is shown) in order to engage and release the fuel basket. This was required in Uzbekistan since the fuel was loaded into the cask in air. The basket was allowed to drip dry for 15 – 20 minutes to remove excess water.

During the reloading of SFA at the facility, special care should be taken in providing adequate physical protection of the loading area and loaded containers. One should be reminded that the TUK-19 containers, vertical cylinders, are normally carried in the vertical position and, may require special metallic frames for transportation by trucks. These were designed and fabricated by INP (Figure 4). Special ISO containers have been designed for future shipments of the TUK-19 casks by air and sea. In this case, the special frames for truck transport are not required.

FIG. 4. TUK-19 Transport Stands.

2.6.2.3. *Radiation safety*

Since the spent fuel emits intensive radioactivity, special precautions should be taken to provide radiation protection of personnel involved in the loading, unloading and transportation of SFA. In order to minimize the amount of absorbed radiation one should have at least three teams formed from personnel having long time experience of working in radiation conditions and knowing well the duties and work to be done under such conditions.

First, adequate radiation monitoring of the SFA storage facility (the reactor hall in the case of Uzbekistan) must be in place. Expected dose rates should be calculated and incorporated into the loading plan. This activity should be done well in advance before shipping. This results in a 3D-map of radiation levels and helps to determine the working limits of time and distance. However, during the loading of SFA from the pool into container, permanent radiation monitoring in the area close to SFA pond must be provided. In addition, each person must wear a personal radiation badge and be fully equipped by special clothing, masks, protective glasses and helmets in accordance with the rules and instructions of working in radiation conditions. All personnel must carry individual dosimeters (e.g. mini-dosimeters like Rados-60 or DPG-03)

Secondly, each of the selected staff members should have clearly defined assigned duties (specific job, location, and time). In case of emergency, they should have additional obligations. The ‘two person rule’, when one staff member can substitute for another if necessary, should be implemented.

Thirdly, in order to avoid incorrect measurements, an independent radiation control group, assigned by the regulatory body, should monitor the radiation levels throughout the loading and shipping process.

One should note that each reloading and shipping operation of SFA is to be attended by the IAEA safeguard’s inspectors who, in addition to sealing the loaded containers, independently verify, via measurement, that each fuel assembly was spent fuel. In the Uzbek case, the measurements of assembly activity were carried out with the use of a gamma-spectrometer consisting of an HPGe detector GC 1518 and multi-channel analyzer InSpectrometer-2000 (Canberra).

While loading the SFAs into the containers the dose rate measurements were carried out at distances of 10, 5, 2, 1 and less than 1 meter. In accordance with international standards, the surface of each TUK-19 container cannot have radiation levels that exceed 2.0 mSv/h. In our case, the measured value was less than 0.5 mSv/h which was consistent with the expected 0.4 mSv/h obtained from calculations. Thus, the radiation safety requirements were completely fulfilled. It should be underlined that the results of gamma-radiation calculations as well as decay heat calculations are very important from the point of view of cask loading. For example, in one TUK-19 container, it is permitted to put four SFA with different radiation activities, burn-up and decay heats providing the upper limits of allowed radiation and total decay heat are not exceeded. Documents for each container should be prepared indicating dose rate, neutron flux and surface contamination.

The loading of containers with SFA should be done in the presence of IAEA safeguards, Euratom inspectors (if an EU shipment), and local customs representatives (if required) who will verify and confirm the quantities of the cargo to the declaration papers.

After loading, each container's seal must be checked for tightness. In the Tashkent case, the seals were checked using the Helium-leakage method. The necessary hardware and equipment for this was brought by MAYAK representatives. After loading is completed, the required Mayak forms must be filled out (Appendix VIII).

2.6.2.4. Additional parameters of spent fuel assemblies

As previously discussed, the physical parameters for each SFA should be provided. By the requirements additional information, including data on the fuel burn-up, the results of the plutonium content calculations and decay heats for each SFA should be provided.

2.6.2.5. Transportation requirements

Depending on the capabilities of a given facility different methods can be utilized for transporting the containers from the facility to the railway station or airport. It should be noted that only four IRT type SFA will fit in one TUK-19 container (SKODA type container fits more than 36 SFA at one load) and the railway car holds 8 containers. It means that facilities with large inventories of SFA to ship, several trips will be necessary from the facility to the railway station. Laws and rules for transportation of dangerous materials vary among the different countries but there are general common rules:

- Ensure safety while transporting;
- Provide physical protection for convoy and cargo;
- Provide safety and physical protection while reloading of SFA from the trucks to railway car;
- Provide physical protection for the fully loaded train until it leaves the railway station;
- Provide physical protection and safe passage of train up to the border of the originating country;
- Provide continuous radiation control of containers, trucks and railway cars.

While selecting the cranes, trucks and identifying the routes (bridges etc.) one must remember the total weight of one loaded truck and its height including containers and other parameters to ensure that there are no obstructions. Also while transporting from the facility to the railway station, the local authorities should provide full safety and security for the whole convoy.

Normal transportation of containers with SFA from the facility to the destination (railway station, airport or sea port) should follow the country's regulatory requirements. This may include but is not limited to:

- Security forces;
- Reactor staff;
- Radiological control inspectors;
- Emergency response personnel.

2.6.2.6. Necessary equipment

For implementing similar projects, the facility should have the minimal sets of instruments and machines available as well as equipment for radiation measurements, monitoring and spectroscopy (for example, System 8004-01, Pelican, UIM -2-2, the personal dosimeters like Rados-60 and DPG-03, spectrometers both portable and stationary, e.g. FH-40G, Target etc.).

2.6.3. Training

The training of personnel is one of the most important parts of facility preparations for the shipment of SFA with the main goal of all exercises to reduce all possible risks related to radiation safety, nuclear security, and physical protection etc.

The training of personnel should include the following:

- Radiation control and monitoring;
- The response of personnel in case of higher than expected radiation;
- The use of remote equipment and video survey;
- Loading of the SFA into the basket of the container, personnel actions in case of failure e.g. the dropping of a basket with SFA into the pool or on the floor. Unexpected cut-off in energy supply while reloading SFA, the use of video cameras by crane operator, the stationary crane failure and use of the backup mobile crane, sudden attack of extremists, sabotage action from outside or personnel;
- Loading of container onto truck, personnel actions in case of dropping of container on the floor, radioactive contamination;
- Transportation of containers from the facility to the railway station; personnel actions in case of a road accident, container falling off of the truck, extremists attack of convoy (training together with security forces), vehicle failure, fire, bad weather (snow, rain storm, strong wind etc);
- Reloading of the containers from trucks to the railcar, failure of mobile crane, dropping of the container, extremists attack;
- Accident with personnel due to carelessness or other means.

There should be at least two complex trainings attended by all staffs to be involved in the transportation procedure including special security forces provided by the government for physical protection.

2.6.4. List of documents used during preparatory works at INP

1. Main safety regulations and physical protection in transportation of nuclear materials, 1983 (OPBZ-83).
2. Safety regulations in transportation of radioactive materials. IAEA (TS-R-1).
3. Sanitary regulations and codes ‘Health requirements on radiation safety’, 1994 (SanPin-№ 0029-94). RUz.
4. Organizational management rules on liquidation of accident consequences on transportation of radioactive materials by railroad transport, 1999 (PLAJT-99).
5. Certificate-permission on package design TUK-19, # RUS/0107/B(U)F-96, prepared and certified by Leading Research Institute of ROSATOM – All-Russian Design and Research Institute of Complex Energy Technology.

6. Certificate-permission on transportation of package TUK-19, # RUS/0107/B(U)F-96, prepared and certified by Leading Research Institute of ROSATOM – All-Russian Design and Research Institute of Complex Energy Technology.
7. Annotation report 'Analysis of requirements distinction IAEA regulations TS-R-1 from OPBZ-83, calculation of strength and thermal conditions of package TUK-19 with SFA IRT-3M and IRT-2M. Development of report parts on safety packing of SFA', prepared by specialized organization ROSATOM – 'Deimos LTD', St. Petersburg.
8. Design documentation on 'Transport package complete with container 19'. Technical description and instructions on exploitation, D.65.009.000 TO, All-Russian Design and Research Institute of Complex Energy Technology.
9. Design documentation on 'Transport package complete with container 19'. Technical terms, D.65.009.000 TO, All-Russian Design and Research Institute of Complex Energy Technology.
10. Characteristics and description of TUK-19 and TK-5 car, # 0977-56/2004 All-Russian Design and Research Institute of Complex Energy Technology.
11. Radiation and nuclear safety calculation of TUK-19 with SFA of research reactors # 0977-57/2004, All-Russian Design and Research Institute of Complex Energy Technology.
12. Technical condition check programme of TUK-19, TUK-42 and TK-5 car, inv. # 12015 All-Russian Design and Research Institute of Complex Energy Technology.
13. FA, spent in nuclear research reactor WWR-SM, Institute of Nuclear Physics Academy of Science of Uzbekistan. Delivery to regeneration plant in the Russian Federation. Technical terms, #0977/48-2004, All-Russian Design and Research Institute of Complex Energy Technology.
14. Modification #1 to technical terms #0977/48-2004, 'Fuel assemblies, spent at the nuclear reactor WWR-SM Institute of Nuclear Physics Academy of Science of Uzbekistan. Delivery to regeneration plant in the Russian Federation (document was prepared and certified by Leading Research Institute of ROSATOM – All-Russian Design and Research Institute of Complex Energy Technology.
15. Report on carrying out interdepartmental test of transport package complete with container 19, 1992, All-Russian Design and Research Institute of Complex Energy Technology.
16. Radiation safety programme on transportation of SFA # 35/2635, 2004, All-Russian Design and Research Institute of Complex Energy Technology.
17. Private programme of quality maintenance in exploitation of conveying equipment for transportation nuclear fissile radioactive materials, 2004, #14524, All-Russian Design and Research Institute of Complex Energy Technology.
18. Drawings of the container TUK-19, drawing of general view L65.303.000 BO; inv #84-00278-2; case type of 19-1-50, drawing of general view 65.304.000 BO, inv #84-00278-3; traverses, drawing of general view 60.031.000 BO, inv. #84-00278-4; All-Russian Design and Research Institute of Complex Energy Technology.
19. Conclusion #05-023 on nuclear safety of SFA transportation type of IRT-2M, IRT-3M in TUK-19, was prepared at Physical Energy Institute in Obninsk and certified by Leading Research Institute of ROSATOM – All-Russian Design and Research Institute of Complex Energy Technology.

20. Expert's statement on corresponding design of transport package complete TUK-19 and transportation of SFA IRT-2M and IRT-3M to requirements of safety regulations in radioactive materials transporting HP-053-04, IAEA TS-R-1, was prepared in Russian Design and Research Institute of Complex Energy Technology in Saratov and certified by Leading Research Institute of ROSATOM – All-Russian Design and Research Institute of Complex Energy Technology.
21. Permission of State Inspectorate on Safety in Industry and Mining, #20-715-05 off 14.09.2005 for the right of carrying out works on SFA from the research reactor WWR-SM Academy of Science of Uzbekistan for reprocessing to Russian Federation.

2.7. Transit country preparation activities (if applicable)

The trilateral agreements have identified 24 research reactors at 17 facilities in 15 countries that have Sovietor Russia supplied fuel. Except the countries like Latvia, Belarus, Ukraine, China and Kazakhstan the remaining 10 countries do not have common borders with the Russian Federation and in the case of the transporting of spent fuel to the Russian Federation one of the serious questions is the transit through the territory of the third country. In the case of using air transport, authorization is received under the framework of international agreements and special exemptions.

The case of transiting SFA through the territory of the third country becomes inevitable and one should solve the problems related to that. Of course, the rules and regulations on the transit of highly radioactive materials (or dangerous goods in general), as it seems on the surface, look quite different from country to country and it is problematic to give one set of general prescriptions which can be common for all countries. Therefore, taking into account the geographic positions of those 11 (e.g. Bulgaria, Czech Republic, Egypt, Germany, Hungary, the Libyan Arab Jamahiriya, Poland, Romania, Uzbekistan, Vietnam and former Yugoslavia) countries which do not have common borders with the Russian Federation as well as keeping in mind the only potentially possible countries to be used as the transit one, in particular, Slovakia, Ukraine and Kazakhstan, it was decided to present, in this section, the description of transit regulations in these two countries.

2.7.1. Kazakhstan experience in transit of spent fuel assemblies

While transporting the SFA from Uzbekistan to the Russian Federation, Kazakhstan actively participated in the performance of that project and made possible the transit and physical protection of the SFA. All procedures were made in accordance with the legislation of Kazakhstan (see also Addendum about Czech experience while transiting through Slovakia and Ukraine).

The key Kazakh organization in obtaining permission and providing transit is Raotrans (former KATEP Company) which was in contact with eight Kazakh ministries: Ministry of Environmental Protection; Ministry of Health; Ministry of Transport and Communications; Ministry of Emergency; Ministry of Energy and Mineral Resources; Ministry of Trade and Industry; Ministry of Internal Affairs; and the National Security Committee. In addition seven other organizations and companies were involved including the Atomic Energy Committee of Kazakhstan.

2.7.1.1. Necessary documentation

The basis documents in obtaining the transit permission through the territory of Kazakhstan were:

- the Decree of the President of Kazakhstan 'On the Export Control';
- the Decree of the Government of Kazakhstan 'On the Approval of the Regulations on the Transit of Items to be the Subject for Export Control'.

Through consultations with the aforementioned ministries, the 'Programme of the Preparation and Transit of SFA from Uzbekistan through Kazakhstan to Russian Federation' was developed. In addition, the government approved the document 'The State Regulation Structure' which established the order and the outline of interactions between the participants of the project. All mentioned documents were endorsed by the Atomic Energy Committee.

2.7.1.2. Main stages of programme performance

The main stages of works in obtaining permission for transit were the following:

1. The confirmation of the validity of certificates to use selected packaging of SFA (containers, special train etc) on the territory of Kazakhstan.

This stage included:

- Receiving from customer (i.e. Mayak or 'Sosny' enterprise) the corresponding certificates, design documents etc. in order to get permission to extend the validity of these documents on the Kazakhstan territory:
- The independent expert review of received documents;
- The State expert review of received documents;
- The submission of reports of independent and state experts and required documents on certificates to the competent authority on atomic energy;
- The receiving of an order from the Atomic Energy Committee on the recognition of validity of certificates and related documents on the territory of Kazakhstan.

2. The preparation of 'Assessment of Radiation Impact' of SFA transit to the environment and population (EIA) and obtaining the state ecological report (approval).

- contracting with organization having a license to develop EIA;
- submission of necessary documentation for developing EIA;
- EIA development;
- Independent expert review of EIA;
- Presentation of independent expert's review and EIA to Ministry of Environmental Protection RK (MEP RK) to make the state expert review of EIA;
- Receiving of the of MER RK conclusion on ecological safety of transit.

3. The Insurance of SNF while in transit through the territory of Kazakhstan.

- Selection of insurance company with coverage to pay damage sum in case of accident.
- Signing the compulsory insurance contract.
- Signing the voluntary insurance contract.

4. Development and coordination of 'The SFA transit programme'.

That is the main document which contained the description of all actions and responsibilities of involved organizations. The programme included:

- General regulations which described the scope of work to be done;
- Information about transportation procedures with information regarding cargo and other equipment;
- The list of participating parties and their responsibilities;
- Accompanying documentation (waybills, dispatch notes etc) to the cargo;
- Security provision during transportation;
- Physical protection provision during transportation;
- Organization and conducting the work on eliminating possible accidents during transportation;
- The list of used documentation;
- Necessary annexes.

5. The obtaining of the permission to transit SFA.

The official permission (license) to transit the SFA has to be obtained from the competent authority of the Ministry of Industry and Trade RK after the completion of the package of required documents.

6. The contracts within Kazakhstan.

There are several organizations which are involved in transit procedures and several contracts should be signed with them. Those include:

- Organization(s) providing the physical protection and safety of SFA while transporting through the territory of Kazakhstan;
- Organization(s) providing necessary actions in case of emergency situations;
- Transportation company which will transit the SFA;
- Customs procedures service organization.

2.7.2. Transit on the territory of Ukraine

Taking into account the geographical position of Ukraine one can assume that its territory will be the most frequently used for the transit of SFA from the countries to the West of Ukraine and therefore the transit of SFA through Ukraine will become an almost inalienable part of a project in which any European country will be involved[7]. Ukraine has long standing experience, corresponding legislation, and normative documents in providing the transit of radioactive and nuclear materials through its territory. In addition, to our knowledge, the government of Ukraine has signed bilateral and trilateral agreements with neighbouring countries on the transit of nuclear and radioactive materials. All these facts, of course, facilitate significantly the formal procedures which are stated in the Law of Ukraine 'On Dangerous Cargos Transport' (Article 26. International transports of dangerous cargos and international cooperation in the field of dangerous cargos transport), the Decrees of the Cabinet of Ministers of Ukraine (dated 15 October 2004, No.1373) 'Procedures for Radioactive Materials Transport through the Territory of Ukraine' and 'On the Adoption of Order of Carrying-Out State Control of International Transfers of Dual-Purpose Goods' (dated 28 January 2004, No.86) as well as in the regulatory documents of the State Nuclear Regulatory Committee of Ukraine on Use of Nuclear Energy and Radiation Safety.

It should be noted that in the case of nuclear material transportation the State Committee on Export Control of Ukraine is the responsible organization for issuing the permission (conclusion for the transit transportation) for the right of international transfer. Based on all diplomatic notes, official appeals and requests as well as on preparations of corresponding documents ,applications etc. the formal permits for transportation of fresh and spent nuclear fuel are normally issued by the State Nuclear Regulatory Committee of Ukraine.

Several meetings were organized by the IAEA that were dedicated to the transportation of nuclear fuel through the territory of Ukraine. One can find in materials of these meetings some additional useful information. The formal procedures to be completed in order to get the permission for the transportation of fresh and spent fuel on the territory of Ukraine are given in the instruction form below.

2.7.2.1. Procedure of permit issue for transportation of fresh and spent nuclear fuel

(In compliance with Instruction on Procedure of Permit Issue for Transportation of Radioactive Materials, approved by Order of the State Nuclear Regulatory Committee of Ukraine 09.24.2003 # 51, Registered with the Ministry of Justice of Ukraine October 9, 2003 # 916/8237).

General provisions

Issue of Permits was initiated in order to ensure safety of transportation of radioactive materials (RM) and to guarantee that transportation is being performed in accordance with the requirements of the Ukrainian legislation, norms, rules and standards of nuclear and radiation safety.

Permit for transportation is issued for consignment (any package, packages and load of RM) of certain size of RM in case of:

- international transportation (export, import and transit of RM),
- transportation of fissile material

[7] Due to political unrest in Ukraine in the latter part of 2007 and in 2008, transit through Ukraine proved more difficult than expected. European countries to the west of Ukraine have been forced to seek alternate routes or transportation modes.

Permits shall be issued by the State Nuclear Regulatory Committee of Ukraine (hereinafter referred to as SNRCU).

19/11 Arsenalna str.,
Kiev 01011
Telephone: (+380 44) 254 35 13
Facsimile: (+380 44) 254 33 11
Internet: www.snrc.gov.ua

Content of the application and required permit documents

The application for Permit shall be submitted to the SNRCU by the consignor, carrier and the consignee of RM or by the legal or physical entity that acts on their behalf. In case the applicant is the consignee, carrier or entity acting on their behalf, assignment of responsibility for transportation safety shall be agreed upon in the contract between them and the consignor.

The application shall contain:

a. Name and address of the consignor and the consignee, sites of departure and destination;

b. Information about consignment:

- proper shipping name and the United Nations number assigned to the given material;
- the name or symbol of each radionuclide or, for mixtures of radionuclides, an appropriate general description or a list of the most restrictive nuclides and description of the physical and chemical form of the material;
- maximum level of activity of the radioactive content in package, stated in Becquerel's (Bq) with appropriate prefix of the International Metric System (SI). For the fissile material, besides the activity level the mass in kilograms should be also indicated;
- the type of packages, numbers, the category of the packages, the transport index, the criticality safety index;
- the identification mark for each competent authority approval certificate (package design or shipment) applicable to the consignment;
  - emergency card number (in case of its absence, an emergency card, developed by the consignor and in compliance to the stated procedure);
  - the type of transportation;
  - information on the consignment security measures in accordance with the regulatory provisions;
  - point of the custom pass;
  - basis for the transportation – contract; export license;

Documents that should accompany the application:

- copies of certificates of approval, pursuant to TS-R-1;
- copy of the export license of the consignment origin country,

- documents that confirm consent of the destination state to the transportation of nuclear fuel;
- copy of the insurance policy or insurance agreement that regulates compensation in case an accident occurs during transportation.

Application procedure and conditions for permit issue

The responsible department of SNRCU reviews an application in order to assess an applicant's fulfilment of requirement for the nomenclature and content of the submittals.

Permit will be issued in case of compliance of the declared conditions of transportation with the Ukrainian legislation and rules. The time period for the application consideration shall not exceed 20 calendar days from the day of receiving the application by the SNRCU.

Decision to reject issue of the permit shall be mailed to the applicant within three days once the decision is made. An applicant shall be informed in writing about refusal reasoning the refusal and giving conditions for additional review. An applicant can appeal the refusal of permit granting in the court.

The Permit is valid up to 1 year.

The Permit extension shall be issued on a basis of the written application. In case of the transportation conditions change in comparison to the initial application, applicant shall provide additional information reflecting the changes. Consideration of the Permit extension and decision making should be done during 20 calendar days following the receipt of the application at the SNRCU.

2.8. European Commission (if applicable)

EU Members have the obligation pursuant to articles 52 and 103 of the EURATOM Treaty to consult the EC before concluding any international agreement with third parties, such as the IAEA and the USA. This specifically includes contracts for export or import of nuclear material, as well as intergovernmental agreements with third parties (e.g. such as any intergovernmental agreement between an EU Member State, Ukraine, and the Russian Federation for transit of spent fuel thru Ukraine).

Excerpt from Article 103 of Euratom Treaty:

> *"Member States shall communicate to the Commission draft agreements or contracts with a third State, an international organization or a national of a third State to the extent that such agreements or contracts concern matters within the purview of this Treaty. If a draft agreement or contract contains clauses which impede the application of this Treaty, the Commission shall, within one month of receipt of such communication, make its comments known to the State concerned. The State shall not conclude the proposed agreement or contract until it has satisfied the objections of the Commission or complied with a ruling by the Court of Justice, adjudicating urgently upon an application from the State, on the compatibility of the proposed clauses with the provisions of this Treaty. An application may be made to the Court of Justice at any time after the State has received the comments of the Commission."*

The European Supply Agency considers HEU to be a strategic material and an 'asset' which might be required by other Member States in the EU and takes this into account in reviewing exports of HEU from the Euratom Community. ESA has approved export of HEU from the Czech Republic and Poland for repatriation to the Russian Federation because of 'political' considerations in regard to Global Threat Reduction. ESA also must review proposed exports of spent research reactor spent fuel from the EU because such material might have other uses within the EU. The EU Legal Office will ask ESA prior to ESA authorization of export of spent fuel whether ESA has explored other options for the spent fuel within the EU, for instance if CERCA or COGEMA might have use for the material.

EU has a requirement to determine whether spent fuel exported from the EU will be properly handled in the country to which it is being exported. The ESA representative said that this could be handled simply by ESA requiring that contracts for the export of spent fuel contain information on the receiver of the fuel (e.g. Mayak), including what the treatment and disposition will be of the fuel including the handling/disposition of fission products from reprocessing.

3. BRIEF DESCRIPTION AND SPECIFICATIONS OF CASKS

3.1. Arrangement of SNF in the casks

SNF is loaded into the TUK-19 and SKODA VPVR/M casks in special untight transport canisters TS1 (for TUK-19 casks) and TS2 (for SKODA VPVR/M casks). Canisters TS1 and TS2 have a unified design and differ only in their height and mass. Canister TS1 is loaded into the TUK-19 cask in a Type 50 or Type 51 basket with a dismantled spacer (Figure 5). A specially designed basket (Figure 6) is used to arrange canisters TS2 in the SKODA VPVR/M cask. The main specifications of the canisters loaded into the TUK-19 and SKODA VPVR/M casks are presented in Table 6.

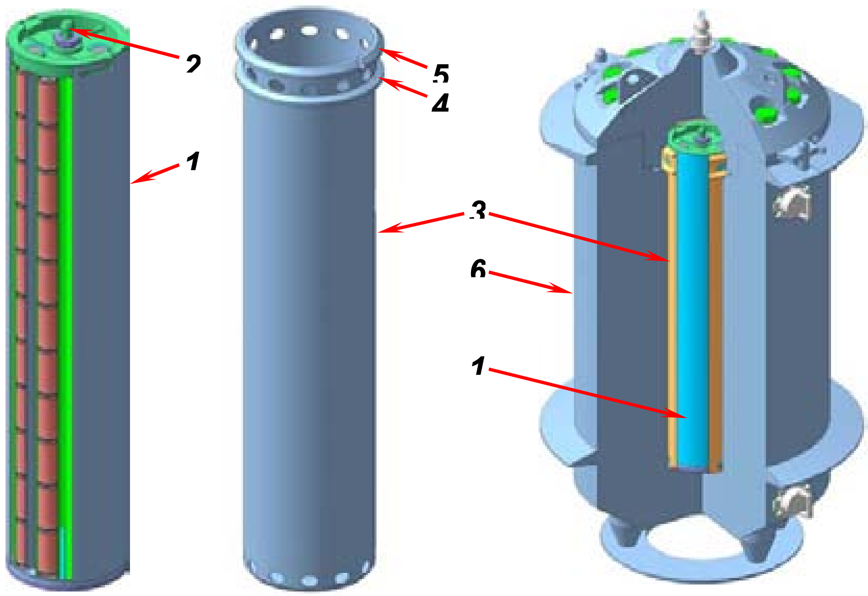


FIG. 5. Arrangement of canister TS1 in the TUK-19 cask.1) canister TS1; 2) pintle used to transfer the canister; 3) type 50 or type 51 basket without a spacer; 4) supporting rib for mounting of the basket into the TUK-19 cask; 5) rib for coupling the grapple; 6) TUK-19 cask with a basket and a canister.

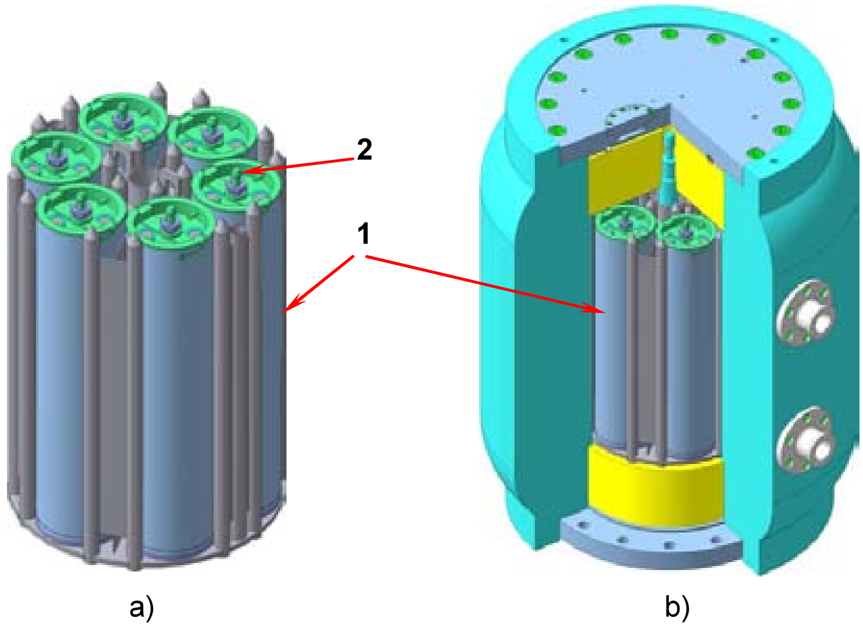


FIG. 6. Arrangement of canisters TS2 in the SKODA VPVR/M cask.a) basket with six canisters TS2; b) SKODA VPVR/M cask without shock absorbers.

TABLE 6. THE MAIN SPECIFICATIONS OF THE CANISTERS

Parameter	**Unit**	**TS1**	**TS2**
Canister overall dimensions, height × diameter	mm	1365×194	860×194
Canister mass	kg	36	25
Maximum mass of SNF in the canister	kg	70	45
Maximum number of TVR-S in the canister	pcs.	132	72
Maximum number of TVR-S in the cask	pcs.	132	432
Maximum dimensions of the fragments loaded into the canister, length × diameter	mm	1265×45	760×45
Number of the canisters per cask	pcs.	1	6

3.2. Transport package TUK-19

Transport package TUK-19 is a Type B(U) package intended for fissile materials, category III yellow. It consists of two components:

- cask 19;
- Type 50 or Type 51 basket.

TUK-19 basic specifications:

- Mass of the empty TUK-19 — 700 kg max.
- Mass of the package — 4806 kg max.
- Dimensions — 2170×910 mm.

Canisters with TVR-S are loaded into the TUK-19 cask by means of a transfer cask.

3.2.1. Cask 19

The main components of cask 19 are a body (pos.1) and a lid (pos.2) (FIG. 7). The cask body is a thick-walled cylindrical vessel. Its inner space is 220 mm in diameter. There are two gate valves (shutoff valves) (pos.3) in the upper and lower parts of the body. During transport of SNF the gate valves are closed and protective covers with rubber gaskets (pos.4) are applied.

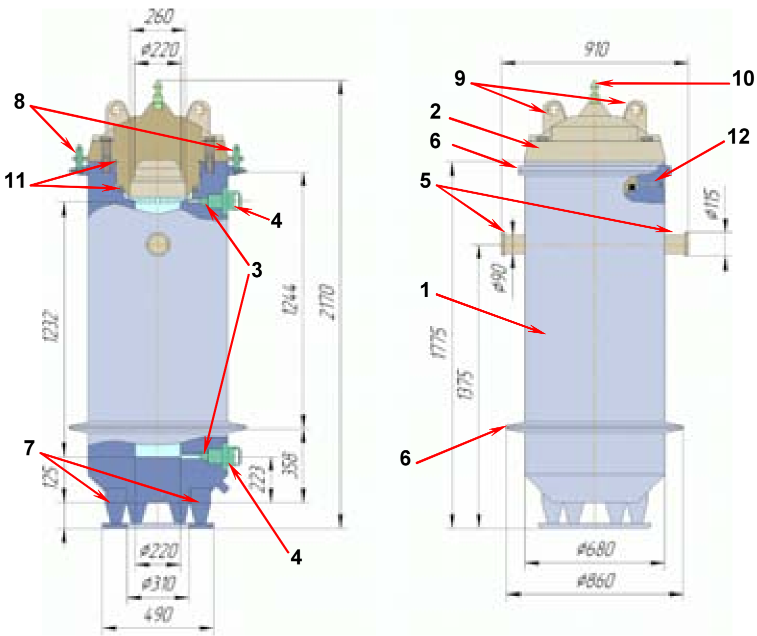


FIG. 7. Cask 19. 1) body; 2) lid; 3) gate valves; 4) protective caps of the gate valves; 5) trunnions; 6) damper rings; 7) shock absorbers; 8) aligner fingers; 9) lugs; 10) pintle; 11) rubber gaskets; 12) offtake from the space between the rubber gaskets.

Cask 19 has two trunnions (pos.5) intended for hooking the cask by means of a special yoke during loading-unloading operations. Two damper rings (pos.6) and six cone-shaped shock absorbers (pos.7) with a bedplate in the lower part of the cask are used to reduce the package mechanical load in case of possible emergency situations. The lid is fixed to the body with twelve bolts M36. Position of the lid on the body is defined by two aligner fingers (pos.8) fastened to the upper damper ring. Three lugs (pos.9) and a pintle (pos.10) are used to place and remove the lid. Rubber gaskets of the cask lid and the gate valves provide leak tightness of cask 19. The ‘body-lid’ joint is sealed by the rubber gaskets made of 51-1481 Rad rubber and the gate valves are sealed by the rubber gaskets made of 51-1758 TU 105.1325-79 rubber. Under emergency conditions the rubber gaskets allow short-term operation at the temperature up to 280°C.

For leak testing of the loaded cask an offtake (pos.12) from the space between the rubber gaskets is used. During transportation a bolt with a sealing rubber gasket is screwed into the threaded channel hole.

Material of the cask 19 basic components:

- body, lid, shock absorbers - steel 08Cr18Ni10Ti;
- trunnions - steel 12Cr18Ni10Ti;
- bolts used to fix the lid - steel 38CrNi3MFA.

A removable yoke (drawing D.65.014.000) is used to transfer the cask by the crane. The yoke design is shown in FIG. 8.

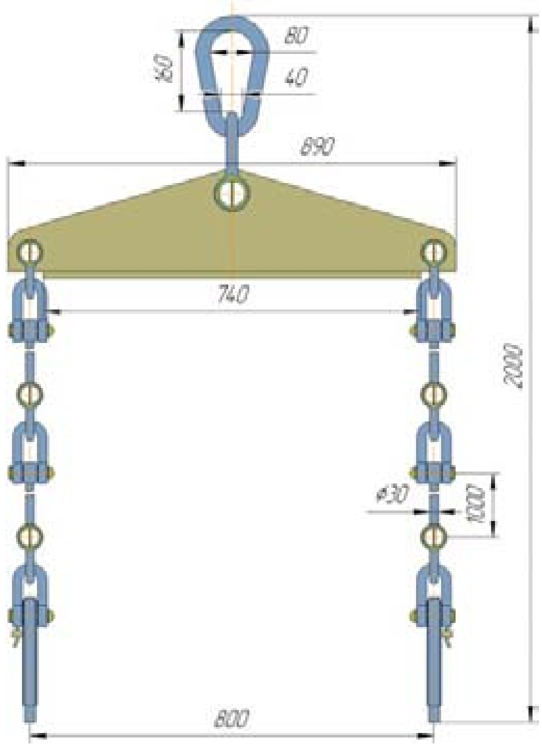


FIG. 8. Yoke used to transfer TUK-19 by the crane.

3.2.2. Basket for canister TS1

Canister TS1 is loaded into the TUK-19 cask in a Type 50 or Type 51 basket with a dismantled spacer (see). The basket consists of a shell and a bottom. The top of the basket has two ribs, one of which serves to install the basket onto the retaining cone of the cask, the other – to transfer the basket by the grapple. The bottom and the shell have holes, which are used to discharge water from the basket and allow air circulation. The type and serial number of the basket are indicated on the lateral surface in the upper part of the shell.

The basket is made of stainless steel 12Cr18Ni10Ti.

Note: hereinafter the basket for canister TS1 implies the Type 50 or Type 51 basket with a dismantled spacer.

3.3. Transport package SKODA VPVR/M

Transport package SKODA VPVR/M is a Type B(U) package intended for fissile materials, category III yellow (see also Appendix IV).

Transport package SKODA VPVR/M has the following specifications:

Overall dimensions:

Height of the cask body without shock absorbers, mm	1 505
Height of the transport package with shock absorbers (regardless of plastic plates), mm	2 155
Outer diameter of the cask body, mm	1 200
Inner diameter of the cask body, mm	600

Overall size measured by the trunnions, mm	1 360
Outer diameter of the transport package with shock absorbers, mm	1 500
Number of loaded canisters TS2, pcs.	6
Empty transport package mass (with shock absorbers), kg, no more	11 950

Mass of the basic cask components:

Body, kg, no more	8 700
Upper primary lid, kg, maximum	518
Lower primary lid, kg, maximum	530
Upper secondary lid, kg, maximum	300
Lower secondary lid, kg, maximum	316
Basket pull rod, kg, maximum	6.5
Trunnion, kg, maximum	56

Tightening torque of the bolts:

Secondary lids of the loaded transport package, Nm	2000 ± 100
Secondary lids of the empty transport package, Nm	500 ± 25
Cover of the valve for gas supply, Nm	70 ± 5
Maximum normal operating pressure, MPa (kg/cm^2), maximum	0.07 (0.7)

3.3.1. Description of the SKODA VPVR/M cask and its components

SKODA VPVR/M cask (FIG. 9) consists of a body, two upper lids, two lower lids and two pull rods.

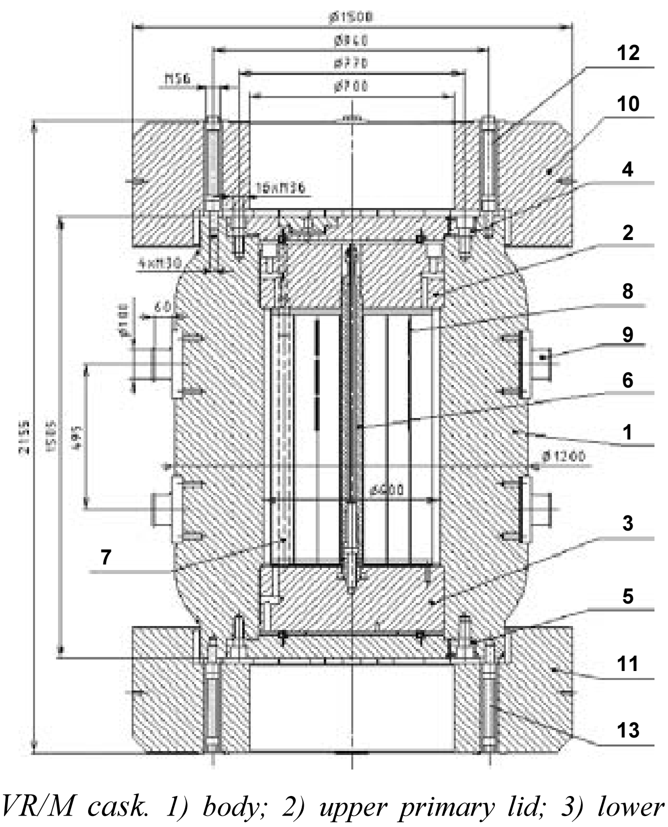


FIG. 9. SKODA VPVR/M cask. 1) body; 2) upper primary lid; 3) lower primary lid; 4) upper secondary lid; 5) lower secondary lid; 6) central suspension; 7) tic rods; 8) basket; 9) trunnions; 10) upper shock absorber; 11) lower shock absorber; 12 and 13) protective plastic plates.

Body

The cask body (pos.1) is a hollow steel thick-walled cylinder with the external surface rounded to narrow in the upper and lower parts. An upper (pos.10) and lower (pos.11) shock absorbers are mounted in the narrowed part of the cask. They are fixed to the body by means of four bolts M30.

The inner space of the cask is of a cylindrical shape with aluminium paint-coated smooth surface. In the upper and lower part of the inner space there are recesses (850 mm and 630 mm in diameter) for primary and secondary lids. The recess surface is provided with stainless steel cladding.

The cask has two pairs of trunnions (pos.9), which serve for transfer and tilting of the cask. Each trunnion is fixed to the body by means of six bolts M20×60. The upper and lower trunnions have the same size.

To transfer SKODA VPVR/M cask by the crane a yoke (drawing Ae 225680/Rev.1) is used. The yoke design is shown in Figure 10. The yoke has removable suspensions, which are used to hook the cask without the upper shock absorber by the trunnions. When the cask is transferred by the shock absorber (or when the shock absorber is transferred alone), the suspension, used to transfer the cask by the trunnions, must be uncoupled from the yoke. The yoke is fastened to the shock absorber with two bolts M56.

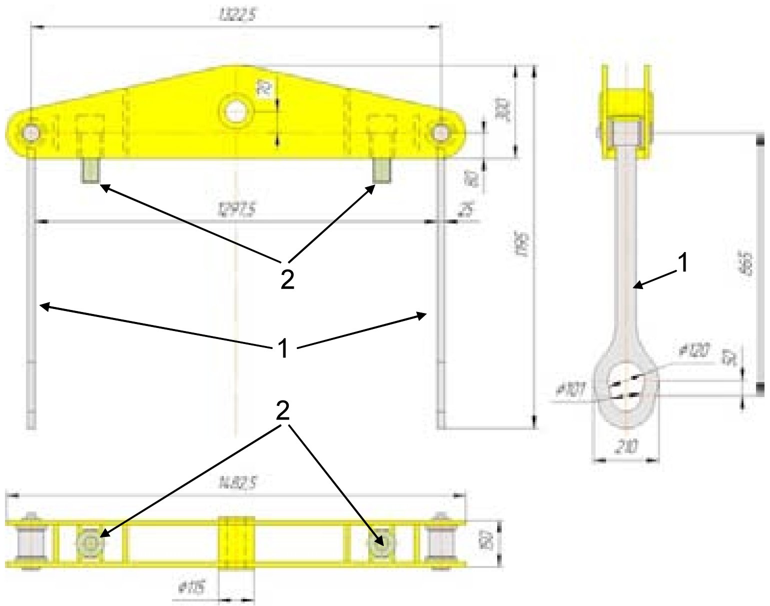


FIG. 10. The yoke for transferring SKODA VPVR/M cask by the crane. 1) suspensions; 2) bolts M56 for fixing yoke on the shock absorbers.

Pull rods

Pull rods (pos.7) are used for pressing the primary lids (pos.2, pos.3) together as well as for mounting the guides of the grapple used for lifting (lowering) the lower primary lid with the basket during SFA loading.

The pull rods are rods 32 mm in diameter. By their lower threaded part the pull rods are screwed into the lower primary lid (pos.3). Their upper threaded parts go through the holes in the basket and the upper primary lid (pos.2) and are fixed on top by means of screw-nuts M24. After tightening of the screw-nuts both the primary lids are tightly pressed together and the basket with fuel is fixed inside the body. It prevents dropping out of the primary lids in case of opening of the secondary lids.

Primary lids

Upper (pos.2) and lower (pos.3) primary lids serve the main biological shielding against irradiation from the cask end surfaces.

The upper primary lid (pos.2) is a 220 mm thick cylindrical steel plate 630 mm in diameter. In the lid centre there is a hole for inserting the basket central suspension (pos.6) and there are also two holes on the edge of the lid, opposite each other, for the basket pull rods. The holes in the lid and the upper parts of the suspension and the pull rods, which enter the holes, are provided with a recess to prevent personnel exposure to radiation during handling the upper cask lids.

There are two holes in the upper primary lid for drying the cask internal space before mounting the upper secondary lid (pos.4). Except for the time needed for drying, these holes are blinded by shielding plugs. The inlet and outlet of the holes for drying lie in different planes in order to reduce the level of ionizing radiation.

The lower primary lid (pos.3) is similar in its size to the upper primary lid. In the centre there is a hole with a bayonet lock for the basket central suspension and there are also threaded holes for the basket pull rods. During SNF loading the lower primary lid with the basket is pulled down through the cask lower hole by means of the central suspension coupled with the lid. If the central suspension and the lid bayonet lock are disconnected, the basket can be drawn out through the cask upper hole.

Secondary lids

Secondary lids are used to seal the cask and protect its contents from undesirable external mechanical effects during handling of the cask.

The upper secondary lid (pos.4) is an 80 mm thick steel plate 850 mm in diameter. It has a step-shaped configuration with a plain spigot 630 mm in diameter in the lower part of the lid, which enters the lower cylindrical recess of the cask body. Eight guiding feathers are symmetrically located on the lateral surface of the lid. The lid is fixed to the body by means of sixteen bolts M36×70.

Two Helicoflex gaskets are mounted on the lid lower surface in order to seal the inner space of the cask. The gaskets are inserted into two concentric grooves and are fixed in grooves by means of four bolts M5 and clamps. An offtake is used for leak testing. It is led out from the space between the gaskets and during transportation it is closed with a plug, sealed by elastomeric silicon rubber gasket. The offtake allows to check pressure between the gaskets and to detect any possible leakage.

There is a valved well in the lid for filling the cask with gas. The well is covered with a massive cap that protects the valve from damage. The cap is fixed by 12 bolts and sealed by a Helicoflex gasket.

A hollow bellows is mounted on the lower surface of the lid. It serves to delimitate the primary and secondary lids position and to mitigate mechanical effects in case of a cask fall. The bellows is fixed in the groove by two bolts M6.

A special mark is available on the lid, which is actually a painted dent 10 mm in diameter that helps to secure the lid in a specified position. The cask body has a similar mark.

The lower secondary lid is similar to the upper secondary lid in its size and characteristics. The only difference is that it does not have a valved well for gas supply.

Sealing system

The SKODA VPVR/M sealing system consists of two pairs of Helicoflex metal gaskets, which are placed in pairs on the surface between the cask body and the upper or lower secondary lid. The sealing system additionally includes a Helicoflex gasket to seal the cap, which covers the valved well in the upper secondary lid. Helicoflex gaskets are expendable items.

Type and characteristics of the SKODA VPVR/M cask gaskets are as follows:

No.	Type	Outer diameter, mm	Inner diameter, mm	Gasket height, mm	Gasket location
1	Helicoflex	660	630	9	Upper secondary lid (inner sealing)
2	Helicoflex	660	630	9	Lower secondary lid (inner sealing)
3	Helicoflex	708	678	9	Upper secondary lid (outer sealing)
4	Helicoflex	708	678	9	Lower secondary lid (outer sealing)
5	Helicoflex	135.5	120.7	4.4	Cap for the gas supply valve (upper secondary lid)

Empty SKODA VPVR/M packages are transported sealed by elastomeric Viton VM-771 type rings (KUBO-TECH AG), which are used instead of Helicoflex gaskets. For transport of SNF elastomeric rings are replaced for Helicoflex gaskets.

Shock absorbers

The cask is provided with two dismountable shock absorbers, which serve to reduce impact dynamic loads in the emergency situations. The shock absorbers are fixed to the cask body end surfaces by four bolts M30×60.

To prevent spontaneous unscrewing of bolts M30×60 during transportation, special plastic plates are screwed into the threaded holes M56×4 of the shock absorbers in such a way so they could support the bolt panes.

The skeleton of the shock absorbers are made of sheet carbon structural steel and are enameled. There are steel plates inside the shock absorbers, which divide the shock absorbers into blocks in radial direction. These blocks are filled with layers of dry fir bars.

Shock absorber characteristics:

a) mass, kg, maximum	620
b) height, mm	430
c) outer diameter, mm	1 510
d) inner diameter, mm	690 (1080)

The shock absorbers possess the marking, which indicates the places of shock absorber coupling with a yoke or a sling. The marking is black against a light-blue background.

Central suspension

The central suspension is used to transfer the basket. At the lower end the suspension is provided with a bayonet lock with a central locking rod, which is coupled with the lower primary lid. On its upper end the suspension has a pintle 40 mm in diameter and a nut used to insert and withdraw the locking rod. The pintle is used to handle the basket during different transfer and technological operations by means of a grapple. In the assembled position the upper part of the suspension with the pintle enters the central hole of the upper primary lid. The upper lid has a recess to prevent personnel exposure to radiation during handling the upper secondary lid.

Central suspension characteristics:

a) mass, kg, maximum	30
b) length, mm	1179
c) pintle diameter, mm	40

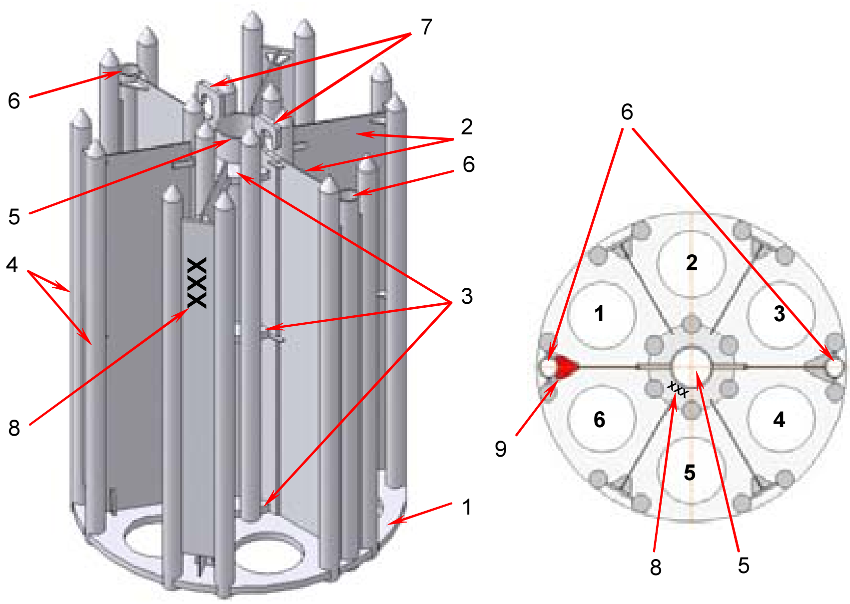


FIG. 11. Design of the basket for canisters TS2 and cell numbers. 1) bottom; 2) partitions; 3) flanges; 4) poles; 5) guide for the central suspension; 6) guides for the pull rods; 7) lugs; 8) basket number; 9) marking.

Basket for the canisters

The basket is used to arrange 6 canisters TS2 in the SKODA VPVR/M cask. FIG. 11 demonstrates the basket design and cell numbers.

The basket is a welded construction consisting of bottom (1), three flanges (3) and six partitions (2) welded to poles (4) and guides for the central suspension (5) and the pull rods (6) of the SKODA VPVR/M cask. The poles and partitions separate the canisters in the baskets. Two lugs (7) are used to transfer the empty basket. All the basket components are made of 12Cr18Ni10Ti stainless steel.

The cells of the basket are counted clockwise starting with the orientation mark. The basket number is indicated on its upper flange and on four side ribs.

3.4. ISO container for transport of SKODA VPVR/M packages

The design of the ISO-container used for transportation of SKODA VPVR/M packages is based on a standard 20-foot transport container. The ISO-container is demonstrated in Figure 12. It is a rectangular steel construction, which has a door for the maintenance personnel on the end-wall and a removable top for loading of the casks. The top rail located above the door is removed to make possible loading and unloading of the casks. The side walls of the container are made of shaped steel sheet and have four locking devices to secure the removable top. A locking device consists of a revolving bar, ending with latches for the container roof at the top and with a handle at the bottom. The handle is used to revolve the bar round its axis.

Each door of the container also has two locking devices. Their design is similar to that of the locking devices used for the container top.

All the locking devices have retainers that secure the bar handles in the closed position. The retainers allow for the seals to be placed onto them. Stowage of the loaded ISO-containers is forbidden.

ISO-container characteristics:

Overall dimensions:

height, mm	2 591
width, mm	2 438
length, mm	6 058
capacity (number of SKODA VPVR/M packages), pcs., maximum	2
mass of loaded ISO-container, kg maximum	30 480

Arrangement of SKODA VPVR/M packages in the ISO-container is demonstrated in FIG. 13.

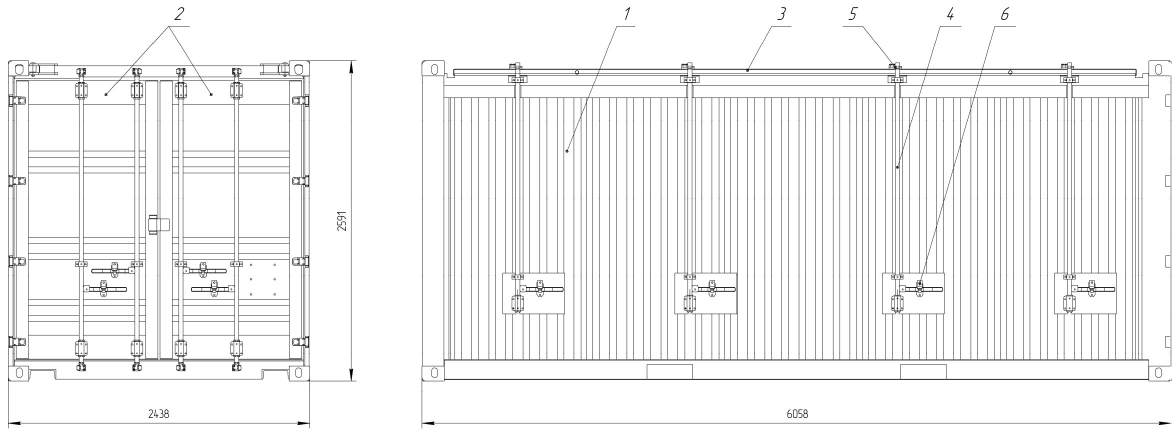


FIG. 12. ISO – container for transport of SKODA VPVR/M packages. 1) body; 2) doors; 3) removable top; 4) revolving bar; 5) latch for the top;6) handle retainer.

3.5. ISO container for transport of TUK-19

The ISO-container is demonstrated in Figure 14. It is a rectangular steel construction, which has a door for the maintenance personnel on the end-wall and a removable top for loading of the casks. The top rail located above the doors is removed to make possible loading and unloading of the casks. The removable top is fixed to the container body from inside by means of eight turnbuckles. The side walls of the container are made of steel sheet. The container doors have locking devices consisting of revolving bars and retainers. The revolving bar has a locking hook at the top and ends with a handle. The handle is used to revolve the bar round its axis. The retainers are used to secure the bar handles in the closed position. The retainers allow to apply seals onto them.

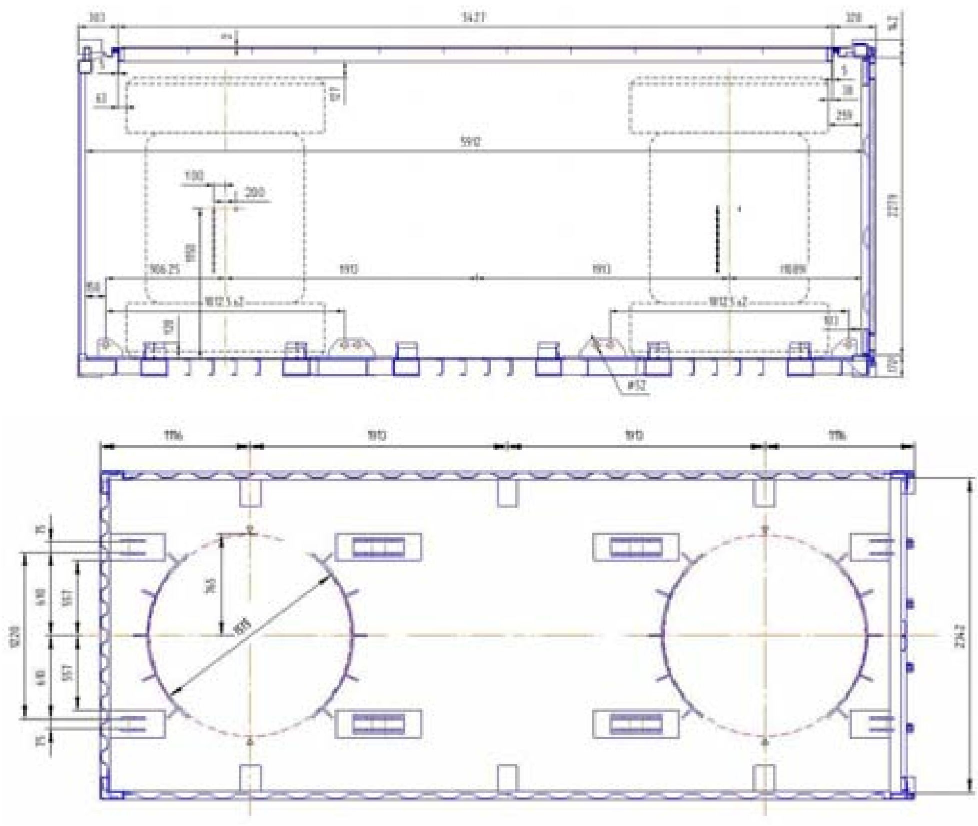


FIG. 13. Arrangement of SKODA VPVR/M packages in the ISO-container.

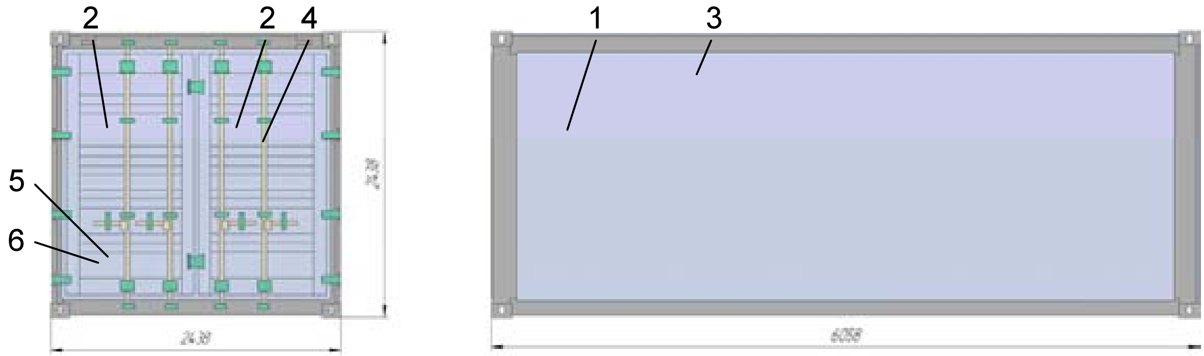


FIG. 14. ISO – container for transport of TUK-19. 1) body; 2) doors; 3) removable top; 4) revolving bar; 5) retainer; 6) handle.

Stowage of the loaded ISO-containers is forbidden.

ISO-container characteristics, overall dimensions:

height, mm	2 438
width, mm	2 438
length, mm	6 058
capacity (number of TUK-19), pcs., no more	3
mass of loaded ISO-container, kg, no more	20 000

Arrangement of TUK-19 in the ISO-container is demonstrated in Figure 15.

Refer to Appendix III for the applicable TUK-19 cask license. As additional information on the TUK-19 cask is made available, it will be added as attachments to this document.

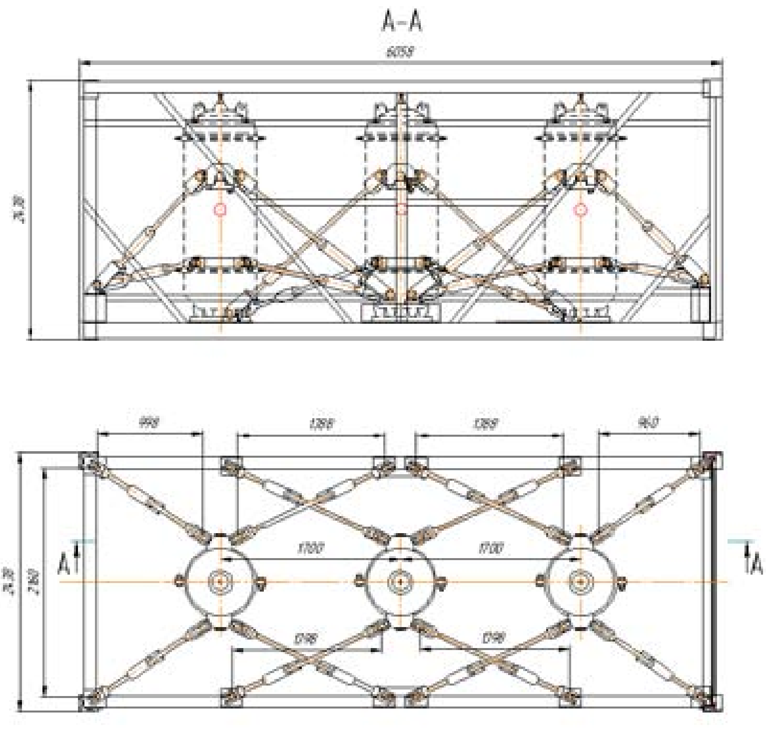


FIG. 15. Arrangement of TUK-19 casks in the ISO-container.

4. TRANSPORTATION

4.1. Transportation responsibilities

4.1.1. Originating country

Per the Foreign Trade Contract, the Originating Country is responsible for (may vary on a case-by-case basis):

- Ensuring that the SNF complies with the applicable RF Industry Standard for SNF transportation to the RF and the ‘Certificate-Permission’ of the transport cask,
- Guaranteeing that the Government of the OC has the technical and administrative capabilities and regulating structure for management of HLW in compliance with international safety standards, if HLW is to be returned,
- Handling the transport casks and loading the SNF into the casks per the existing procedures,
- Allowing access of Mayak technical personnel during the loading and handling process in the OC,
- Transportation to the rail yard from the storage site,
- Providing a locomotive for rail transportation in the OC,
- Providing the required length of rail needed to side the special train, ensuring appropriate security will be in place, and ensuring that electric, water and fuel will be available,
- Providing physical protection up to title transfer,
- Completion of all of the required documents, permits, and licenses as well as passing of customs formalities in the OC,
- Notification to the IAEA of the SNF transfer.

4.1.2. Russian Federation

The Foreign Trade Contract is the main document that defines the responsibilities of the Russian Federation for the shipment. Specifically, the responsibilities of the ‘Performer’ (FCNRS representing the RF) include:

- The return or final storage in the RF of the HLW,
- Providing the ‘special train’ composed of the TUK-19 railcars or Skoda ISO containers, escort railcar, and buffer railcars if needed,
- Providing technical personnel to maintain the special train and provide emergency response,
- Physical protection from the moment of title transfer in the RF,
- Completion of all of the required documents, permits, and licenses as well as passing of customs formalities on the territory of the RF,
- Notification to the IAEA of the SNF receipt,
- Receipt and temporary storage of the SNF before reprocessing,
- Reprocessing of SNF and interim storage for a set time period.

Emergency response is provided by a special department within Rosatom.

4.1.3. Transit (if applicable)

Transit countries are responsible for the following within their country:

- Providing a locomotive for the 'special train' and rail support,
- Liability Insurance,
- Providing physical protection of train and goods,
- Providing emergency response support,
- Providing customs and border support,
- Issuance of transit permits.

4.2. Transportation modes

4.2.1. Rail

The preferred mode of transportation is by rail. The TUK-19 casks are transported in TK-5 railcars and possibly 20 foot ISO containers in the future[8]. SKODA VPVR/M casks are transported in 20 foot ISO containers (2 per ISO) on flat bed railcars. Each train consists of: an engine; TK-5 or flat bed (for ISOs); a personnel and maintenance railcar (TK-VS); two buffer cars; and railcar for physical protection forces. The possible difference in the gage of the rails must be considered when shipping from originating points in Europe. Trains containing loaded casks are identified with the highest category (KP-1), which ensures the highest priority and reduces delays. Empty containers may be returned using category KP-3 or KP-4 depending on the scheduled next use.

4.2.2. Sea

To date, two shipments have been completed using the sea (or waterway) as a mode of transportation. Bulgaria used a barge on the Danube River to ship its spent fuel through Romania. Hungary shipped its spent fuel via the Mediterranean Sea and Atlantic Ocean to a port in Murmansk. Experiences using sea vessels have been included in the shipment summaries of Bulgaria and Hungary included in the country attachments.

4.2.3. Air

Air shipment of spent nuclear fuel

The shipment of spent nuclear fuel by air may be attractive for some RRRFR participating countries for various reasons. IAEA TS-R-1, Regulations for the Safe Transport of Radioactive Materials, gives requirements for the air shipment of nuclear materials in Type B(U) casks, with restrictions on the activity limits, or in Type C casks designed and tested for the shipment of spent fuel by air. Unfortunately, neither the TUK-19 nor the VPVR/M casks, both Type B(U) casks, are certified for air shipment and there are no certified Type C casks. To provide additional transportation options, the RRRFR programme is attempting to certify the TUK-19 casks for air shipment of the Romanian spent fuel. If successful, this option may be available for other RRRFR countries.

[8] ISO containers are being designed and fabricated to facilitate the shipment of TUK-19 casks by sea, truck, and air.

At the time of this writing (September 2008), an application has been submitted by Mayak to Rosatom and VNIIEF for Russian certification of the TUK-19 cask for air shipment of type S-36 spent fuel assemblies from Romania to the Russian Federation. This certification request is based on the TS-R-1 guidelines and Russian NP-053-04 requirements that the cask shall not contain activities greater than $3000A_2$ (see the requirements documents for definitions of A_2). The certification is expected to be granted by RF by February 2009 and, if so, an application will be subsequently submitted for air shipment certification by Romania.

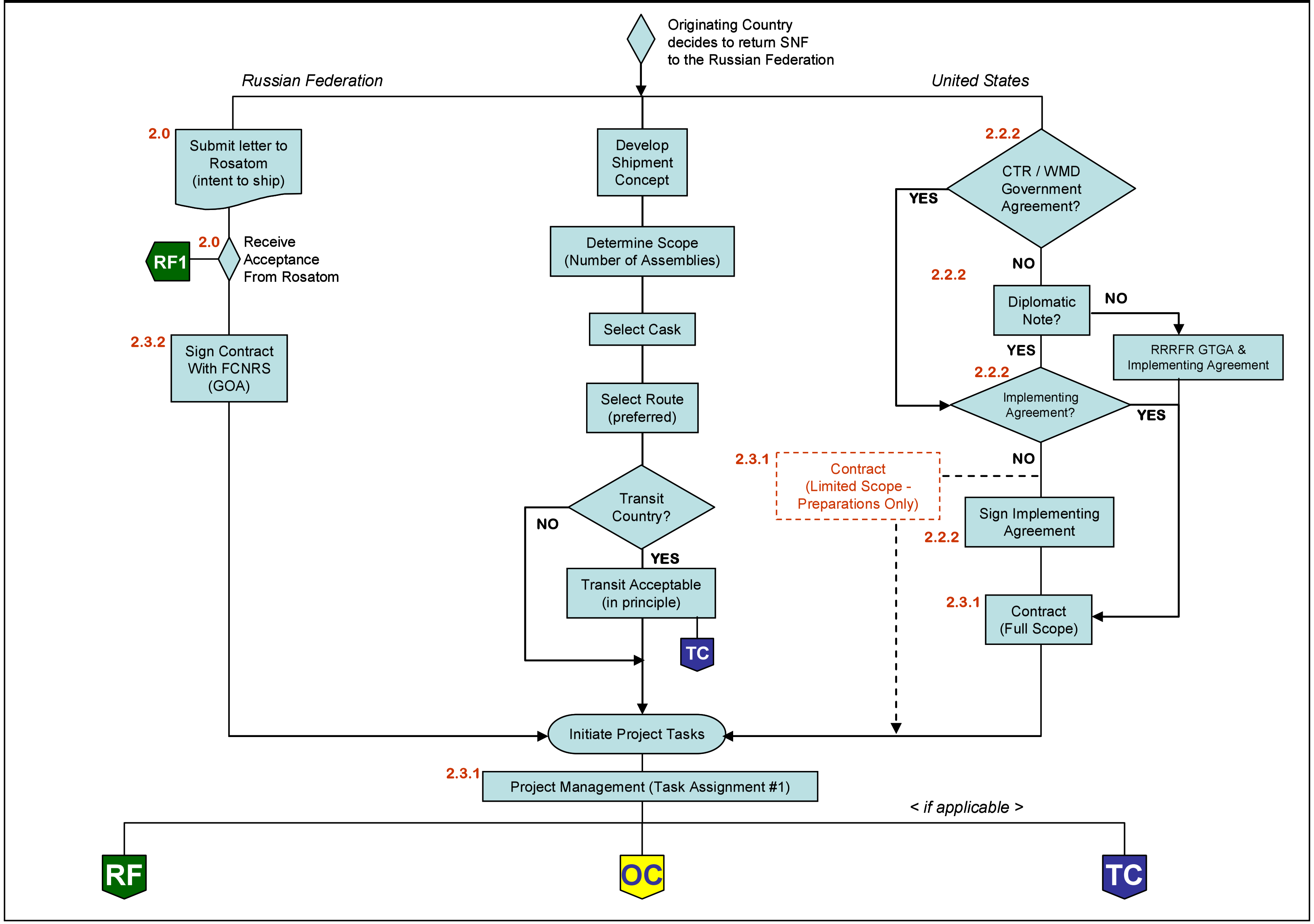
Air shipment from Romania will require that the casks be transported by road, to and from the originating and destination airports, and by air to the destination airport. These two modes of transport were requested in the Russian certificate application. To provide easy handling of the casks for this road and air transport, a special freight container was designed to hold 1, 2, or 3 casks per container. To take advantage of standard shipping container handling equipment and procedures, the cask container was designed to comply with International Organization for Standardization (ISO) requirements for freight containers. The container design was certified in April 2008 by the Russian Maritime Registry of Shipping as meeting ISO standards for freight containers. Cask tiedown rods will secure each TUK-19 cask inside the shipping container to prevent the load from shifting during transport. The Volga-Dnepr aircraft company designed tiedowns to secure the shipping containers inside the aircraft and has stated that the containers can be air shipped in either the model AN-124-100 or AN-124-100-150 aircraft.

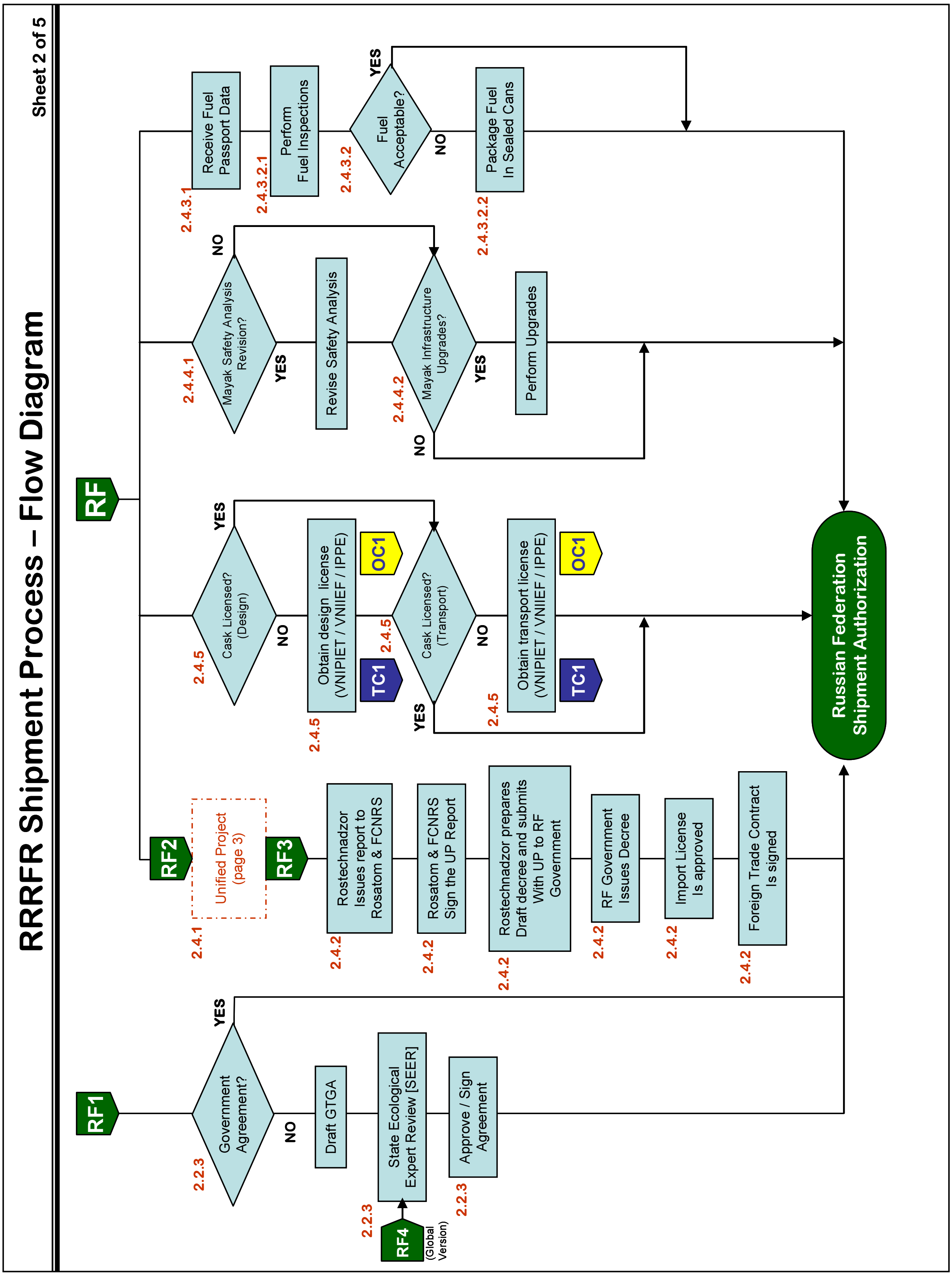
There are 20 TUK-19 casks available for RRRFR shipments. Although Romania will only ship 18 casks, a total of 7 shipping containers and 20 sets of tiedowns will be fabricated to allow the transport of up to 20 casks in one shipment. In addition, handling procedures have been demonstrated at Mayak with a TUK-19 cask in a prototype shipping container. The procedure for loading and unloading a cask shipping container in an AN-124-100 civilian cargo aircraft was demonstrated in August 2008 when empty VPVR/M casks were shipped from Mayak to Budapest in a configuration similar to what will be used for the TUK-19 cask air shipment. A custom shipping container lifting yoke was also designed, fabricated, and demonstrated. After completion of the Romania air shipment in 2009, all equipment and procedures will be available for other RRRFR country shipments.

APPENDIX I. RRRFR PROGRAMME FLOW CHART

RRRFR Shipment Process – Flow Diagram

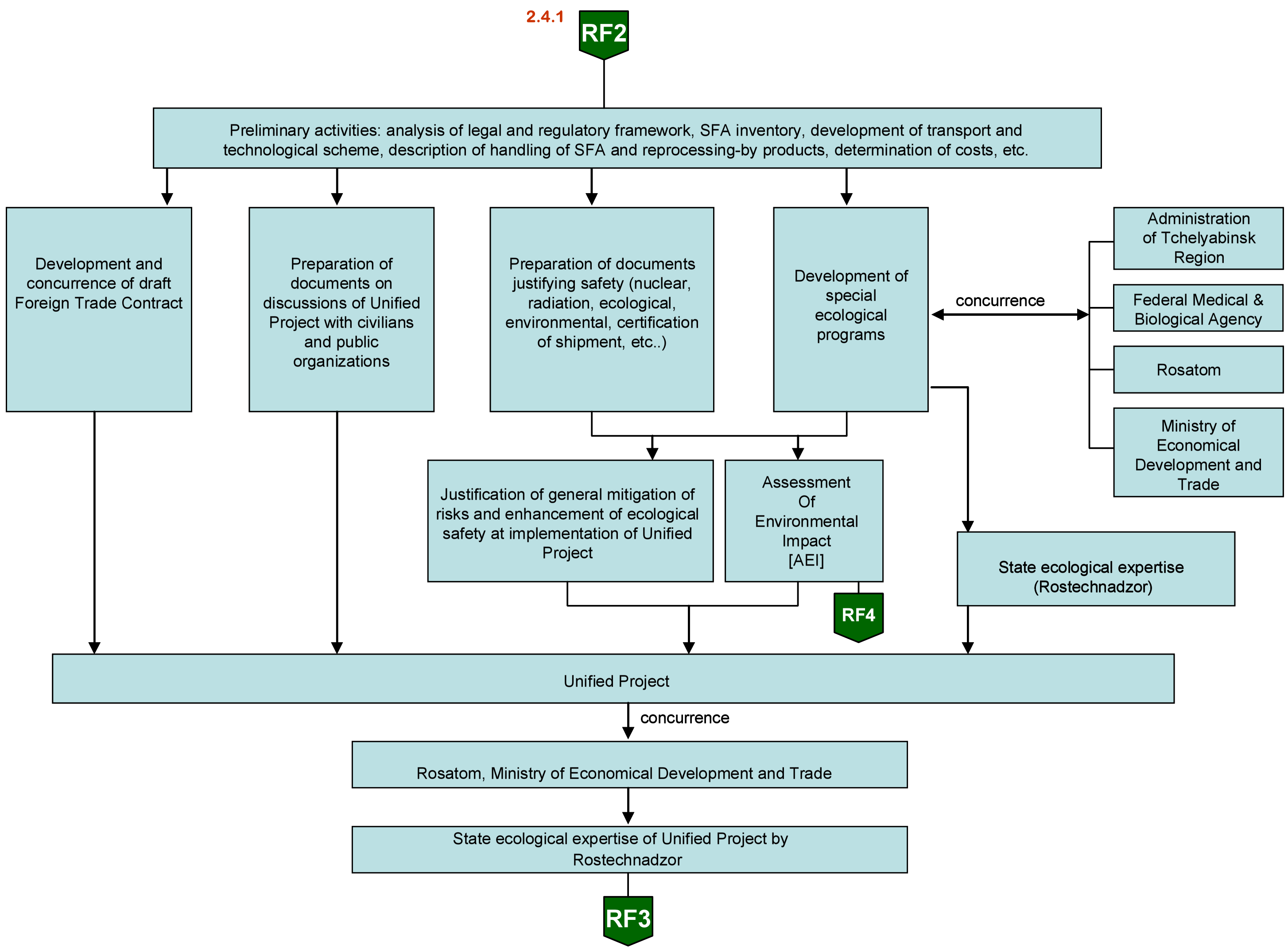
Sheet 1 of 5




RRRFR Shipment Process – Flow Diagram
Sheet 2 of 5
RF1
2.2.3
Government Agreement?
NO
YES
Draft GTGA
State Ecological Expert Review [SEER]
2.2.3
RF4
(Global Version)
2.2.3
Approve / Sign Agreement
RF2
2.4.1
Unified Project (page 3)
RF3
2.4.2
Rostechnadzor Issues report to Rosatom & FCNRS
2.4.2
Rosatom & FCNRS Sign the UP Report
2.4.2
Rostechnadzor prepares Draft decree and submits With UP to RF Government
2.4.2
RF Government Issues Decree
2.4.2
Import License Is approved
2.4.2
Foreign Trade Contract Is signed
RF
2.4.5
Cask Licensed? (Design)
YES
NO
2.4.5
Obtain design license (VNIPIET / VNIIEF / IPPE)
TC1
OC1
2.4.5
Cask Licensed? (Transport)
YES
NO
2.4.5
Obtain transport license (VNIPIET / VNIIEF / IPPE)
TC1
OC1
Russian Federation Shipment Authorization
2.4.4.1
Mayak Safety Analysis Revision?
NO
YES
Revise Safety Analysis
2.4.4.2
Mayak Infrastructure Upgrades?
NO
YES
Perform Upgrades
2.4.3.1
Receive Fuel Passport Data
2.4.3.2.1
Perform Fuel Inspections
2.4.3.2
Fuel Acceptable?
YES
NO
2.4.3.2.2
Package Fuel In Sealed Cans

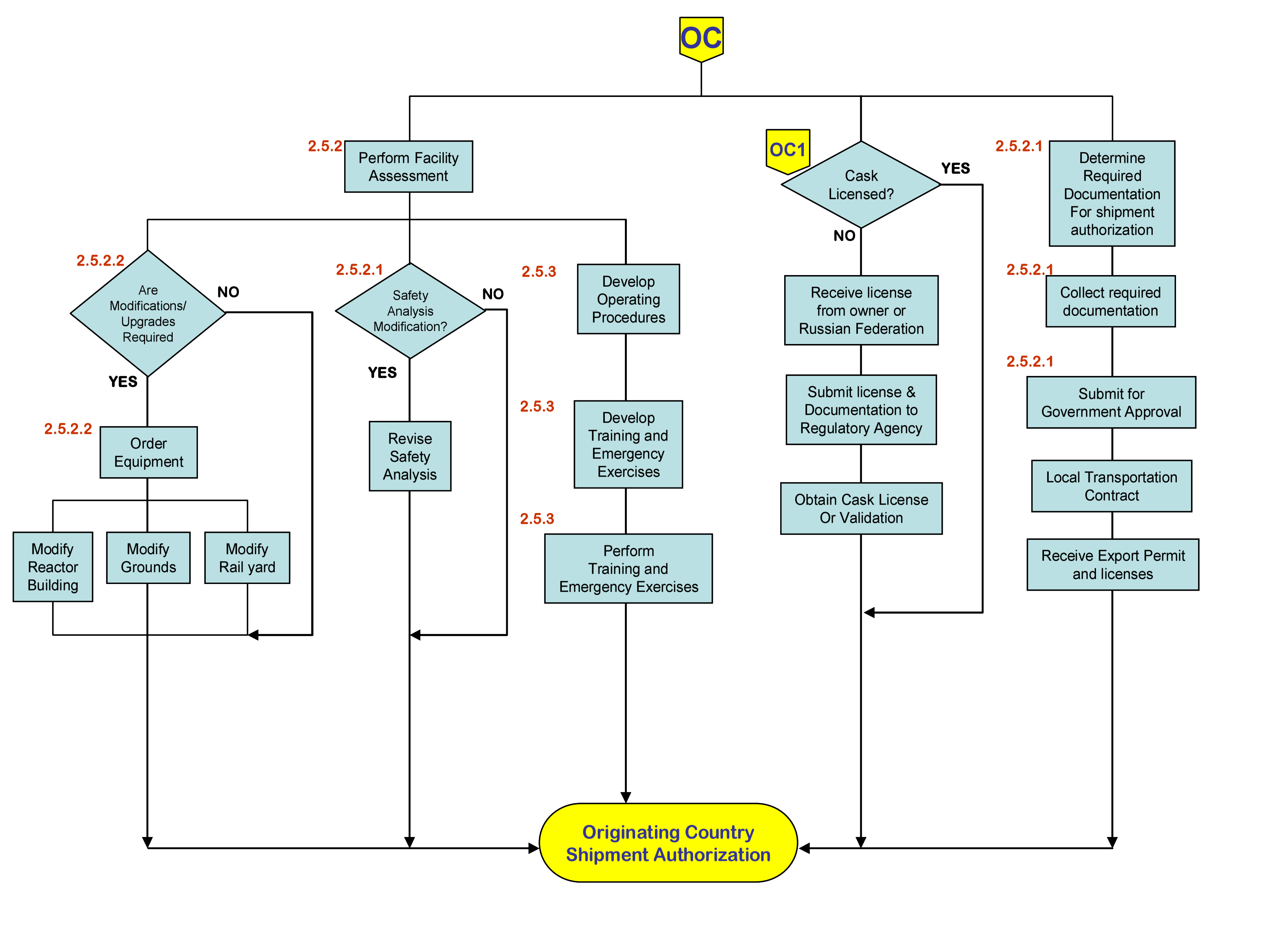
RRRFR Shipment Process – Flow Diagram

Sheet 3 of 5



RRRFR Shipment Process – Flow Diagram

Sheet 4 of 5



APPENDIX II. CONTRACT – TASK PLAN INSTRUCTIONS

Guidelines for the RRRFR Task Plan Worksheets
Ken Allen, August 19, 2005

The RRRFR Task Plan worksheets were revised to provide a better summary of the Task cost and schedule estimates. The Summary Worksheet now shows all costs by Subtask instead of showing labour hours by month. All worksheets were revised to make calculations and to link values to the Summary Worksheet. Each worksheet was formatted to print on one page (8.5”×11” letter format).

II.1. General guidelines

1. Enter information for the blue text and blue values. The blue text ‘ABCDEF’ is a placeholder for text entries.
2. Replace the blue ‘X’ in all places with the Task Number. Subtasks are identified as X.1, X.2, etc. For example, for Task 3, ‘X.1’ should be changed to ‘3.1’ to identify Subtask 3.1.
3. Do not change the black text or black values. Many of the Summary worksheet cells link to other worksheet cells.
4. Delete unnecessary Subtask information where appropriate. Up to 12 Subtasks are allowed on most worksheets. Delete unnecessary cell contents but do not delete any columns.
5. Add more Travel Worksheets, if required, and delete them if not required. Use one Travel Worksheet for each trip.
6. Link the appropriate cell on the worksheets to the appropriate cells on the Summary Worksheet.
7. Before submittal, change all blue text and values to black. Other colours are allowed if highlighting is required.
8. Before submittal, check that each worksheet will print on one page. If not, adjust the page margins (view page) to fit the table.

II.2. Worksheet guidelines

Summary worksheet (Summary tab)

This worksheet summarizes all Task costs and schedule dates on one page and provides space for an authorized contractor signature. The values are either linked from other worksheets or calculated in the appropriate cells.

1. Provide all information shown in blue text.
2. The Task Revision number should match the Revision Number of the Task Description. In most cases, this will be the number zero (0 = original version).
3. Change the Task Plan Revision Number each time the Task Plan is re-submitted for approval. The original submittal should use the number zero.
4. Enter the Task Title as shown in the Task Description.
5. The Estimated Task Award Date should be earlier than, or match, the earliest Start Date for the first Subtask.
6. The Estimated Completion Date should match the last Finish Date on the Labor Worksheets.

7. The Total Task Cost is calculated. This should match the largest value in the Task Cumulative Total row.
8. Change the Subtask numbers in the column headings (X.1, X.2, etc.) to match the number of Subtasks for the particular Task. Delete unused Subtask Number headings and values. Do not delete the columns.
9. Link the Start Date cell for each Subtask with the first Start Date cell on the Labor Worksheet for that Subtask.
10. Link the Start Date in the Task Total column to the earliest Start Date cell on the Summary Worksheet.
11. Link the Finish Date cell for each Subtask to the last Finish Date cell on the Labor Worksheet for that Subtask.
12. Link the Finish Date in the Task Total column to the last Finish Date cell on the Summary Worksheet.
13. Link the Total Labor Hours cell to the Total Subtask Labor Hours cell on the Labor Worksheet for that Subtask.
14. Link the Total Labor Cost cell to the Total Subtask Labor Cost cell on the Labor Worksheet for that Subtask.
15. Link the Overhead Rate cell to the Total Overhead Rate cell on the Overhead Costs Worksheet. The Overhead Rate should be the same for all Subtasks.
16. The Overhead Cost is calculated by multiplying the Total Labor Cost and the Overhead Rate for each Subtask.
17. Link the Material Cost cell to the Subtask Materials Cost cell on the Materials Worksheet for that Subtask.
18. Link the Other Direct Charges cell to the Subtask Cost cell on the Other Direct Charges Worksheet for that Subtask.
19. Link the Subcontractor Cost cell to the Subtask Cost cell on the Subcontractors Worksheet for that Subtask.
20. Link the Travel Cost cell to the Subtask Cost cell on the Travel Summary Worksheet for that Subtask.
21. The Subtask Total Cost is calculated.
22. The Task Cumulative Total value is calculated.
23. The values in the Task Total column are calculated.

Labor Category Worksheet (Labor Rates tab)

This worksheet identifies all types of workers by function and their labor rates. The Labor Rate cells are linked to the Labor Worksheets.

1. Provide all information shown in blue text.
2. Provide a name for the Labor Category of type of worker. Use short but descriptive names. Add or delete names from the worksheet if required.
3. Provide a unique 2-letter Abbreviation for each Labor Category name. These abbreviations are used on the Labor and Travel worksheets.
4. Provide the labor rate for each Labor Category in $USD per hour.
5. Link each Labor Rate to the appropriate Labor Rate ($/hour) cells on each Labor Worksheet.
6. Identify the functional responsibilities for each Labor Category.

Overhead Costs Worksheet (Overhead tab)

This worksheet identifies all overhead costs to be applied to the labor cost.

1. Provide all information shown in blue text.
2. Provide a name for each Overhead Item.
3. Provide a value for each Overhead Rate as a percentage of the labor cost.
4. Provide a justification for the Overhead Rate. Explain why the Overhead Item is required and why the percentage shown is necessary.
5. The Total Overhead Rate is calculated.
6. Link the Total Overhead Rate cell to the Summary Worksheet.

Materials Worksheet (Materials tab)

This worksheet identifies all materials and their costs by Subtask.

1. Provide all information shown in blue text.
2. Delete unnecessary Subtask values and calculations. Do not delete Subtask columns.
3. The Total Materials Cost is calculated.
4. Provide the Material name, Quantity, Unit, and Unit Price for each material. Use appropriate Units, such as, each, box, lot, m^2, kg, etc. Provide each Unit Price in $USD.
5. Determine which Subtask will procure each material. The worksheet calculates the material cost as the Quantity multiplied by the Unit Price. For flexibility, the template worksheet calculates the same material costs for all cells in each row. To prevent duplicate costs, keep the calculated value for the appropriate Subtask and delete the calculations for all other Subtask cells in that row.
6. Provide the source of the Unit Price, such as, vendor quotation, catalogue, internet, sales representative, prior purchase, etc. This information will help determine if the cost is reasonable.
7. Provide comments. Explain why the material is necessary, why the supplier was selected, justify the cost, explain any special circumstances, etc.
8. Link each Subtask Materials Cost cell to the appropriate Material Cost cell on the Summary Worksheet.
9. The Total Materials Cost is calculated.

Other Direct Charges Worksheet (ODC tab)

This worksheet identifies all Other Direct Charges (ODC), which are costs that do not fit other worksheet categories.

1. Provide all information shown in blue text.
2. Delete unnecessary Subtask values and calculations. Do not delete Subtask columns.
3. Provide a name for the Charge. Delete the example charges that do not apply. Add charges if necessary.
4. Provide a Basis for Charge for each item. Explain why the charge is required and how the charge was calculated. This information will help determine if the cost is reasonable.
5. Enter the cost, in $USD, for each charge in the Subtask cell in which the work will be performed.
6. Link the Subtask Cost cell to the appropriate Other Direct Charges cell on the Summary Worksheet.
7. The Total Task Cost is calculated.

Subcontractors Worksheet (Subcontractors tab)

1. This worksheet identifies all Subcontractors and their costs. Be prepared to provide more detailed information for each Subcontractor.
2. Provide all information shown in blue text.
3. Delete unnecessary Subtask values and calculations. Do not delete Subtask columns.
4. Provide the Subcontractor Name, city, and country.
5. Provide a Description of Work for each subcontractor.
6. Provide a Justification for selecting each subcontractor.
7. Enter the cost, in $USD, for each subcontractor in the Subtask cell in which the work will be performed.
8. Link the Subtask Cost cell to the appropriate Subcontractor Cost cell on the Summary Worksheet.
9. The Total Subcontractor Cost is calculated.

Travel Summary Worksheet (Travel Summary table)

This worksheet summarizes the costs of all travel by subtask. The input values should be linked to come from the individual Travel Worksheets. The total Subtask Cost is linked to the appropriate Travel Cost cell on the Summary Worksheet.

1. The individual Travel Worksheets must be completed before this worksheet.
2. Provide all information shown in blue text.
3. Delete unnecessary Subtask values and calculations. Do not delete Subtask columns.
4. Provide a Destination name for each Trip Number. The Trip Number and Destination must match the information on the individual Travel Worksheets.
5. Link the Total Trip Cost from the individual Travel Worksheet to the appropriate Subtask cell on the Travel Summary Worksheet. Multiple trips, or no trips, may be listed for each Subtask.
6. The Subtask Cost is calculated.
7. Link the Subtask Cost cell to the appropriate Travel Cost cell on the Summary Worksheet.
8. The Total Travel Cost is calculated.

Labor Worksheet (Labor 1, Labor 2, etc. tabs)

These worksheets identify all jobs, schedule dates, labor hours, and labor costs for each Subtask. Use one Labor Worksheet for each Subtask. The results of these worksheets are linked to the Summary Worksheet.

1. Provide all information shown in blue text.
2. Use one worksheet for each Subtask.
3. Delete unnecessary Labor Category values and calculations on each worksheet. Do not delete columns.
4. Provide the Assumptions information. Add assumptions if helpful.
5. Provide Labor Category 2-letter abbreviations as column headings. Use the abbreviations from the Labor Category Worksheet.
6. Provide the number people of each Labor Category that will work on the Subtask.
7. Link each Labor Rate ($/hour) cell to the appropriate cell on the Labor Category Worksheet.
8. Provide a Job Number for each job required to complete the Subtask. Use the format X.Y.Z, where X = Task number, Y = Subtask number, and Z = Job number. For example, Job Number ‘3.5.2’ would be Task 3, Subtask 5, Job 2.

9. Provide a short Job Description for each Job Number.
10. Provide Start and Finish dates for each Job. Enter numerical dates in US format as MM/DD/YYYY, where MM = month, DD = day, and YYYY = year. The dates will be changed to a DD-MMM-YY format by the spreadsheet.
11. Provide the number of hours each Labor Category will work on each Job.
12. The Total Labor Hours by Category will be calculated as the sum of each Labor Category multiplied by the Number of Each Category.
13. The Total Labor Cost by Category is calculated as the Labor Rate multiplied by the Total Labor Hours by Category.
14. The Total Subtask Labor Hours value at the top of the worksheet is calculated.
15. Link the Total Subtask Labor Hours cell to the Total Labor Hours cell on the Summary Worksheet for that Subtask.
16. The Total Subtask Labor Cost value at the top of the worksheet is calculated.
17. Link the Total Subtask Labor Cost cell to the Total Labor Cost cell on the Summary Worksheet for that Subtask.

Travel Worksheet (Travel 1, Travel 2, etc. tabs)

These worksheets estimate all travel and travel costs for the Task. The results of these worksheets are linked to the Travel Summary Worksheet.

1. Provide all information shown in blue text.
2. Use one Travel Worksheet for each trip. Add or delete worksheets as required.
3. Provide a unique Trip Number for each Travel Worksheet.
4. The Job Number, Destination(s), and Purpose must match the work to be performed by the Job Number described on the appropriate Labor Worksheet.
5. Provide the 2-letter abbreviation for the Labor Category of all travellers on the trip.
6. Enter the correct value in the Number of Travellers cell.
7. Provide information for each day of the travel. Enter the appropriate Day Number for the costs reported. Multiple lines may be used for a single Day, if required.
8. Provide the travel Location. Use the location where the travel cost is incurred.
9. Provide a short Description. For example, for a trip from London to Vienna, the Location would be ‘London’ and the Description might be ‘Departure to Vienna.’ If a taxi is required, the description might be ‘Taxi from airport to hotel’.
10. Enter the estimated costs for ONE person. The Total Amount Claimed costs for Transportation and Subsistence will multiply the entered costs by the Number of Travellers to give a total cost for all travellers.
11. If an automobile is used for the travel, enter the distance (km) and the rate ($/km). The Transportation-Automobile-Cost value is calculated.
12. If another type of transportation is used for each traveller, enter the cost per person in the Transportation-Other cell. If there is transportation cost for all travellers, enter the cost in the Total Amount Claimed–Other cell.
13. Enter the estimated cost for lodging and meals for each person for each day.
14. The Total Amount Claimed costs for Transportation and Subsistence are calculated (see item 10). The Transportation-Other and Subsistence–Other costs are included in these calculations.
15. The Total Amount Claimed-Other cost is NOT calculated. Enter a value if required.
16. The Subtotal costs for Total Amount Claimed are calculated.
17. The Total cost at the bottom of the worksheet is calculated.
18. The Total Trip Cost at the top of the worksheet is linked to the Total cost at the bottom.

Link the Total Trip Cost at the top of the worksheet to the Cost by Subtask cell on the Travel Summary Worksheet for that Subtask.

APPENDIX III. TUK-19 CASK LICENSE

ФЕДЕРАЛЬНОЕ АГЕНТСТВО ПО АТОМНОЙ ЭНЕРГИИ

СЕРТИФИКАТ-РАЗРЕШЕНИЕ
НА ПЕРЕВОЗКУ

Перевозка упаковок ТУК-19
с отработавшими тепловыделяющими сборками
типа ИРТ-2М, ИРТ-3М
исследовательского реактора ВВР-СМ

RUS/0107/B(U)F-96T

Выдан 16 мая 2005 года

Срок действия **31 мая 2008 года**

Заместитель руководителя Агентства **С.В. Антипов**

Москва

Лист утверждения

СОГЛАСОВАНО
Вр. и. о. руководителя
Федеральной службы
по экологическому,
технологическому
и атомному надзору
___________ А.Б. Малышев
«____» _______ 2005г

СОГЛАСОВАНО
Главный Государственный
санитарный врач по объектам и
территориям, обслуживаемым
Федеральным Управлением
«Медбиоэкстрем»
___________ В.В. Романов
«_03_» __05__ 2005г

УТВЕРЖДАЮ
Заместитель руководителя
Федерального агентства
по атомной энергии
___________ С.В. Антипов
«_16_» _05__ 2005г

СЕРТИФИКАТ-РАЗРЕШЕНИЕ НА ПЕРЕВОЗКУ

Перевозка упаковок ТУК-19
с отработавшими тепловыделяющими сборками
типа ИРТ-2М, ИРТ-3М
исследовательского реактора ВВР-СМ

RUS/0107/B(U)F-96T

Действителен до 31 мая 2008 года

Начальник Управления по регулированию
безопасности объектов ядерного топливного
цикла, надзору за учетом и контролем
ядерных материалов и радиоактивных веществ
и физической защитой Федеральной службы
по экологическому, технологическому
и атомному надзору
___________ В.С. Беззубцев
«_13_» __05__ 2005г

Главный инженер
ФГУП «ГИ «ВНИПИЭТ»
___________ В.И. Калинкин
«_26_» _апреля_ 2005г

Технический директор
ФГУП «ПО «Маяк»

__ВЭД–1866__ А.П. Суслов
«_21_» _04_ 2005г

Начальник Управления ядерной
и радиационной безопасности
Федерального агентства
по атомной энергии
___________ А.М. Агапов
«_03_» __05__ 2005г

Начальник отдела организации
специальных перевозок Управления
вывода из эксплуатации ядерных
и радиационноопасных объектов
Федерального агентства
по атомной энергии
___________ В.В. Ананьев
«_3_» _05__ 2005г

Заявитель, грузополучатель	**Федеральное государственное унитарное предприятие «Производственное объединение «Маяк» (ФГУП «ПО «Маяк») г. Озерск Челябинской обл.**
Грузоотправитель	**Институт ядерной физики Академии наук, Республика Узбекистан, п. Улугбек**

Настоящий сертификат-разрешение допускает перевозку на транспортных средствах, описание которых приведено в разделе 1, упаковок ТУК-19 с радиоактивным содержимым в виде отработавших тепловыделяющих сборок типа ИРТ-2М, ИРТ-3М реактора ВВР-СМ на условиях исключительного использования в соответствии с требованиями документов, указанных в разделе 7.

Соответствие конструкции упаковки ТУК-19 с отработавшими ТВС типа ИРТ-2М, ИРТ-3М требованиям «Правил безопасности при транспортировании радиоактивных материалов» НП-053-04 и «Правил безопасной перевозки радиоактивных материалов. Издание 1996 года». МАГАТЭ №TS-R-1 (правила МАГАТЭ №TS-R-1) подтверждено сертификатом-разрешением на конструкцию упаковки RUS/0107/B(U)F-96.

Настоящий сертификат не освобождает грузоотправителя от выполнения любого требования правительства любой страны, на территорию или через территорию которой будет транспортироваться данная упаковка.

Обозначение транспортного упаковочного комплекта: **ТУК-19**
Опознавательный знак упаковки: **RUS/0107/B(U)F-96.**

1. ТРАНСПОРТНЫЕ СРЕДСТВА

1.1. Транспортное средство для перевозки упаковок - специальный железнодорожный вагон ТК-5 черт. ТК-5 С600Д1СБ или вагон ТК-5 черт. ТК-5 С600Д1СБ, дооборудованный по черт. Л.65.661.00.000 съемной радиационной защитой в виде стальных плит, устанавливаемых вдоль боковых стенок вагона.

Вагон ТК-5 представляет собой четырехосный транспортер с кузовом. Кузов вагона имеет три отсека: грузовой и два вспомогательных. В грузовом отсеке вагона имеется рама для размещения и крепления восьми упаковок.

Предусмотрена естественная вентиляция кузова вагона. Крыша грузового отсека выполнена в виде двух створок, открывающихся гидроприводом.

При перевозке упаковок формируется специальный поезд, в состав которого включается два вагона ТК-5, вагон сопровождения ТК-ВС или связка вагонов сопровождения ВС-ТК-3 и ВС-ТК-4, вагоны прикрытия произвольной конструкции.

Вагоны сопровождения предназначены для размещения персонала сопровождения специального поезда и охраны, а также оборудования и средств жизнеобеспечения персонала.

Количество упаковок в вагоне – 8 штук.

Категория перевозки упаковок с ОЯТ железнодорожным транспортом – КП-1.

1.2. Для перевозки ТУК-19 с ОЯТ за пределами Российской Федерации допускается использование автомобильного транспортного средства, дооборудованного в соответствии с техническими требованиями к автомобильному транспортному средству, изложенными в документе «Сборки тепловыделяющие, отработавшие в ядерном исследовательском реакторе ВВР-СМ Института ядерной физики Академии наук Республики Узбекистан. Поставка на завод регенерации России. Технические условия», уч. №0977/48-2004.

Крепление упаковки на автотранспортном средстве осуществляется в соответствии со схемой, разработанной грузоотправителем.

На одном автотранспортном средстве допускается перевозка одной упаковки.

2. РАДИОАКТИВНОЕ СОДЕРЖИМОЕ

2.1. В транспортном упаковочном комплекте ТУК-19 осуществляется перевозка отработавших ТВС типа ИРТ-2М и ИРТ-3М, которые удовлетворяют требованиям документа «Сборки тепловыделяющие, отработавшие в ядерном исследовательском реакторе ВВР-СМ Института ядерной физики Академии наук Республики Узбекистан. Поставка на завод регенерации России. Технические условия», уч. № 0977/48-2004.

2.2. Характеристики ОТВС ИРТ-2М, ИРТ-3М, допускаемых к загрузке в ТУК-19 при перевозке восьми упаковок в вагоне ТК-5, дооборудованном съемной радиационной защитой, соответствуют сертификату-разрешению на конструкцию упаковки RUS/0107/B(U)F-96.

Ограничения по времени выдержки ОТВС ИРТ-3М, допускаемых к загрузке в ТУК-19, по сравнению с сертификатом-разрешением RUS/0107/B(U)F-96 при перевозке восьми упаковок в вагоне ТК-5, недооборудованном радиационной защитой, приведены в таблице.

Тип ТВС	Обогащение топлива по урану-235	Глубина выгорания топлива	Время выдержки ОТВС, не менее
	%	%	год
ИРТ-3М	36	до 50	9
		от 50 до 60	10
ИРТ-3М	90	до 56	8
		от 56 до 64	9
		от 64 до70	9,5
		от 70 до 74	12

3. РАДИАЦИОННАЯ БЕЗОПАСНОСТЬ

3.1. При перевозке в железнодорожном вагоне ТК-5 восьми упаковок и при перевозке на автомобильном транспортном средстве одной упаковки, загруженных ОТВС с характеристиками, приведенными в разделе 2 настоящего сертификата, мощность эквивалентной дозы ионизирующего излучения на поверхности транспортного средства и на расстоянии 2 м от вертикальных плоскостей, образованных внешними боковыми поверхностями транспортного средства, не превышает, соответственно, значений 2 мЗв/ч и 0,1 мЗв/ч, допускаемых правилами НП-053-04, правилами МАГАТЭ №TS-R-1 и «Санитарными правилами по радиационной безопасности персонала и населения при транспортировании радиоактивных материалов (веществ). Санитарные правила и нормативы. СанПиН 2.6.1. 1281-03».

3.2. При перевозке упаковок железнодорожным транспортом выполняются положения «Программы радиационной защиты при транспортировании отработавшего ядерного топлива». №35/2635, ФГУП «ПО «Маяк», 2004.

4. УСЛОВИЯ ЭКСПЛУАТАЦИИ

Эксплуатация транспортного упаковочного комплекта ТУК-19, упаковки и вагона ТК-5 осуществляется в соответствии с документами «Комплект транспортный упаковочный с контейнером 19. Техническое описание и инструкция по эксплуатации Д. 65.009.000 ТО» и «Вагон ТК-5. Техническое описание и инструкция по эксплуатации. №ТК ТО 1».

5. АВАРИЙНЫЕ УСЛОВИЯ

5.1. В случае аварии при перевозке упаковок необходимо руководствоваться аварийной карточкой № 914-В.

5.2. В случае возникновения аварийной ситуации оперативно доложить:

– диспетчеру Оперативной отраслевой диспетчерской ФГУП «Атомспецтранс» (круглосуточно) по тел.(095) 239-44-81;

– диспетчеру ФГУП «СКЦ Федерального агентства по атомной энергии» по тел. (095) 933-60-44, (095) 239-24-28, (095) 953-23-05; факс: (095) 933-60-45; (095) 239-24-35;

– диспетчеру ФГУП «АТЦ Федерального агентства по атомной энергии» (круглосуточно) по тел.: (812) 247-56-53;

– диспетчеру ФГУП «ПО «Маяк» по тел. (35130)216-59.

6. ОБЕСПЕЧЕНИЕ КАЧЕСТВА

Качество при эксплуатации упаковок ТУК-19 и вагонов ТК-5 обеспечивается в соответствии со следующей документацией:

Частная программа обеспечения качества при эксплуатации средств транспортирования для перевозки ядерных делящихся радиоактивных материалов. ПОК-(Э)-2004, инв. № 14524, ФГУП «ПО «Маяк».

Программа проверки технического состояния ТУК-19, ТУК-42 и вагона ТК-5, инв. № 12015. ФГУП «ПО «Маяк».

7. НОРМАТИВНЫЕ И РУКОВОДЯЩИЕ ДОКУМЕНТЫ

7.1. Правила безопасности при транспортировании радиоактивных материалов. НП-053-04. Федеральная служба по экологическому, технологическому и атомному надзору, 2004.

7.2. Правила безопасной перевозки радиоактивных материалов. Издание 1996 года. №TS-R-1 МАГАТЭ, Вена, 2000.

7.3. Нормы радиационной безопасности (НРБ-99). СП 2.6.1. 758-99. Минздрав России, 1999.

7.4. Основные санитарные правила обеспечения радиационной безопасности (ОСПОРБ-99). СП 2.6.1.799-99. Минздрав России, 2000.

7.5. Санитарные правила по радиационной безопасности персонала и населения при транспортировании радиоактивных материалов (веществ). Санитарные правила и нормативы СанПиН 2.6.1. 1281-03. Минздрав России, 2003.

7.6. Инструкция по перевозке специальных грузов (ИСП) МПС, 1980.

7.7. Аварийная карточка № 914-В, инв. № 30-728 ДСП, Минатом России, 1996.

7.8. Сборки тепловыделяющие, отработавшие в ядерном исследовательском реакторе ВВР-СМ Института ядерной физики Академии наук Республики Узбекистан. Поставка на завод регенерации России. Технические условия. Уч. №0977/48-2004. ФГУП «ГИ «ВНИПИЭТ», 2004.

8. ДОКУМЕНТАЦИЯ, НА ОСНОВАНИИ КОТОРОЙ СОСТАВЛЕН СЕРТИФИКАТ-РАЗРЕШЕНИЕ

8.1. Заявка №35/2436 на выдачу сертификата-разрешения на перевозку отработавших ТВС типа ИРТ-3М, ИРТ-2М в транспортном упаковочном комплекте ТУК-19 железнодорожным и автомобильным транспортом. ФГУП «ПО «Маяк», 2004.

8.2. Сертификат-разрешение на конструкцию упаковки. Транспортный упаковочный комплект ТУК-19 с отработавшими тепловыделяющими сборками типа ИРТ-2М, ИРТ-3М исследовательских реакторов. RUS/0107/B(U)F-96.

8.3.Транспортный упаковочный комплект ТУК-19 для перевозки отработавших тепловыделяющих сборок типа ИРТ-2М, ИРТ-3М. Сводный отчет по безопасности. Инв. №3448. ФГУП «ГИ «ВНИПИЭТ», 2005.

8.4. Экспертное заключение о соответствии конструкции транспортного упаковочного комплекта ТУК-19 и перевозки в нем отработавших тепловыделяющих сборок ИРТ-2М, ИРТ-3М требованиям Правил безопасности при транспортировании радиоактивных материалов НП-053-04 и Правил безопасной перевозки радиоактивных материалов МАГАТЭ (TS-R-1). Регистрационный номер 126-1011. ФГУП «РФЯЦ-ВНИИЭФ», 2005.

Информация о сертификате-разрешении
Сертификат-разрешение RUS/0107/B(U)F-96T разработан впервые.

По всем вопросам, связанным с сертификатом-разрешением, следует обращаться:
в Управление ядерной и радиационной безопасности Федерального агентства по атомной энергии:
ул. Б. Ордынка, д. 24/26, Москва, 119017, тел. (095) 239-29-27, факс (095) 951-68-43;

в Федеральную службу по экологическому, технологическому и атомному надзору:
ул. Таганская, д. 34, Москва, 109147, тел. (095) 911-60-64, факс (095) 912-12-23;

в ФГУП «ГИ «ВНИПИЭТ»: ул. Савушкина, д.82, Санкт Петербург, 197183,
тел/факс (812) 430-46-32.

Действительны только учтенные копии сертификата-разрешения с подлинной печатью ФГУП «ГИ «ВНИПИЭТ» или Управления ядерной и радиационной безопасности Федерального агентства по атомной энергии.

APPENDIX IV. SKODA VPVR/M CASK LICENSE (ENGLISH VERSION)

STÁTNÍ ÚŘAD PRO JADERNOU BEZPEČNOST
Senovážné náměstí 9, 110 00 Praha 1

In Prague, on: 23 March 2005
Ref. No.: 6943/2005
Document No.: 27305/2004
Attended by: RAW and SNF Disposal Department

D E C I S I O N

The State Office for Nuclear Safety, as the administration body competent pursuant to Section 3(2)(c) of Act No. 18/1997 Coll., on the peaceful use of nuclear energy and ionizing radiation (the Atomic Act) and on amendments and supplements to some other acts, as amended, in the administrative procedure opened on 30 December 2004 on the basis of an application submitted by ŠKODA JS a. s., Orlík 266, 316 06 Plzeň, Identification Number 25235753 (the "Applicant"), of 20 December 2004 in the matter of the type approval of a cask for transport and storage of spent nuclear fuel from Škoda VPVR/M research reactors, presented as an enclosure to letter No. JAD-GŘ/106/04 of 20 December 2004 pursuant to the provisions of Section 23 of Act No. 18/1997 Coll.:

I

t y p e – a p p r o v e s

the Škoda VPVR/M transport and storage cask, the B(U)F type,

for road and rail transport, inland waterways and sea transport

of spent nuclear fuel – fuel assemblies or elements from research nuclear reactors, and assigns the cask the following identification designation:

CZ/048/B(U)F–96.

For the purposes of international identification, the State Office for Nuclear Safety assigns the type-approval decision of the Škoda VPVR/M cask for spent nuclear fuel transport the following code designation:

CZ/048/B(U)F–96 (Rev. 1).

The Škoda VPVR/M cask of the B(U)F type, identification designation CZ/048/B(U)F–96, meets the requirements of the International Atomic Energy Agency recommendation titled "Edition of IAEA Safety Standards, Rules for Safe Transport of Radioactive Materials, Issue 2003, Requirements, Ref. No. TS-R-1, IAEA, Vienna, 2004" and of those international traffic regulations which refer to the International Atomic Energy Agency rules cited above.

II

t y p e – a p p r o v e s

the Škoda VPVR/M transport and storage cask, the B(U)F type,

for storage

of spent nuclear fuel – fuel assemblies or elements from research nuclear reactors.

Description of Škoda VPVR/M cask:

The Škoda VPVR/M cask, identification designation **CZ/048/B(U)F–96,** as illustrated in the Enclosure which forms an integral part of this Decision, is intended for road and rail transport, inland waterways and sea transport of 36 undamaged fuel assemblies (FA) with spent nuclear fuel (SNF) from research nuclear reactors or 36 stainless containers with damaged FA and/or with fuel elements from damaged FA and/or with parts of fuel elements from damaged FA. The cask can also be used to store:

- 36 undamaged FA with SNF of EK-10, IRT-2M or IRT-3M types; and/or
- 36 stainless containers with damaged FA of EK-10 type; and/or
- 36 stainless containers with fuel elements or parts of damaged FA of EK-10 type.

The cask manufacturer is ŠKODA JS a. s., Orlík 266, 316 06 Plzeň.

The cask body is of a cylindrical shape, with the external surface rounded to narrow in the upper and lower parts.

The inner space of the cask of a cylindrical shape with aluminium paint-coated smooth surface houses a basket made of ATABOR sheets, consisting of 36 square cells for fuel and a central hole for basket suspension. The cask is closed by means of a system of two upper and two lower lids equipped with sealing. Each of the lids is attached to the cask body separately with screws.

The upper primary lid consists of a thick-walled cylindrical plate of 630 mm in diameter. The centre of the lid provides a hole for the central basket suspension. The lid also provides holes for drying up the inner space of the cask before sealing the secondary lid and holes for the basket pull rods. The lower primary lid is analogical in dimensions with the upper one. The central hole provides a thread for fixing the central suspension and there are threaded holes for the basket pull rods.

The upper secondary lid is a round plate the inner front area of which is stepped to fit into the inner recess of the cask body to fix the lid along with the 8 guide springs against undesirable external forces. The guide springs are attached with screws along the circumference of the lid. The lid provides also a valve well for vacuuming and filling the cask with helium. The well is covered with a massive cap. The lower secondary lid is analogical in dimensions with the upper one but lacks the well for the helium-filling valve. Each of the secondary lids is attached to the body with 16 M36 screws. The inner space between the primary and secondary lid serves for monitoring the cask leak proof quality.

General nominal parameters of the Škoda VPVR/M cask:

Outer cask body diameter	1 200 mm
Height without shock absorbers	1 505 mm
Height with shock absorbers	2 155 mm
Cask cylindrical wall thickness	300 mm
Maximum weight of loaded cask	
- without shock absorbers	11 150 kg
- with shock absorbers	12 390 kg
Maximum weight of loaded FA with SNF	450 kg.

For transport, casks must be provided with the following visible, legible and permanent data:

- Designation of the carrier, the consignee, or both;
- An UN number preceded with letters "UN" and followed with the correct transportation title;
- Maximum weight of filled cask in kg;
- Cask identification designation: CZ/048/B(U)F–96;
- Cask serial number;
- Title and type: Škoda VPVR/M, B(U)F type;
- The radioactivity symbol executed in a manner resistant to fire and water.

The type-approved Škoda VPVR/M cask of B(U)F type, identification designation CZ/048/B(U)F–96, can be used for road and rail transport, inland waterways and sea transport, as well as for storage of loaded assemblies (LA), namely:

A. Undamaged fuel assembly

B. Stainless hermetic container
   a) with damaged fuel assembly
   b) with fuel elements from damaged fuel assembly
   c) with parts of fuel elements from damaged fuel assembly

under the following conditions only:

1. Cask radioactive contents admissible for transport

a) Types of LA with SNF which can be loaded into cask	EK-10, S-36, VVR-M, VVR-M2, VVR-M5, VVR-M7, VVR-(S)M, IRT-2M, IRT-3M, TVR-S
b) Number of LA in cask	max. 36
c) Total activity of all LA in cask	max. $3.93.10^{15}$ Bq
d) Residual thermal power of one LA in cask	max. 37.5 W
e) Total LA residual thermal power in cask	max. 450 W

f) Initial nominal enrichment of fresh nuclear fuel with isotope ^{235}U — max. 90 % by weight
g) Weight of ^{235}U in every LA in cask — max. 500 g

2. Cask radioactive contents admissible for storage

a) Types of LA with SNF which can be loaded into cask — EK-10, IRT-2M IRT-3M
b) Number of LA in cask — max. 36
c) Total activity of all LA in cask — max. $3.93.10^{15}$ Bq
d) Residual thermal power of one LA in cask — max. 37.5 W
e) Total LA residual thermal power in cask — max. 450 W
f) Initial nominal enrichment of fresh nuclear fuel with isotope ^{235}U — max. 80 % by weight
g) Maximum weight of ^{235}U in every LA in cask — 500 g

3. Method of loading fuel assemblies with SNF or fuel elements with SNF into cask

a) Aftercooling period of LA with SNF (except for EK-10) — at least 36 months
b) The following table determines the number of LA with SNF (except for EK-10) which can be loaded into cask in dependence on fuel burn-up and on its aftercooling period:

Burn-up [MWd/LA	**Aftercooling period [years]**				
	3	**4**	**5**	**6**	**7**
	Maximum number of fuel assemblies in cask [pcs]				
20	36	36	36	36	36
40	36	36	36	36	36
60	36	36	36	36	36
80	36	36	36	36	36
100	23	34	36	36	36
120	19	29	36	36	36
140	17	25	36	36	36
160	15	22	36	36	36
180	13	20	36	36	36
200	12	18	33	36	36

c) Aftercooling period for LA with SNF of the EK-10 type on initial nominal enrichment with isotope ^{235}U to 10 % by weight — at least 240 months
d) A maximum number of 36 symmetrically distributed LA, each of them containing maximum 49 fuel elements or their parts from FA of the EK-10 type with SNF, with maximum mean burn-up of 20 MWd/tU, with the initial nominal enrichment with isotope ^{235}U to 10 % by weight, can also be placed in cask.

4. Cooling medium

The cooling medium inside the cask is helium gas of maximum operating pressure up to 0.07 MPa (absolute pressure).

5. Leak test

The cask must be subject to a documented helium leak test for SNF transport and storage in the cask in accordance with Chapter 7.7 "Vacuuming and Leak Tests" of safety documentation "Transport and Storage Cask for Spent Fuel from Research Reactors (Škoda VPVR/M Cask), Safety Documentation for Type Approval according to SÚJB Decree No. 317/2002 Coll.", Ae 11543/Dok, Rev. 1, ŠKODA JS a. s., Plzeň, February 2005, with the criterion of maximum leakage being 1.10^{-7} $Pa.m^3.s^{-1}$ for every examined sealing barrier.

6. Drying the inner space of loaded cask

After closing and decontamination of a cask loaded with FA with SNF or with fuel elements with SNF, the cask inner space must be dried and the drying documented in accordance with Chapter 7.4.8 "Drying" of safety documentation "Transport and Storage Cask for Spent Fuel from Research Reactors (Škoda VPVR/M Cask), Safety Documentation for Type Approval according to SÚJB Decree No. 317/2002 Coll.", Ae 11543/Dok, Rev. 1, ŠKODA JS a. s., Plzeň, February 2005.

The contents of residual water in the cask inner space after drying must not exceed 10g of H_2O per m^3 of cask inner capacity and this value must be achieved before executing the helium leak tests. The dryness criterion of the volume being dried is the meeting of the $\Delta p/\Delta t \leq 300$ Pa/15 min condition for pressure increase rate in the space being dried on absolute pressure less than 600 Pa in the cask inner space.

7. Dosimetric check

After decontamination, the cask must be subject to a documented dosimetric check and the dose equivalent input may not exceed 2 mSv/h and 0.1 mSv/h on the cask surface and at a distance of 2 m there from respectively.

Non-fixed cask surface contamination must not exceed:

- for gamma and beta active nuclides 4.0 Bq/cm^2,
- for alpha active nuclides with low toxicity 4.0 Bq/cm^2,
- for other alpha active nuclides 0.4 Bq/cm^2,

after averaging the results of rubbing an area of 300 cm^2 at the locations of the highest cask local contamination. This condition applies also to empty casks.

8. Maximum admissible cask surface temperature

The level of cask outer surface temperature at easily accessible locations must not exceed 85 °C during transport. If the cask outer surface temperature is higher than 50°C, transport must be realized under the conditions of exclusive use.

The cask body surface temperature must not exceed 85 °C during SNF storage.

9. Handling and maintenance

Casks will be handled and maintained in accordance with Chapter 7 "Operation and Maintenance" of safety documentation "Transport and Storage Cask for Spent Fuel from Research Reactors (Škoda VPVR/M Cask), Safety Documentation for Type Approval according to SÚJB Decree No. 317/2002 Coll.", Ae 11543/Dok, Rev. 1, ŠKODA JS a. s., Plzeň, February 2005.

10. In-service inspections

In-service inspections will be performed and documented in accordance with Chapter 6 "Periodicity of Cask In-Service Inspections" of document "Appendix No. 10 to Škoda VPVR/M Cask Safety Documentation, Manual for Compliance Verification and Assessment of Škoda VPVR/M Cask Qualities and Parameters according to the provisions of Section 6 of Decree No. 317/2002 Coll.", Ae 11 543/Dok, Rev. 1, ŠKODA JS a. s., Plzeň, December 2004, namely:

- Yearly periodical visual checks of secondary lid screws, joints between secondary lid and cask body, suspension pin screws and suspension pins on storage;
- Yearly periodical checks of pressure in cask;
- Visual check of all cask basic components after every transport and before starting filling an already used cask. Before any basket handling operation, check the central suspension bayonet terminal for integrity. After every transport, replace the Helicoflex sealing of both cask secondary lids;
- Periodical checks of suspension pin screws for corrosion once in five years.

11. Quality assurance

11.1. Every cask identified CZ/048/B(U)F–96 and assigned a serial number must be manufactured in compliance with the type-approved cask and must meet the parameters declared in safety documentation "Transport and Storage Cask for Spent Fuel from Research Reactors (Škoda VPVR/M Cask), Safety Documentation for Type Approval according to SÚJB Decree No. 317/2002 Coll.", Ae 11543/Dok, Rev. 1, ŠKODA JS a. s., Plzeň, February 2005. The manufacturer is responsible for meeting this condition.

11.2. Casks must be manufactured in accordance with the applicable Quality Plan of ŠKODA JS a. s., PZJ 02-04, Revision No. 2 of 18 February 2005, relating to the manufacture of cask of this design type. The manufacturer is responsible for meeting this condition.

11.3. The compliance of every cask with the approved type must be verified and documented by means of a written certificate of compliance. The manufacturer is responsible for meeting this condition.

12. Marking

Pursuant to the provisions of Section 20(1)(b) of Act No. 18/1997 Coll. and Section 9(f) of Decree No. 317/2002 Coll., on type-approving casks for transport and storage of nuclear materials and radioactive substances, on type-approving ionizing radiation sources and on transport of nuclear materials and selected radioactive substances (on type-approving and transport), any transport cask must be marked and labelled in accordance with Articles 34 to 36, 38 to 39 and 41 to 44 of Supplement No. 4 to Decree No. 317/2002 Coll.

13. General conditions

13.1 The Decision of the State Office for Nuclear Safety (SÚJB) on type approval for the Škoda VPVR/M cask, identification designation CZ/048/B(U)F–96, will only be valid for a cask of given serial number with a written certificate of compliance to certify, in accordance with condition 11.3. of this Decision, that the cask of the particular serial number has been manufactured in compliance with the submitted safety documentation and meets the parameters declared therein.

13.2. The holder of approval pursuant to Section 9(1)(m) of Act No. 18/1997 Coll. has the obligation to present a copy of the type-approval decision for the Škoda VPVR/M cask, identification designation CZ/048/B(U)F–96, and a copy of the written certificate of compliance according to condition 11.3 of this Decision to the competent bodies upon request.

13.3. The State Office for Nuclear Safety must be informed of the serial numbers of all casks of identification designation CZ/048/B(U)F–96 by delivering a written certificate of compliance according to condition 11.3 of this Decision. The holder of approval pursuant to Section 9(1)(m) of Act No. 18/1997 Coll. will send the written certificate of compliance to the State Office for Nuclear Safety before using every cask for the first time.

13.4. The holder of approval pursuant to Section 9(1)(m) of Act No. 18/1997 Coll. will send a report of the results of the in-service inspections performed according to condition 10 of this Decision to the State Office for Nuclear Safety without request for every Škoda VPVR/M cask of given serial number.

13.5. The holder of approval pursuant to Section 9(1)(m) of Act No. 18/1997 Coll. is responsible for meeting the conditions of this Decision except for condition 11.

13.6. The meeting of conditions:

- 1, 2 and 3 of the Decision will be documented in a cartogram of cask loading and pertinent data about fuel assembly with SNF;
- 4, 5, 6, 7, 10 and 11 of this Decision will be documented in writing.

13.7. Before using a Škoda VPVR/M cask, identification designation CZ/048/B(U)F–96, for the first time, the holder of approval pursuant to Section 9(1)(m) of Act No. 18/1997 Coll. must show to the State Office for Nuclear Safety his having pertinent cask handling regulations in place which are in compliance with the documentation mentioned in conditions 5, 6, 9 and 10 of this Decision.

13.8. The operational records of Škoda VPVR/M cask of given serial number must be archived by the holder of approval pursuant to Section 9(1)(m) of Act No. 18/1997 Coll. during the whole period of the cask service life.

13.9. Any application for type approval of Škoda VPVR/M cask, identification designation CZ/048/B(U)F–96, for SNF transport filed before the end of validity of this Decision must be accompanied with updated safety documentation to prove, in particular, the fact that no changes in strength, shielding and leakage characteristics or other cask qualities declared in the safety documentation assessed by SÚJB before the issue of decision Ref. No. 6943/2005 of 23 March 2005 occurred due to cask radiation, thermal and pressure stress and/or as a consequence of handling the cask in SNF transport and storage, and that the Škoda VPVR/M casks meet the qualities declared in the already assessed safety documentation for the next period.

14. Accident reporting

The State Office for Nuclear Safety must be informed immediately of any cask defect or accident in handling the cask, identification designation CZ/048/B(U)F–96, loaded with FA with SNF, fuel elements with SNF or even empty, concerning in particular cask drop or turnover. A report will be made on such accident and sent by the holder of approval pursuant to Section 9(1)(m) of Act No. 18/1997 Coll. within fourteen days of the occurrence to the State Office for Nuclear Safety and, without unnecessary delay, the cask will be put out of operation temporarily, while meeting all the nuclear safety and radiation protection requirements.

The State Office for Nuclear Safety will decide on the conditions of re-using the cask on the basis of a justified proposal of the holder of approval pursuant to Section 9(1)(m) of Act No. 18/1997 Coll. and after meeting all the nuclear safety and radiation protection requirements.

15. Decision validity

15.1. The Decision on cask type approval does not supersede other permits of the State Office for Nuclear Safety issued according to Section 9(1) of Act No. 18/1997 Coll. and/or permits or authorizations for activities issued by other central state administration bodies according to special regulations.

15.2. The Decision on cask type approval does not relieve the holder of approval pursuant to Section 9(1)(m) of Act No. 18/1997 Coll. of his obligation to meet the requirements of other transport-competent bodies and the requirements of any country to or through which the Škoda VPVR/M cask, identification designation CZ/048/B(U)F – 96, will be transported.

15.3. This Decision supersedes the decision of the State Office for Nuclear Safety, Ref. No. 15230/2004, of 23 July 2004.

The type approval as specified in Sections I and II of this Decision is being issued for a period until 1 July 2011.

111121 is the registration number assigned pursuant to Section 15(1)(a) of Act No. 18/1997 Coll.

The administration fees of CZK 5000 were paid according to Clause No. 97(a) of the supplement to Act No. 368/1992 Coll., on administration fees, as amended.

Rationale:

ŠKODA JS a. s., in an enclosure to its letter, Ref. No. JAD-GŘ/106/03 of 20 December 2004, submitted an application for a type approval of Škoda VPVR/M cask for transport and storage of spent nuclear fuel from research reactors, which was received by the State Office for Nuclear Safety on 30 December 2004. The application was submitted in accordance with Section 23 of Act No. 18 /1997 Coll., as amended, and Section 3(1)(2a) of Decree No. 317/2002 Coll. The application was accompanied by safety documentation "Transport and Storage Cask for Spent Fuel from Research Reactors (Škoda VPVR/M Cask), Safety Documentation for Type Approval according to SÚJB Decree No. 317/2002 Coll.", Ae 11543/Dok, Rev. 0, ŠKODA JS a. s., Plzeň, December 2004.

The State Office for Nuclear Safety assessed the submitted safety documentation and, as it did not meet all the requirements of Act No. 18/1997 Coll. and its implementation regulations, the Office summoned an inspection day for 10 February 2005, which resulted in SÚJB requirement for preparation and presentation of a revision of the safety documentation by 21 February 2005.

On 21 February 2005, a representative of ŠKODA JS a. s. delivered to SÚJB and handed over under record safety documentation "Transport and Storage Cask for Spent Fuel from Research Reactors (Škoda VPVR/M Cask), Safety Documentation for Type Approval according to SÚJB Decree No. 317/2002 Coll.", Ae 11543/Dok, Rev. 1, ŠKODA JS a. s., Plzeň, February 2005.

In addition to the safety documentation, the following documents were submitted to SÚJB in accordance with Section 23 of Act No. 18/1997 Coll. and Section 3 of Decree No. 317/2002 Coll.:

1. Applicant identification
2. The particulars of the application for cask type approval in accordance with Decree No. 317/2002 Coll.
3. The assessment of the transport cask Škoda VPVR, UJV Z-1369, ÚJV Řež, a. s., January 2005.

SÚJB states that the submitted safety documentation meets the requirements of the provisions of Section 23 of Act No. 18/1997 Coll., as amended, and the requirements of Decree No. 317/2002 Coll., and, therefore, it type-approves the Škoda VPVR/M cask for road and rail transport, inland waterways and sea transport, as well as for storage of spent nuclear fuel and assigns the cask identification designation CZ/048/B(U)F–96.

Advice:

Pursuant to Section 61 of Act No. 71/1967 Coll., on administrative procedure (administration regulations), this Decision is appeling able to the Chairman of the State Office for Nuclear Safety within 15 days of the day of delivery.

Ing. Karel **B ö h m**
Deputy for Nuclear Safety

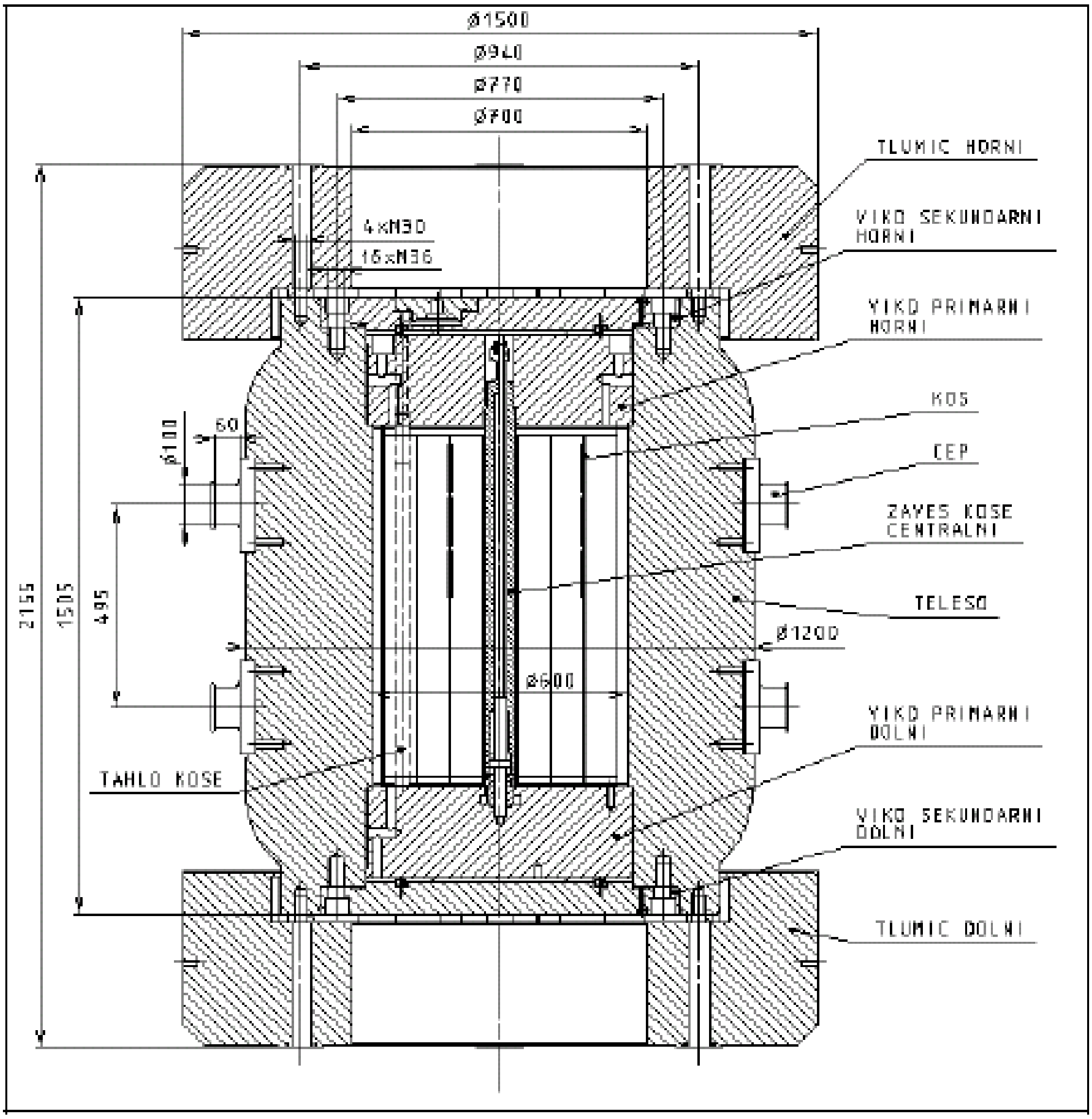
--signed--

Enclosure: Illustration of Škoda VPVR/M cask

Addressee - Applicant: ŠKODA JS a. s.
Orlík 266
316 06 Plzeň

Enclosure to Decision, Ref. No. 6943/2005

Illustration of Škoda VPVR/M Cask
Identification Designation CZ/048/B(U)F-96



APPENDIX V. SHIPMENT FORMS OF THE RUSSIAN FEDERATION

(1) Transfer Protocol of Empty Transport Packing Units and Documents

Протокол передачи порожних транспортных упаковочных комплектов и документации
Transfer protocol of empty transport packing units and documents

1 Передаваемые транспортные упаковочные комплекты __________в количестве _____шт.
Transferred transport packing units (тип / type) in the amount of items

2 Передаваемая документация:
Transferred documents:

2.1 Акт контроля мощности эквивалентной дозы гамма-излучения и уровня радиоактивного загрязнения вагонов-контейнеров и защитных контейнеров, отправляемых с предприятия ……………………..
Inspection certificate of equivalent dose rate from gamma-rays and levels of radioactive contamination of railroad cars and protection containers shipped from ………………*(Institution).*

2.2 Протоколы испытаний на герметичность защитных контейнеров __________
Leakage test protocol of protection container (тип / type)

заводские номера ____
serial No.

2.3 Акт проверки технического состояния и готовности вагон-контейнерного поезда к рейсу.
Inspection certificate of technical condition and readiness of container train for shipment.

Место передачи_______________________
Transfer point

Передал____
Transferring agent (подпись, расшифровка подписи / signature, full name)

Принял____
Recipient (подпись, расшифровка подписи / signature, full name)

«____»________________20__ г.
Date of transfer:

(2) Radioactive Contamination Survey Sheet (see next page)

Акт контроля мощности эквивалентной дозы гамма-излучения и уровня радиоактивного загрязнения вагонов-контейнеров и защитных контейнеров, отправляемых из………………(наименование организации)

Inspection certificate of equivalent dose rate from gamma-rays and levels of radioactive contamination of railroad cars and protection containers shipped from ……………… (Institution)

№ п/п No.	Номер вагона Car No.		Обозначение защитного контейнера Protection container ID	Заводской номер защитного контейнера Protection container serial number	Максимальная мощность эквивалентной дозы гамма-излучения на наружной поверхности защитного контейнера, мЗв/ч Maximum equivalent dose rate from γ-rays at the exterior surface of protection container, mSv/h	Максимальный уровень радиоактивного загрязнения поверхностей (усредненный по площади 300 см^2), бета-част./мин·см^2 Maximum level of surface radioactive contamination (averaged by 300 cm^2), beta-particles/min·cm^2					
	по системе МПС ICS system	завод-ской номер Serial number				вагона Railroad car				защитного контейнера Protection container	
						наружная поверхность Exterior surface		внутренняя поверхность Interior surface		наружная поверхность Exterior surface	
						нефиксированное Non-fixed	фиксированное Fixed	нефиксированное Non-fixed	фиксированное Fixed	нефиксированное Non-fixed	фиксированное Fixed
1											
2											

Мощность эквивалентной дозы гамма-излучения и уровни радиоактивного загрязнения не превышают допустимых значений согласно ТУ «Сборки тепловыделяющие, отработавшие в ядерном исследовательском реакторе …………… ……………………………*(наименование организации)*. Поставка на завод регенерации России». Equivalent dose rate from gamma-radiation and levels of radioactive contamination do not exceed the permissible values in accordance with Technical Specification ‘Fuel Assemblies from research reactor …………… ……………………………*(Institution)*. Shipment to the reprocessing plant in the Russian Federation’.

Ответственное лицо ………………………………………….. «__» ________ 20__ г. _________________ ______________________

Authorized representative (наименование организации/institution) Date: (личная подпись/signature) (и.о. фамилия/full name)

(3) Leakage Test Protocol of Protection Container

Протокол испытаний на герметичность защитного контейнера __________
Leakage test protocol of protection container (*тип / type*)

На предприятии ________________________
At facility

«____»____________20__ г. проведено испытание герметичности
Date: a leakage test was performed

порожнего/empty, загруженного ОТВС/loaded with IFA защитного контейнера________*(тип)*
(ненужное зачеркнуть / cross out one) protection container *(type)*

заводской №____
Serial No.

в соответствии с документом «Комплект транспортный упаковочный с контейнером ___________
in accordance with a document titled "Transport packing unit with container (тип / type)

Техническое описание и инструкция по эксплуатации»
Technical specification and operational manual"

Заключение: Защитный контейнер герметичен.
Conclusion: Protection container is leak-proof.

Ответственное лицо________________________
Authorized person

«____»____________20__ г. _________________ _________________________
Date: (личная подпись / signature) (и.о. фамилия / full name)

(4) Inspection Certificate of Technical Condition and Readiness of Container Train for Shipment

Акт проверки технического состояния и готовности вагон-контейнерного поезда с ОТВС к рейсу
Inspection certificate of technical condition and readiness of container train with SNF for shipment.

На ____
At (указывается место проверки/indicate inspection site)

выполнена проверка технического состояния вагонов-контейнеров ______________
technical condition of container cars was inspected (тип/type)

с установленными в них защитными контейнерами __________________
equipped with protection containers (тип/type)

заводские
номера____

serial numbers

с чехлами _________________

with baskets (тип/type)

заводские
номера____

serial numbers

и вагонов сопровождения ____

and convoy cars (указывается обозначение/indicate ID)

Упаковки с ОТВС закреплены в опорах вагонов-контейнеров в соответствии с требованиями эксплуатационной документации. Вагоны-контейнеры и вагоны сопровождения осмотрены работниками вагонного хозяйства ____ железной дороги. Неисправностей вагонов-контейнеров, вагонов сопровождения и их оборудования, влияющих на безопасность транспортирования, не обнаружено. Вагоны-контейнеры опломбированы. Вагоны сопровождения заправлены дизельным топливом. Вагоны сопровождения и вагоны-контейнеры сформированы в вагон-контейнерный поезд. Сопроводительная документация на ОТВС и упаковки с ОТВС передана ответственному сопровождающему вагон-контейнерного поезда. Вагон-контейнерный поезд готов к рейсу.

SNF packages are fastened to the container-car support in accordance with operating requirements. Container cars and convoy cars were inspected by the staff of ____________________(*railway car unit).* No malfunctions affecting transportation security were found in the container cars, convoy cars and their equipment. Container cars are sealed. Convoy cars are fueled with diesel. Convoy cars and container cars are organized in a container train. Accompanying documents on SNF and SNF packages are handed over to the train convoy officer. The container train is ready for shipment.

Ответственное лицо ____ ______________________________

Authorized person (личная подпись/signature) (и.о. фамилия/full name)

«__» ____________20__ г.

Date:

Ответственный сопровождающий

вагон-контейнерного поезда_________________________________ ______________________________

Authorized convoy officer of (личная подпись/signature) (и.о.фамилия/full name)

the container train

«__» ____________20__ г.

Date:

Представитель вагонного хозяйства ____ железной дороги

Representative of railway car unit of railway

_________________________________ ______________________________

(личная подпись/signature) (и.о.фамилия/full name)

«__» ____________20__ г.

Date:

(5) Transfer Protocol of Transport Packing Units Loaded with IFA and Documents

Протокол передачи загруженных ОТВС транспортных упаковочных комплектов и документации
Transfer protocol of transport packing units loaded with IFA and documents

1 Передаваемые транспортные упаковочные комплекты _________ в количестве ________шт.
Transferred transport packing units (тип / type) in the amount of items

2 Передаваемая документация
Transferred documents

2.1 Паспорта ОТВС, загруженных в чехлы ________________
Passports of IFA loaded in baskets (тип / type)

заводские номера:____
serial No.

2.2 Паспорта упаковок ОТВС с контейнерами ________________
Passports of IFA packages with containers (тип / type)

заводские номера:____
serial No.

2.3 Акт контроля мощности эквивалентной дозы гамма- и нейтронного излучения и уровня нефиксированного радиоактивного загрязнения вагонов-контейнеров и упаковок с ОТВС, отправляемых из …………………………..*(наименование организации)*
Inspection certificate of equivalent dose rate from gamma- and neutron radiation and levels of non-fixed radioactive contamination of container cars and IFA packages shipped from ……………………………. *(Institution)*

2.4 Протоколы испытаний на герметичность защитных контейнеров ________________
Leakage test protocols of protection containers (тип / type)

заводские номера:____
serial No.

2.5 Акт проверки технического состояния и готовности вагон-контейнерного поезда с упаковками с ОТВС к рейсу
Inspection certificate of technical condition and readiness of container train loaded with IFA packages for shipment.

2.6 Сопроводительная накладная №____________________
Dispatch note No.

2.7 Накладная-разрешение №____________________
Permit waybill No.

Место передачи________________________________
Transfer point

Передал_______________________________________
Transferring agent (подпись, расшифровка подписи / signature, full name)

Принял_______________________________________
Recipient (подпись, расшифровка подписи / signature, full name)

«____»_________________20__ г.
Date of transfer:

(6) Passport of IFA Loaded in the Basket

1 Обозначение типа реактора / Reactor type					
2 Обозначение ТВС / Fuel assembly (FA) type					
3 Заводской номер ТВС / FA serial No.					
4 Номер чертежа ТВС / FA Drawing No.					
5 Вид ядерного топлива и его масса, г / Nuclear fuel type and mass, g					
6 Масса ТВС, кг / FA mass, kg					
7 Исходная масса суммы изотопов урана, г Initial mass of uranium isotopes aggregate, g					
8 Исходная масса урана-235, г / Initial mass of U-235, g					
9 Дата изготовления ТВС / FA manufacturing date					
10 Дата установки ТВС в реактор / Date of FA insertion in the reactor					
11 Дата остановки реактора для выгрузки ТВС Date of the reactor shutdown for FA unloading					
12 Время выдержки, год, мес. / Holdup time, year, month					
13 Глубина выгорания, % / Burnup fraction, %					
14 Масса суммы изотопов урана (расчетная) в ТВС, г, в т.ч. Mass of uranium isotopes aggregate (estimated) in FA, g including U-232 U-235 U-238					
15 Масса суммы изотопов плутония (расчетная) в ТВС, г в т.ч. Mass of plutonium isotopes aggregate (estimated) in FA, g including Pu-238 Pu-239 Pu-240 Pu-241 Pu-242					
16 Герметичность оболочек твэлов Leak-tightness of fuel rod jackets	герметичны / sealed негерметичны (газовая неплотность) /unsealed (gas leakage)				
17 Номер ячейки чехла по картограмме загрузки чехла, в которую установлена ТВС Cell number from the basket loading chart where FA is inserted					
18 Остаточное тепловыделение ТВС на момент загрузки в ТУК, Вт Residual heat of FA at the loading into transport packing unit, W					
19 Суммарное тепловыделение ТВС, загруженных в чехол, Вт Total heat of FA loaded into the basket, W					
20 ТВС переработана на заводе …………………………………………. (заполняется ответственным лицом) FA is reprocessed at the facility………………………………………….. (to be filled by the authorized person) дата / date подпись / signature фамилия / last name					

Примечание: Массы изотопов урана и плутония рассчитаны по методике ______________________,
(указывается наименование)
точность методики ______________________________________
(указывается погрешность расчета)

Note: Masses of uranium and plutonium isotopes are calculated by methods ________________________,
precision of the method __________________________________
(indicate the calculating error)

Заключение: ОТВС соответствуют требованиям технических условий «Сборки тепловыделяющие, отработавшие в ядерном исследовательском реакторе ………………*(тип)* ………………………*(название организации)*. Поставка на завод регенерации России».

Conclusion: IFA comply with the requirements of Technical Specification "Fuel Assemblies from research reactor ……………*(type)*…………………*(Institution)*. Shipment to the reprocessing plant in Russia".

Ответственное лицо _______________________ _______________________
Authorized representative (личная подпись / signature) (и.о. фамилия / full name)

Date: «___»__________20__ г.

(7) IFA Package Passport

1 Наименование предприятия, обозначение типа реактора ________________________________
Name of facility/institution, type of reactor

2 Обозначение транспортного упаковочного комплекта ________________________________
Transport packing unit

3 Тип чехла ________________________________
Basket type

4 Заводской номер чехла ________________________________
Basket serial number

5 Загружено ОТВС (шт.) ________________________________
IFA loaded (items)

6 Загрузка чехла выполнена по картограмме в соответствии с приложением К ТУ «Сборки тепловыделяющие, отработавшие в дерном исследовательском реакторе …………………*(тип)* ……………………………… *(наименование организации)*. Поставка на завод регенерации России».
The basket is loaded with regard to the loading chart in accordance with Attachment K to Technical Specification “Fuel Assemblies from research reactor ……………*(type)* ……………………………*(Institution)*. Shipment to the reprocessing plant in Russia”.

Номер ячейки чехла по картограмме загрузки чехла / Cell number in the shroud loading chart	Обозначение и заводской номер ТВС / Fuel Assembly ID and serial number
1	
2	
3	
4	

7 Обозначение защитного контейнера ________________________________
Protection container ID

8 Заводской номер защитного контейнера ________________________________
Serial number of protection container

9 Дата и время окончания загрузки ОТВС
в защитный контейнер (закрытие крышки) ________________________________
Completion date and time of IFA loading into
protection container (top sealing)

10 Мощность эквивалентной дозы излучения
на поверхности упаковки в точке с максимальным
уровнем излучения, мЗв/ч:
Equivalent dose rate at the package surface at the point of
maximum radiation level, mSv/hr:

гамма-излучение ________________________________
γ-rays (указать положение точки / indicate the point position)

нейтронное излучение ________________________________
neutrons (указать положение точки / indicate the point position)

суммарная ________________________________
total (указать положение точки / indicate the point position)

11 Нефиксированное радиоактивное загрязнение
наружной поверхности упаковки, усредненное
по площади 300 см^2, в районе с максимальным
уровнем загрязнения, бета-част./мин·см^2 ________________________________
Non-fixed surface radioactive contamination of exterior (указать район / indicate the area)
package averaged by 300 cm^2 at the area of maximum
contamination level, beta-particles/min·cm^2

12 Упаковка ОТВС установлена в вагон-контейнер ______________, заводской номер ________________
IFA package is placed into a container car (тип / type), serial No.

Приложение: 1 Паспорт ОТВС, загруженных в чехол _________________, заводской № ________
Attachment: 1 Passport of IFA loaded into the basket (тип / type) serial No.

2 Протокол испытаний на герметичность защитного контейнера ___________, заводской № ____________
Leakage test protocol of protection container (тип/ type), serial No.

Состав транспортного упаковочного комплекта и его загрузка ОТВС, маркировка защитного контейнера и чехла, уровни радиоактивного загрязнения и мощность эквивалентной дозы излучения соответствуют ТУ «Сборки тепловыделяющие, отработавшие в ядерном исследовательском реакторе ……….*(тип)* …………………..*(название организации)*. Поставка на завод регенерации России».

Transport packing unit and its loading with IFA, marking of the protection container and basket, levels of radioactive contamination, and equivalent dose rates comply with Technical Specification “Fuel Assemblies from research reactor ……………. …………………………*(Institution)*. Shipment to the reprocessing plant in Russia”.

Дата отправки из ………………………………………….   «___» _____________20__ г.
Shipment from (наименование организации / name of institution)   Date:

Ответственное лицо _____________________   ___________________________
Authorized person (личная подпись / signature)   (и.о. фамилия / full name)

(8) Radioactive Dose Rates Survey Sheet

Акт контроля мощности эквивалентной дозы гамма- и нейтронного излучения и уровня радиоактивного загрязнения вагонов-контейнеров и упаковок с ОТВС, отправляемых из…………………………….*(наименование организации)*
Inspection certificate of equivalent dose rate from gamma- and neutron radiation and levels of radioactive contamination of container cars and SNF packages shipped from ……………………………. *(Institution)*

Номер вагона Car No.		Обозначение защитного контейнера Protection container ID	Заводской номер защитного контейнера Protection container serial number	Максимальная мощность эквивалентной дозы гамма- и нейтронного излучения, мЗв/ч Maximum equivalent dose rate from γ- and neutron radiation, mSv/h									Максимальный уровень нефиксированного радиоактивного загрязнения поверхностей (усредненный по площади 300 см^2), бета-част./мин·см^2 Maximum level of non-fixed surface radioactive contamination (averaged by 300 cm^2), beta-particles/min·cm^2		
по системе МПС ICS system	Заводской номер Serial number			на наружной поверхности упаковки (защитного контейнера) Exterior surface of package (protection container)			на наружной поверхности вагона Exterior surface of the railroad car			на расстоянии 2 м от вагона At a distance of 2 m from the railroad car			Вагона-контейнера Container car		Упаковки (защитного контейнера) Package (protection container)
				γ	η	Сумма Total	γ	η	Сумма Total	γ	η	Сумма Total	наружная поверхность Exterior surface	внутренняя поверхность Interior surface	наружная поверхность Exterior surface

Мощность эквивалентной дозы гамма- и нейтронного излучения и уровни нефиксированного радиоактивного загрязнения не превышают допустимых значений согласно ТУ «Сборки тепловыделяющие, отработавшие в ядерном исследовательском реакторе ……………. …………………………….*(наименование организации)*. Поставка на завод регенерации России». Equivalent dose rate from gamma- and neutron radiation and levels of non-fixed surface radioactive contamination do not exceed the permissible values in accordance with Technical Specification ‘Fuel Assemblies from research reactor ……………. …………….*(Institution)*. Shipment to the reprocessing plant in the Russian Federation’.

Ответственное лицо ………………………………………….. «__» _________ 20__ г. __________________ _______________________
Authorized representative (наименование организации/institution) Date: (личная подпись/signature) (и.о. фамилия/full

(9) Leakage Test Certificate

На предприятии ________________________
At facility

«____»____________20__ г. проведено испытание герметичности
Date: a leakage test was performed

порожнего/empty, загруженного ОТВС/loaded with IFA защитного контейнера________*(тип)*
(ненужное зачеркнуть / cross out one) protection container *(type)*

заводской №____
Serial No.

в соответствии с документом «Комплект транспортный упаковочный с контейнером ___________
in accordance with a document titled "Transport packing unit with container (тип / type)

Техническое описание и инструкция по эксплуатации»
Technical specification and operational manual"

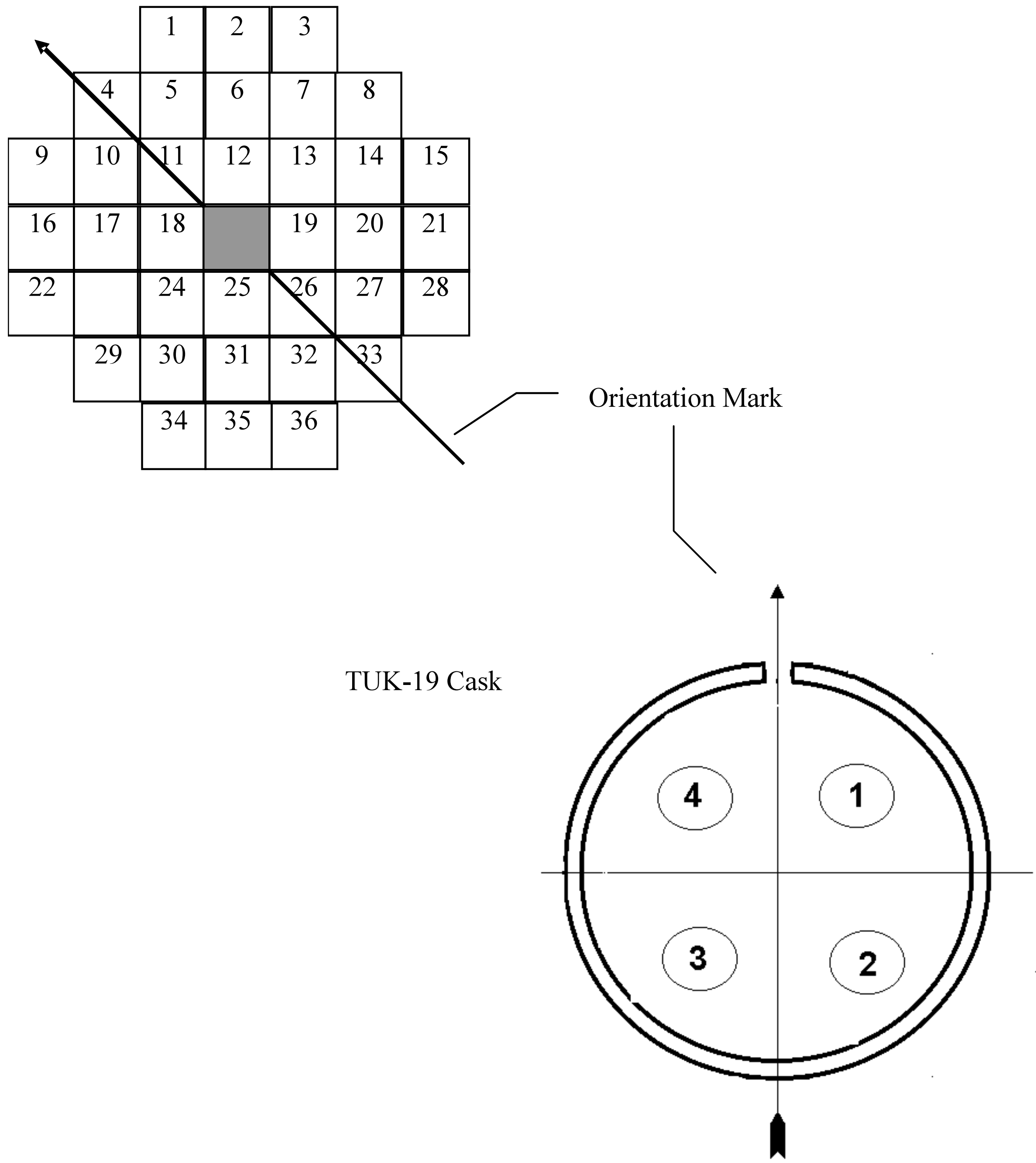
Заключение: Защитный контейнер герметичен.
Conclusion: Protection container is leak-proof.

Ответственное лицо________________________
Authorized person

«____»____________20__ г. __________________ __________________________
Date: (личная подпись / signature) (и.о. фамилия / full name)

(10) Basket Loading Scheme (see next page)

Map of basket loading (Skoda VPVR/M or TUK-19): Basket No__________________



Chief engineer of research reactor

" "_______________20 ______________ ______________________________

Signature Name

(11) Technical Condition Certificate

На ____
At (указывается место проверки / indicate inspection site)

выполнена проверка технического состояния вагонов-контейнеров _____________
technical condition of container cars was inspected (тип / type)

с установленными в них защитными контейнерами ________________
equipped with protection containers (тип / type)

заводские номера____
serial numbers

с чехлами ________________
with baskets (тип / type)

заводские номера____
serial numbers

и вагонов сопровождения ____
and convoy cars (указывается обозначение / indicate ID)

Упаковки с ОТВС закреплены в опорах вагонов-контейнеров в соответствии с требованиями эксплуатационной документации. Вагоны-контейнеры и вагоны сопровождения осмотрены работниками вагонного хозяйства ____________________________________ железной дороги. Неисправностей вагонов-контейнеров, вагонов сопровождения и их оборудования, влияющих на безопасность транспортирования, не обнаружено. Вагоны-контейнеры опломбированы. Вагоны сопровождения заправлены дизельным топливом. Вагоны сопровождения и вагоны-контейнеры сформированы в вагон-контейнерный поезд. Сопроводительная документация на ОТВС и упаковки с ОТВС передана ответственному сопровождающему вагон-контейнерного поезда. Вагон-контейнерный поезд готов к рейсу.

IFA packages are fastened to the container-car support in accordance with operating requirements. Container cars and convoy cars were inspected by the staff of __________________(*railway car unit).* No malfunctions affecting transportation security were found in the container cars, convoy cars and their equipment. Container cars are sealed. Convoy cars are fueled with diesel. Convoy cars and container cars are organized in a container train. Accompanying documents on IFA and IFA packages are handed over to the train convoy officer. The container train is ready for shipment.

Ответственное лицо ________________________________ _________________________
Authorized person (личная подпись / signature) (и.о. фамилия / full name)

«__» ___________20__ г.
Date:

Ответственный сопровождающий
вагон-контейнерного поезда____________________________ _________________________
Authorized convoy officer of (личная подпись/signature) (и.о.фамилия/full name)
the container train

«__» ___________20__ г.
Date:

Представитель вагонного хозяйства ____________________________________ железной дороги
Representative of railway car unit of railway

__________________________ _________________________
(личная подпись/signature) (и.о.фамилия/full name)
«__» ___________20__ г.
Date:

(12) Permit Waybill

Накладная-разрешение №_____________
PERMIT WAYBILL
от «__»___________20__ г.
Date:

Отправитель ____
Consignor
Получатель ____

Consignee
Основание ____
Background (номер договора/agreement number)
Через____
Via (фамилия, имя, отчество/full name)
В контейнерах ______
In containers
Опломбировано пломбами ____
Seals affixed
____

№ п/п No.	Обозна-чение ОТВС SNF	Номер вагона (заводской) Railroad car No. (serial number)	Номер контейнера Container No.	Количество ТВС, загруженных в контейнер Number of fuel assemblies (FA) loaded into a container	Масса ядерного топлива во всех ТВС, загруженных в контейнер, г Mass of SNF in all FAs loaded into the container, g	Исходная масса суммы изотопов урана, г Initial mass of uranium isotopes aggregate, g	Расчетная масса суммы изотопов урана во всех ТВС, загруженных в контейнер, г Estimated mass of uranium isotopes aggregate in all FAs loaded into the container, g	Расчетная масса U-235 во всех ТВС, загруженных в контейнер, г Estimated mass of U-235 in all FAs loaded into the container, g	Расчетная масса суммы изотопов плутония во всех ТВС, загруженных в контейнер, г Estimated mass of plutonium isotopes aggregate in all FAs loaded into the container, g	Расчетная масса суммы изотопов урана и плутония во всех ТВС, загруженных в контейнер, г Estimated mass of uranium and plutonium isotopes aggregate in all FAs loaded into the container, g
1	2	3	4	5	6	7	8	9	10	11
				Итого, г Total, g						

Расчетная масса суммы изотопов урана, г ____
Estimated mass of uranium isotopes aggregate, g (заполняется прописью/to be filled in words)
Руководитель ____________________________ ____________________________________
Senior manager (личная подпись/signature) (и.о. фамилия/full name)
Выдал ____________________________ ____________________________________
Issued (личная подпись/signature) (и.о. фамилия/full name)
Принял ____________________________ ____________________________________
Accepted (личная подпись/signature) (и.о. фамилия/full name)

(13) Dispatch Note

Отправитель:
Consignor:

Получатель:
Consignee:

СОПРОВОДИТЕЛЬНАЯ НАКЛАДНАЯ
DISPATCH NOTE

от «____» __________20__ г.
date:

1 Основание ____
Background (номер и дата договора / number and date of contract)

____

2 Состав груза:
Shipped Goods:

№ п/п No.	Номер вагона Railroad car No.		Заводской номер защитного контейнера Protection container serial No.	Примечание Notes
	По системе МПС ICS system	Заводской номер Serial number		
1				
2				

____
текст оттиска пломб защитных контейнеров
text of the seal impression on protection containers

____
текст оттиска пломб вагонов-контейнеров
text of the seal impression on container cars

Итого вагонов-контейнеров ____
Total container cars (цифрой и прописью / in numbers and in words)

3 Упаковки с ОТВС размещены и закреплены согласно
IFA packages are placed and fastened in accordance with

____

ТУ погрузки и крепления, чертеж, схема размещения упаковок, инструкция по эксплуатации
Technical specification of loading and fastening, drawing, package allocation scheme, operational manual

Лицо, ответственное за погрузку ____
Authorized person for loading (личная подпись, и.о. фамилия, дата / signature, full name, date)

4 Уровни радиоактивного загрязнения поверхности ТУК и вагонов-контейнеров, мощность эквивалентной дозы гамма- и нейтронного излучения не превышает допустимых норм.
Levels of radioactive surface contamination of the transport-packing unit and container cars, equivalent dose rate from gamma- and neutron radiation do not exceed the permissible norms.

Ответственный представитель дозиметрической службы ________________________________
Authorized representative of Radiation Monitoring Service (личная подпись, и.о. фамилия, дата / signature, name, date)

5 Груз сдал
Goods handed over

Материально-ответственное лицо ____
Materially-responsible person (должность, личная подпись, и.о.фамилия, дата/ position, signature, name, date)

М.П. / Stamp

Должностное лицо, ответственное за отправку груза____________________________________
Authorized person for shipment (должность, личная подпись, и.о.фамилия, дата / position, signature, name, date)

6 Груз в соответствии с данной накладной, сопроводительную документацию и четыре экземпляра накладной-разрешения получил.
The goods stated in this dispatch note, accompanying documents and four copies of permit waybill are received.

Ответственный сопровождающий____
Responsible convoy (личная подпись, и.о.фамилия, дата / signature, name, date)

7 Груз в соответствии с данной накладной от ответственного сопровождающего принял
The goods stated in this dispatch note are received from the responsible convoy

____

(должность, личная подпись, и.о.фамилия, дата / position, signature, name, date)

8 Замечания по приемке груза
Comments on the goods acceptance

____
____
____
____
____
____
____

(должность, личная подпись, и.о.фамилия лица, сделавшего замечания, дата / position, signature, name of the commenting person, date)

APPENDIX VI. POINTS OF CONTACT

The following table includes a list of contacts for various subject areas concerning the shipment of spent nuclear fuel to the Russian Federation under the RRRFR programme.

Subject	Point of Contact	Organizartion	Phone numbers	E-mail Addresses
International Projects	Pablo Adelfang	IAEA – NEFW	43.1.2600.22770	P.Adelfang@iaea.org
	Edward Bradley	IAEA – NEFW	43.1.2600.22759	E.Bradley@iaea.org
	Bekhzad Yuldashev	IAEA – NEFW	43.1.2600.24674	B.Yuldashev@iaea.org
RRRFR Programme	Igor Bolshinsky	NNSA/INL	202.586.4119	Igor.bolshinsky@nnsa.doe.gov
Romania,Bulgaria	Ken Allen	NNSA/INL	208.526.9441	Ken.allen@inl.gov
Hungary, Ukraine	John Dewes	NNSA/SRNL	803.952.6093	John.dewes@srs.gov
Czech Rep./Poland	Mike Tyacke	NNSA/INL	208.526-1601	Michael.tyacke@inl.gov
Latvia, Libyan Arab Jamahiriya	Stan Moses	NNSA/ORNL	865.574.8142	mosessd@ornl.gov
Uzbekistan, Kazakhstan	Jay Thomas	NNSA/SRS	803.952.5939	jay.thomas@srs.gov
Russian Laws	Luibov Yungerova	State Atomic Energy Corp. Rosatom	007 499 9492512	LyubovYungerova@dmvs.minatom.net
	Alexander Buchelnikov		007 499 9494828	abuchelnikov@faae.ru
Federal Center for Nuclear and Radiation Safety	Alexey Grishin	FCNRS	007.495.9136715	a.grishin@fcnrs.ru
	Oleg Kriger			o.kriger@fcnrs.ru
Mayak Facility (Shipment, Receipt, Fuel Acceptance, TUK-19 cask, Reprocessing)	Vladimir Savkin	Mayak		vsavkin@po-mayak.ru
Spent fuel importation	Alexei Smirnov	R&D 'SOSNY'	007.842 3539829	office@sosny.ru
	Elena Leschenko			
SKODA Cask	Miroslav Picek	SKODA	420.378.042.244	Miroslav.picek@skoda-js.cz

APPENDIX VII. CONTRIBUTING ORGANIZATIONS

- Institute of Nuclear Physics, Uzbekistan Academy of Sciences, Uzbekistan
- International Atomic Energy Agency (IAEA), Austria
- US Department of Energy (US DOE), National Nuclear Security Administration (NNSA), United States of America
- Production Association Mayak, Russian Federation
- Techsnabexport, Russian Federation
- State Atomic Energy Corporation Rosatom, Russian Federation
- KATEP, Kazakhstan
- Sosny Company, Russian Federation
- Nuclear Research Institute – Rez, Czech Republic
- Institute of Nuclear Physics, Latvian Academy of Sciences, Latvia
- Institute for Nuclear Research and Nuclear Energy (INRNE), Sofia, Bulgaria
- Hungarian Academy of Sciences KFKI Atomic Energy Research Institute (AEKI), Hungary

APPENDIX VIII. SUMMARY REPORTS ON SHIPMENTS IN EACH COUNTRY

VIII.1. RRRFR PROGRAMME – SHIPMENT SUMMARY OF UZBEKISTAN

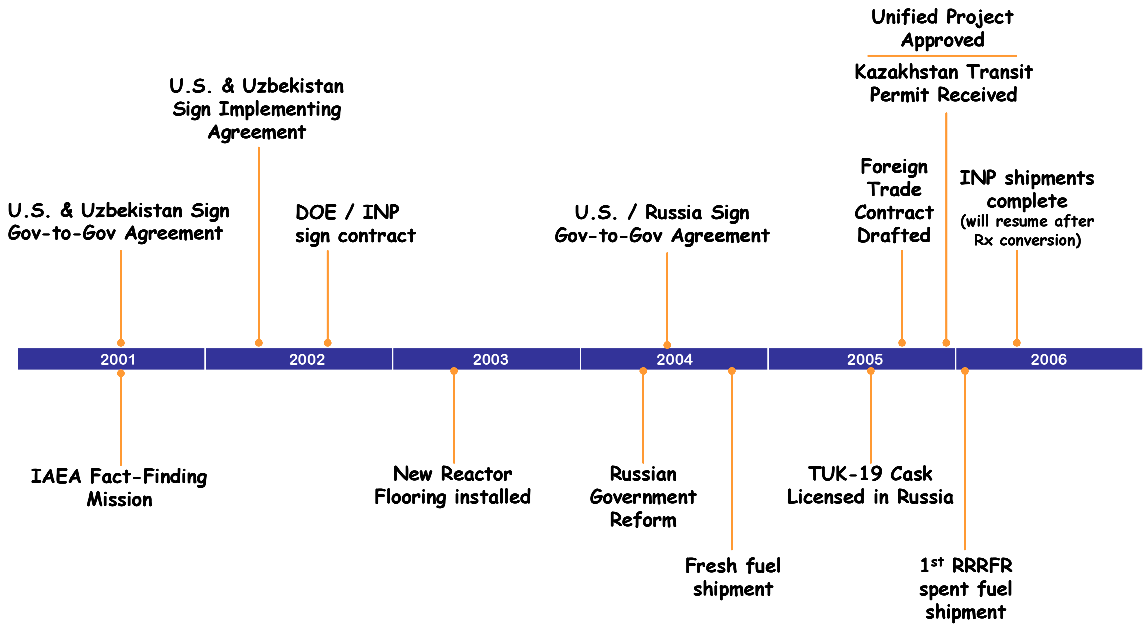
Reactor Name and Operator: WWR-SM, Institute of Nuclear Physics, Tashkent, Uzbekistan
Dates of shipment: 10 January – 15 April, 2006. Four shipments total.

VIII.1.1. Introduction

Reactor background

The WWR-SM research reactor at the Institute of Nuclear Physics of the Uzbek Academy of Sciences is located in Ulugbek, 30 km north-east of Tashkent. The reactor was put into operation at a power level of 2 MW in September 1959. It was reconstructed in 1971-1979 to upgrade the reactor power and enhance the experiment capacity of the reactor. The reactor is designated to carry out experiments in the fields of nuclear physics and nuclear engineering, neutron activation analysis, solid state physics and isotope production. Between 1971 and 1978, the reactor was reconstructed and the reactor power was increased to 10MW and 15 vertical irradiation channels were added around the core. The reactor originally used 90% enriched IRT-3M fuel assemblies until it was converted to use 36% IRT-3M fuel assemblies.

Timeline (first meeting to shipment completion)



Quantities shipped

IRT-3M assemblies enriched to 90% 235U: 210 (32 kgs of end-of-life uranium)
IRT-3M assemblies enriched to 36% 235U: 42 (31 kgs of end-of-life uranium)

VIII.1.2. Organizations involved and responsibilities

Organization	Country	Description and Responsibilities
NNSA	United States of America	National Nuclear Security Administration – division of the DOE that manages and funds the RRRFR Programme.
INP	Uzbekistan	Primary contractor with NNSA and primary contractor with Mayak. INP provided project management and was responsible for all of the activities within Uzbekistan.
Rosatom	Russian Federation	Federal Atomic Energy Agency – responsible for regulating the import of research reactor fuel.
Mayak	Russian Federation	Prime contractor with INP. Mayak was the shipper of record, provided the shipping containers and rail cars, unloaded the fuel, and is responsible for reprocessing and interim storage.
Techsnabexport (TENEX)	Russian Federation	TENEX – one of the two companies in the Russian Federation authorized by the Russian Government to import spent nuclear fuel. TENEX was subcontracted by Mayak to complete the Unified Project and authorize the import of the SNF.
VNIPIET and VNIIEF	Russian Federation	Subcontracted by TENEX to perform the safety analyses, prepare the required documentation, and obtain the licenses for the TUK-19.
KATEP	Kazakhstan	Company authorized to manage spent fuel shipments in Kazakhstan. KATEP coordinated all activities for the transit of the spent fuel.
KAEC	Kazakhstan	Kazakhstan Atomic Energy Committee – nuclear regulator for Kazakhstan. Approved the transit permits and cask license.

VIII.1.3. Legal Framework

Uzbekistan and Russian Federation

The Governments of Uzbekistan and the Russian Federation agreed upon and signed an agreement (1997) on the peaceful use of atomic energy in which the focus was the dedication of the management of spent fuel. This GTGA was important because it served as the legal basis for the importation of spent nuclear fuel and the basis for the development of the Unified Project. With the government-to-government agreement in place, INP was permitted to contract with Mayak for the return of the spent fuel.

Uzbekistan and the United States of America

Two GTGAs provided the legal framework between the USA and Uzbekistan. They were: the ‘USA/Uzbekistan Non-Proliferation Agreement’ signed in June 2001; and the ‘DOE/Ministry of Foreign Affairs (MFA) Non-Proliferation Agreement’ signed in March 2002. The first agreement provided liability protection and tax exemption for non-proliferation activities and the second delegated the DOE and the MFA as agents with permission to enter into a contract for the spent fuel return.

Uzbekistan and Kazakhstan (transit country)

The transit of the spent fuel through the territory of Kazakhstan was granted by decree from the Government of Kazakhstan.

VIII.1.4. Casks used/special licensing requirements

The design license for the TUK-19 had been allowed to expire in 2000 due to its inactivity. The transportation license, which is shipment specific and issued for each shipment campaign, required development. The transportation license included information such as: duration of the shipment; actual radioactive content; mode of transport; emergency card information; and proposed shipment category to name a few. Both the design and transportation licenses were analyzed and prepared by VNIPIET in less than five months with approval by Rosatom following shortly thereafter.

The Kazakhstan license for the design and transportation of the TUK-19 cask was issued by the Competent Authority, Kazakhstan Atomic Energy Committee (KAEC) of the Ministry of Energy and Mineral Resources (MEMR). The approval process involved reviews from both independent and state experts. The TUK-19 license in the Russian Federation was issued according to the regulatory guidelines developed in the Russian Federation, not the IAEA TS-R-1 guidelines adopted by the KAEC. Therefore, KAEC requested that VNIPIET prepare a comparative analysis that confirmed the compliance of the TUK-19 safety analysis to the IAEA TS-R-1 guidelines. KATEP was chosen to coordinate all of the TUK-19 licensing activities and the license was issued by the KAEC in less than four months.

The TUK-19 license validation in Uzbekistan was issued by the State Inspectorate on Safety in Industry Mining using the Russian license. This activity was completed within two months.

TUK-19 casks.

VIII.1.5. Transit arrangements

The following main activities were completed to receive authorization to transit the territory of Kazakhstan:

- TUK-19 cask certificate validation.
- Development of 'Assessment of Radiation Impact of SNF Transit to Environment and Population (EIA)' and receiving the State ecological conclusion.
- Development and approval of the SNF Transit Programme.
- Signing of the contracts for: rail transportation; physical protection; emergency preparedness; and customs.

The transit programme was quite extensive and included provisions for liability, route selection, security, physical protection, and emergency preparedness.

VIII.1.6. Facility preparations (unique)

A number of facility and equipment enhancements were completed to support the loading and shipping of the TUK-19 casks. The major activities completed were:

Remote Crane Camera.

- New reactor hall flooring was installed to increase safety and help prevent the spread of contamination.
- New reactor hall lighting and remote cameras were installed to improve the conditions for fuel and cask handling. Previously, the crane operator used mirrors and visual cues to assist with the alignment of the basket and cask. The new remote cameras improved the loading operations, making loading quicker and safer.
- A backup generator was installed to provide emergency power if electrical power was lost during the loading operations.
- New transport racks were fabricated to secure the TUK-19 casks to the trucks during transport from the reactor to the rail yard.
- New trucks were procured to ensure the safe transport of the SNF and to reduce the number of road transports.
- Additional radiological monitoring and communications equipment was purchased.
- A self-releasing grapple was designed, fabricated and used to load the basket containing fuel assemblies into the cask

VIII.1.7. Shipment logistics summary (unique experiences)

The shipment consisted of the transport of 252 IRT-3M spent fuel assemblies enriched to 36% and 90% ^{235}U. Several months prior to the shipment, the fuel assemblies were inspected by

Mayak experts. All of the spent fuel assemblies met the acceptance criteria for shipment and receipt with none requiring encapsulation. The TUK-19 cask was chosen because it was designed for Russian research reactor fuel and for use in the Russian designed reactors. The TUK-19 has the capacity to hold 4 IRT-3M assemblies and a total of 16 casks were available for each shipment. The casks were transported to Mayak by rail in 2 TK-5 railcars. Each TK-5 railcar holds 8 TUK-19 casks and has a roof that can be opened for loading and unloading operations. With a maximum of 64 IRT-3M fuel assemblies transported in each shipment, four shipments were needed to return the 252 spent fuel assemblies to Mayak.

The shipment process was identical for each shipment. The TK-5 railcars transported the empty TUK-19 casks from Mayak, through Kazakhstan to a rail yard near INP. The casks were off-loaded and transported to the reactor hall and staged for loading. The casks were allowed to acclimate for 24 hours before opening. Detailed cask loading plans were prepared in advance to ensure that none of the cask license contents limits (i.e. decay heat, activity, cooling time) were exceeded. IAEA inspectors were present and verified the presence of 137Cs in 100% of the spent fuel assemblies. Each of the measurements was taken during the basket loading process and did not significantly affect the loading process. Once the four spent fuel assemblies were placed in the basket, the basket was remotely raised out of the spent fuel pool by the overhead crane and allowed to drip dry (removal of most of the water) for 15 minutes. After the drying period, the basket was placed into the cask. The cameras at this point proved to be a tremendous improvement to historical loading operations. Due to the in-air loading the grapple was designed to self-release once the basket was fully lowered in the cask. This grapple worked flawlessly during all 64 cask loading operations. One reactor operator along with two radiological protection operators entered the reactor hall carefully monitoring the radiation levels. The operators were able to approach the cask and connect the crane hook to the cask lid. The cask lid was then installed on the cask and secured with two bolts prior to movement to its assigned storage spot. The remaining bolts were installed and torqued and the cask prepared for hermetic seal testing. A helium detector was used to confirm a proper seal per the TUK-19 handling instructions. The time to load a TUK-19 cask averaged less than one hour per cask.

On the day of the shipment, the TUK-19 casks were transported to the rail yard and loaded into the TK-5 railcars while under constant security surveillance. Final surveys were conducted and the shipment left by a dedicated train at the predetermined time specified by the authorities. The transit time from Tashkent to Mayak was less than four days and the total turnaround time to return the empty casks was approximately three weeks. All four shipments were completed in less than four months, four months ahead of the baseline schedule. There were no incidences reported during the loading of the casks at INP and unloading of the fuel at Mayak.

Lessons learned (major differences from previous shipments)

Because this was the first shipment of research reactor spent fuel to the Russian Federation, a significant amount of information was learned that would apply to future shipments from other RRRFR programme countries. This experience demonstrated the need to identify all of the legal and technical requirements as soon as possible. It is also recommended that a dedicated project manager or team be appointed due to the significant work load. All documentation to be used for customs declarations and cargo manifests should be consistent. It is good practice to provide this documentation in advance to the customs agents for review. Lastly, it is important to have Mayak experts characterize and inspect the fuel to be shipped well in advance of the shipment to help reduce delays associated with suspect or deformed fuel assemblies.

VIII.2. SHIPMENT SUMMARY OF LATVIA

Reactor name and operator

Salaspils research reactor, State Hazardous Wastes Management Agency (BAPA)
Dates of shipment: 12 May 2008

VIII.2.1. Introduction

Reactor background

The Nuclear Research Reactor IRT was originally operated by the then Institute of Physics of the Latvian Academy of Sciences. The reactor was started up on 26 September 1961, with the nominal power of 2000 kW using 10 weight percent 235U fuel (EK-10). The IRT is a pool aqueous reactor with a core located at about 8 m in distilled water inside a biological concrete shield. The reactor was reconstructed in 1979 and reached 5000 kW with 90 wt% enriched fuel (IRT-2M). The original mission at the Institute was to conduct research in nuclear spectroscopy, solid state radiation physics and chemistry, radiation biology and nuclear technology. The reactor (when operating) had 10 horizontal and 12 vertical experimental channels together with a unique radiation loop facility.

The IRT was officially shutdown in1998 and is currently being decommissioned. The Latvian State Hazardous Wastes Management Agency (BAPA) is responsible for the dismantlement the reactor systems.

VIII.2.2. Timeline (first meeting to shipment completion)

Officials from the US Government (DOE/NNSA RRRFR Programme) met with officials from the Latvian Government in February 2003 for the initial fact finding. The US Team, along with IAEA and Russian officials, toured the facilities, observed the spent nuclear fuel in the spent fuel pool (along side the reactor), and discussed inventory and return schedules.

Approximately 3 kg of Fresh HEU Fuel was shipped to Russian, May 2005, from the Salaspils research reactor by air. The fuel was shipped to Dimitrovgrad where it was blended down.

Approximately 14.4 kg of spent nuclear HEU fuel was shipped to Mayak, May 2008, from the Salaspils research reactor by rail.

Quantities shipped

Fresh HEU Fuel: ~3 kg; Spent Nuclear HEU Fuel: ~14.4 kg

Organizations involved and responsibilities

A State Agency for Radioactive Waste Management, BAPA.

BAPA continues to decommission the Salaspils research reactor. Now that the fresh and spent fuel have been removed, the water in the reactor biological shield (serving as a backup to the spent fuel pool water) will be drained and the concrete shield demolished and removed.

VIII.2.3. Legal Framework

Country and Russian Federation

Latvian-Russian Federation Agreement, 3 December 2007

Country and the United States of America

Latvian-US Weapons of Mass Destruction Agreement, 25 April 2005

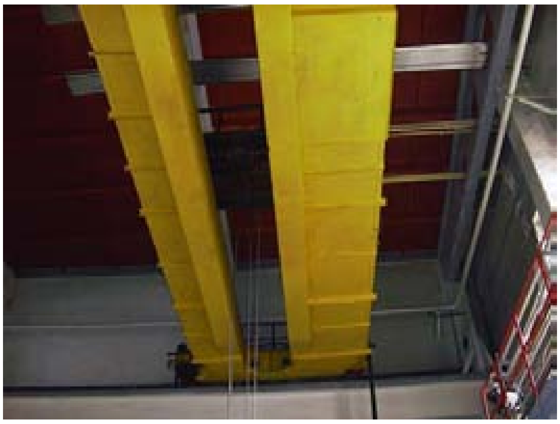
Country and transit countries (if applicable): Not Applicable

Casks used/special licensing requirements: TK-19

Transit arrangements: None. Latvia borders the Russian Federation.

Facility preparations (unique):

Reactor hall's crane: While the lifting capacity of the reactor hall crane was adequate, it required modifications to meet Latvian current operating requirements.



Reactor hall crane.

Container transport platform: A new manual container transport system was required to move the containers into and out of the reactor hall. The transport platform was designed to match the existing rail spur into the reactor hall.

Transport Platform

Manual Operations

Video surveillance system: A new, remote camera system was installed (along with a secondary control system) to allow for remote loading of the spent fuel. Video cameras were installed around the cask loading area. A massive data storage system was included to capture real-time operations. An in-pool video camera and detector was installed to verify fuel assembly information and to measure fuel assembly spectra.

Remote Video Operations

Under Water Camera

Assembly Inspection

SNF Assembly Testing

SNF assembly's removing system: A new 2 axis telfer system was installed above the spent fuel pool to articulate the basket from the cask, to the pool, and back to the cask.

Assembly Removal Telfer

Basket Removing System

Emergency SNF container's lid transport mechanism: A new 2 axis telfer system was install pool-side to provide emergency cask lid lifting. The main reactor hall crane was the primary mechanism for removing the cask lid and for closing the cask.

Emergency Lid Removal System

Container fixing equipment: A rigid work station was constructed pool-side to fix the cask and to provide emergency mechanism in the event the spent fuel basket was dropped during loading.

Container Fixing System

Container Fixing System

Container Leak Test Equipment: A vacuum system designed to meet the cask leak test requirements.

Leak Test Equipment

IAEA Tamper Indicating Seal

Container Transport System: Semi-trailer/Truck system to haul casks from rail head (TUK-5 Rail Cars) to reactor hall. The trailer was fitted with 3 and 1 cask support stands.

Trailer with cask support stands

Cask unloading to TUK-5 Rail cars

VIII.2.4. Shipment logistics summary (unique experiences)

Experience for overall logistic can be divided in several objects:

- Transportation from the Salaspils research reactor (SRR) to the loading site,
- Transportation of SNF to the border of Russian Federation and transfer of cargo at the territory of Russian Federation.

In the first case, the main activities were connected with:

- Site selection for loading,
- Transport routes evaluation,
- Transport vehicles arrangement to meet legislation's requirements, and
- Guarding during transportation.

All activities were planned in early stages of the project, which gives a possibility to evaluate planned activities and, if it was necessary, to choose the alternative solutions. Such approach facilitated the logistic operations and allowed to reach planned results at planned time. The basic problems were connected with the site selection, since all planned sites were controlled by the private companies. Fortunately, these problems were solved timely and they did not play any hindering role during loading of SNF in train. The after-shipment analysis indicated that all planning stages, as well as, implementation stages of the project were well performed. The close cooperation with different project stakeholders, (e.g. different ministries, customs, border guards, and commercial companies) significantly facilitated the project implementation.

For the second case, the cooperation between specialists from the Russian Federation, DOE and Latvian organizations had the essential impact on performance of all logistic operations timely with planned results. It is necessary to stress the key role of DOE experts, especially Dr. Igor Bolshinsky and Stan Moses in formation of preconditions for only one shipment instead planned two from the beginning of the project.

The main activities were connected with:

- Safe parking of train,
- Safe transportation of SNF at the territory of Latvia,
- Guarding during parking and transportation of cargo, and
- Transfer of cargo at the territory of Russian Federation.

Taking into account the experience from another similar projects and project management support from DOE experts, all planned activities were performed without the delays during SNF transportation. Only one 2 hours delay occurred which was for the transfer of cargo at the territory of Russian Federation due to the paperwork delay in the custom of RF. The essential role in definition of all necessary activities for the shipment of SNF from Latvia had the common meetings with all involved sides in Latvia, Russian Federation, as well as, workshops in Serbia and Romania.

VIII.2.5. Lessons learned

- Then involvement of all stakeholders must be in the early stage of the project implementation. Common meetings with the experts from all involved sides and organizations were strongly facilitating factor for SNF shipment from Latvia.
- Possibility to share with information from other similar projects significantly facilitated the SNF shipment project from Latvia.
- Support for project management from the DOE side made easier the performance of project's activities.
- The planning activities for SNF shipment project must be performed taking into account 1-2 alternative solutions. The evaluation's strategy for selection of loading site and possibility to change it secured the implementation of SNF shipment from Latvia.

VIII.3. SHIPMENT SUMMARY OF CZECH REPUBLIC

Note: The following shipment summary was developed from information contained in the report – 'Lessons Learned Report - High and Low-enriched Uranium Spent Nuclear Fuel Shipment from the Czech Republic to the Russian Federation', Nuclear Research Institute Řež plc, Czech Republic, September 2008, Revision 1'.

This summary contains excerpts from the lessons learned report. For a copy of the full detailed version, please contact Igor Bolshinsky (igor.bolshinsky@nnsa.doe.gov) or Mike Tyacke (Michael.tyacke@inl.gov).

Reactor Name and Operator: LVR-15 Research reactor
Nuclear Research Institute, Rez
Dates of shipment: 1 – 8 December, 2007

VIII.3.1. Introduction

Spent Nuclear Fuel (SNF) designated for return to the Russian Federation had accumulated at NRI Rez from operation of the VVR-S and LVR-15 reactors from the 1950s until 2005; it included the following nuclear materials:

- EK-10 fuel assemblies (enrichment 10% U235)
- IRT-M fuel assemblies (enrichment 36% U235)
- IRT-M fuel assemblies (enrichment 80% U235)
- EK-10 fuel rods (enrichment 10% U235)
- EK-10 fuel rods (enrichment 6.5% U235).

EK-10 fuel was used in the reactor roughly until the end of the 1970s; subsequently, the reactor was converted to use IRT-2M fuel. Since that time, EK-10 fuel has been stored mainly in dry concrete barrels and IRT-2M in wet storage pools in the reactor building and in High-Level Radioactive Waste Storage building.

In 2005, NRI signed a framework contract with DOE that assures the USA' financial support of 450 million CZK (about 22 million USD) for the preparation and realization of HEU SNF transport to the Russian Federation, including financing procurement of the casks for HEU SNF shipment. The USA also financed the shipment of fresh HEU nuclear materials to the Russian Federation within the scope of separate contracts among IAEA, NRI, and Russian organizations.

To date, the following activities were successfully performed in the Czech Republic within the scope of the RRRFR Programme and the Reduced Enrichment for Research and Test Reactors Programme:

- December 2004—transport of a small amount of HEU materials from NRI to the Russian Federation (by air),
- October 2005—conversion of the VR-1 school reactor at Czech Technical University in Prague from HEU to LEU nuclear fuel as the first reactor using the new Russian LEU nuclear fuel (including air transport of nuclear materials),
- October 2006—transport of non-irradiated fuels of various types, nuclear materials, and plutonium to the Russian Federation (by air).

At the end of November 2007, all these activities culminated with the unique shipment to the Russian Federation of 527 fuel assemblies of SNF type EK-10 (enrichment 10% U235) and IRT-M (enrichment 36% and 80% U235) and 657 irradiated fuel rods of EK-10 fuel, which were used in LVR-15 reactor.

VIII.3.2. Organizations involved and responsibilities

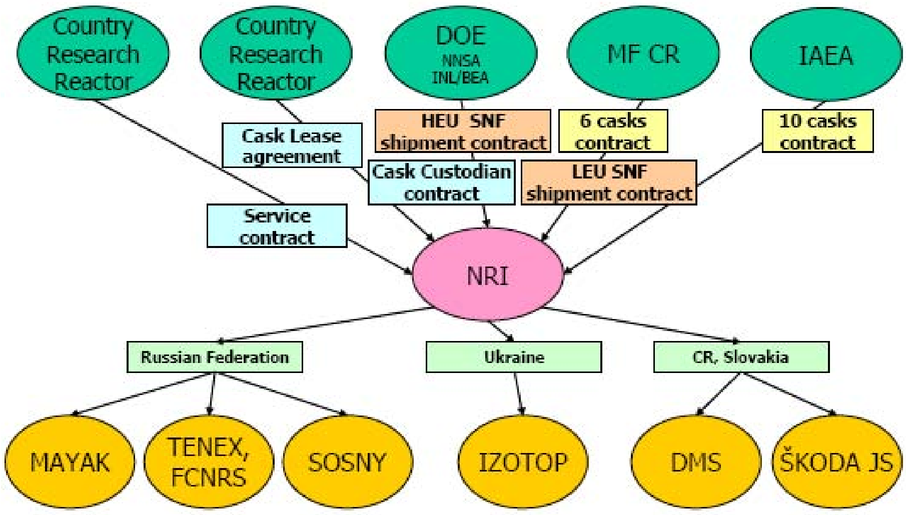
Czech Republic

- Nuclear Research Institute Řež plc (ÚJV Řež - NRI)
- State Office for Nuclear Safety (SÚJB – SONS)
- DMS s.r.o. (DMS)
- Police of the Czech Republic—security (PR)
- České dráhy, a.s.—Czech Rail— operator of railway infrastructure (ČD)
- Czech Fire Department (HZS ČR)

Slovakia

- Nuclear Research Institute Řež plc (ÚJV Řež - NRI)
- Slovak Nuclear Regulatory Authority (ÚJD - SNRA)

- DMS s.r.o. (DMS)
- Police force—security (PZ)
- Railway police—security (ŽP)
- Cargo Slovakia, a.s.—rail transport (ŽSSK Cargo)
- Slovak railways—operator of railway infrastructure (ŽSR)
- Fire department and paramedics—emergency services (HaZZ)



Ukraine

- Nuclear Research Institute Řež plc (ÚJV Řež - NRI)
- State Nuclear Regulatory Committee of Ukraine (SNRCU)
- IZOTOP
- Ukrainian Railways—Ukrzaliznica (UZ)
- Internal Troops of Ukraine (national police authority - Ministry of Internal Affairs)
- Special Transportation Service of Ukraine (Ministry of Transportation and Communications)
- Emergency Troops of Ukraine (Ministry of Emergency Situations)

Russian Federation

All organizational matters for transport in the Russian Federation were addressed by the Foreign Trade Contract signed by ÚJV Řež – NRI and TENEX, acting as agent for FPGU Mayak.

VIII.3.3. Legal Framework

See also section 2.6 for legal framework discussion.

Casks used/special licensing requirements

The nuclear material (SNF of type EK-10 and IRT-2M) was transported in 16 VPVR/M casks of a type approved and designated as CZ/048/B(U)F-96 by decision of SUJB-SONS No. 6943/2005. For usage in Slovakia, validation was performed by decision of ÚJD – SNRA No. 109/2007. For usage in Ukraine, decision No. 14-21/4194 by the SNRCU was issued on

August 7, 2007. The Russian Cask Package Design License No. RUS/3065/B(U)F-96 was issued by the Russian Federal Agency for Atomic Energy on January 23, 2006.

For transport, the casks were placed in pairs into special 20-ft ISO ‘hard top’ containers (a total of eight).

Transit arrangements: See section 4 for a summary of the transit arrangements.

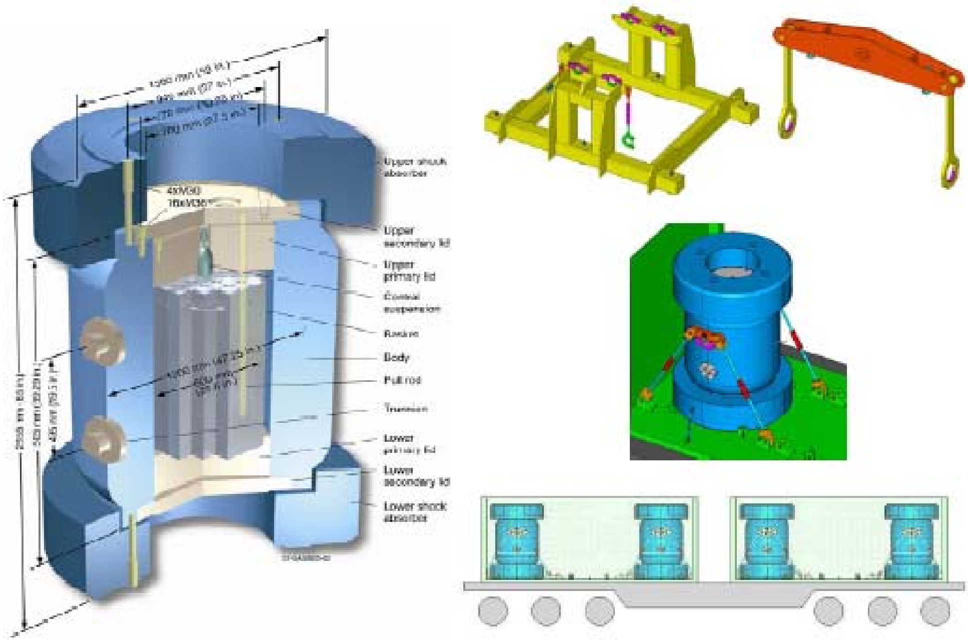
Facility preparations (unique): Refer to the detailed report in Section 4.1.1.

Shipment logistics summary (unique experiences):

VIII.3.4. Transport route

By law, this was a top-secret (from the standpoint of information on transport routes and dates) combined road and rail transport operation.

The road transport route led from NRI Řež to a rail freight yard along suitable roads. Road transport from NRI to the rail freight yard took place in two batches (four trucks, one ISO container with two Škoda VPVR/M casks in each). The time between the two transports was held to a minimum so as not to cause unnecessary public interest regarding the exceptional events and measures taken on public roads. For this reason, all VPVR/M casks were first loaded into ISO containers, and only then did transport of the first batch from NRI Řež to the transfer yard begin. Road transfer was provided by DMS vehicles and staff in accordance with the transport timetable.



The rail transport route was laid out in accordance with documentation; the version selected led from the Czech Republic to Slovakia via a selected border station to TKD Dobrá, and then to the Slovak/Ukrainian border. At TKD Dobrá a wide-gauge train was present. This train was sent out from FGUP Mayak in time so that it would be available at TKD Dobrá for transfer upon arrival of the load. The load continued through the Ukraine and the Russian Federation without further transfer to its final destination at FGUP Mayak.

Transport in the Czech Republic and Slovakia took place in accordance with ADR (The European Agreement concerning the International Carriage of Dangerous Goods by Road) and RID (Regulations concerning the International Transport of Dangerous Goods by Rail). The main documents for preparation of transport were relevant transport instructions and emergency regulations of individual carriers (DMS, ČD, ŽSR, and ŽSSK CARGO).

Rail transport in the Czech Republic and Slovakia took place in accordance with approved timetables. Timetables were compiled by the department of special transport of GŘ ČD and GR ŽSR. The timetables were adhered to for the entire time, with approximately 30-minute discrepancies from the planned schedule. Timetables were coordinated between the railways of neighboring countries (ČD, ŽSR, and UŽ). The timetable of the special train was compiled in accordance with principles of free traffic flow, minimizing stops, and the amount of time spent at stations.

During the course of the entire road and railway transport operation in the Czech Republic and Slovakia, no exceptional events were noted, nor were any exceptional events expected.

At TKD Dobrá, the containers were transferred from the European-gauge train onto a wide-gauge train that had already arrived courtesy of FGUP Mayak 3 days prior to the transfer.

Transport in Ukraine and the Russian Federation took place in accordance with the CIS Countries Agreement Concerning the Carriage of Dangerous Goods by Rail (SMGS). The main documents for preparation of transport were relevant transport instructions and emergency regulations of individual carriers (IZOTOP, Ukrainian railways, Mayak, and Russian railways).

VIII.3.5. Nuclear safety and radiation protection

The main elements of protection were conforming to all regulations regarding the use of casks and adhering to radiation protection limits.

The loading of VPVR/M casks and properly securing them in 20-ft containers must be seen as important for transport safety. This was performed and checked in accordance with documentation. The same attention was paid during all phases of transport to the technical condition of transport facilities and the proper securing of containers on road and rail vehicles. Dosimetry measurement checks were performed during loading at NRI Řež prior to the commencement of road transport, prior to the commencement of rail transport, during entrance into Slovakia, and during unloading at TKD Dobrá. Measurement results have been documented.

All values required for the cask and container were measured (dosage equivalent input on the surface of the cask, DE input at a distance of 1 m from the cask, DE input at a distance of 2 m from the surface of the container, contamination on the surface of the cask, and on the surfaces of the 20ft container). Measurement results were documented.

During the entire time of railway transport in Slovakia, one nuclear safety specialist (employee of the carrier responsible for handling nuclear material) and two employees of the carrier performed dosimetry. Personal dosimetric checks were arranged for all participants in transport in accordance with approved radiation safety documents.

Thermo luminescent dosimeters were mainly used; in a minority of cases, film dosimeters were used. After transport was completed, the dosimeters were evaluated. Doses exceeding the recording level of personal dosimeters were not noted in any cases.

In conclusion to this section, it can be said that all conditions related to the use of casks and limit values of radiation protection were upheld during transport.

VIII.3.6. Security

During the entire time of transport in the Czech Republic, Category II security was provided and in Slovakia Category I security was provided. Security was provided on the basis of cooperative agreements between the transporter, DMS, and the Czech police, Slovak police, and Slovak railway police. Cooperation between Czech and Slovak police in the area of their common border took place on the basis of an interstate agreement and an agreement with the police of the Czech Republic.

Security was provided fully in accordance with approved SNR transport security documentation.

Pyrotechnical checks of trucks and the special train, including containers, took place in accordance with police pyrotechnical documentation. All pyrotechnical checks had negative results.

Responsibility for the security of nuclear material transported via the special train was officially transferred from the police of the Czech Republic to the Slovak railway police at the train station on the border between the Czech Republic and Slovakia.

Critical locations along the entire transport route (e.g., railway overpasses, bridges, tunnels, and railway stations) were secured by police.

All employees of the transporter and carrier were given indemnification issued by the transporter, authorizing them for activities related to the transport. No other persons were allowed into the loading, transfer, and handover locations.

The protection of secret information was ensured in accordance with current legislation applicable to this area in individual states. By following the rules for protection of secret information and via selection and training of employees of all organizations involved, the entire transport event (in which very many people participated, directly or indirectly) was successfully kept secret in such a way that no attempt at a breach of security was made.

From the very beginning of preparations for transport, it was expected that the most complicated security point will be the handover of responsibility for security for the special load at the border between Slovakia and Ukraine.

This was the subject of an entire number of negotiations between the transporter, Slovak, and Ukrainian officials and bodies starting in November 2006, within the scope of preparations of an implementation agreement within the provisions of a so-called four-sided agreement on the transport of nuclear materials between the governments of the Russian Federation, the Czech Republic, Slovakia, and Ukraine dated April 1998. These negotiations were difficult. It was only in October 2007 that a written agreement was signed between the relevant ministries of Slovakia and Ukraine.

Upon arrival at the border, however, a dramatic change occurred, where Ukrainian customs officials did not respect the agreement between both ministries and prevented the entry of armed Slovak guards onto Ukrainian territory. It was only several hours later that a decision was made to perform the transfer of responsibility for security right at the state border (which had been the original Slovak proposal). Responsibility for security was thus handed over by members of the Slovak railway police to members of MVD Ukraine with a total delay of 4 hours. During the entire time of negotiations regarding the location and manner of the handover, security was not weakened nor otherwise compromised.

Records regarding the handover of responsibility for security of nuclear material and records of pyrotechnical checks performed are on file.

VIII.3.7. Lessons learned (major differences from previous shipments)

The above transport of SNF through the Czech Republic and Slovakia was prepared by the transporter in cooperation with affected organizations and officials of the Czech Republic and Slovakia from the beginning of 2006 (thus almost 2 years).

During transport, no deviations from plan occurred, with the exception of the manner of handover on the Slovak/Ukrainian border. It was very important and useful that two NRI and one Mayak representatives accompanied the transport from the research facility to the Russian border. This fact allowed managing and solving unexpected situations en route.

The transport documentation had been prepared 3 months before the shipment, and several times accordingly checked. One copy of the documentation for FGUP Mayak has been issued in the form of laminated copies to avoid the paper form documentation damage within the next 20 years of the NRITENEX contract (return of vitrified rad waste after reprocessing).

The last four days before the shipment, the representative of FGUP Mayak worked at NRI to check the completeness of the documentation from the point of view of the SNF receiver. This limited time seems to be insufficient to complete all additional Mayak last-minute requirements. It is recommended to have 2 weeks reserved for this final documentation check. Some small part of the documentation (mainly related to the real transport documents) was prepared on board the train. For these purposes, it is highly recommended to have a laptop, printer, scanner, and so forth at your disposal to allow operatively preparing missing or additional documents.

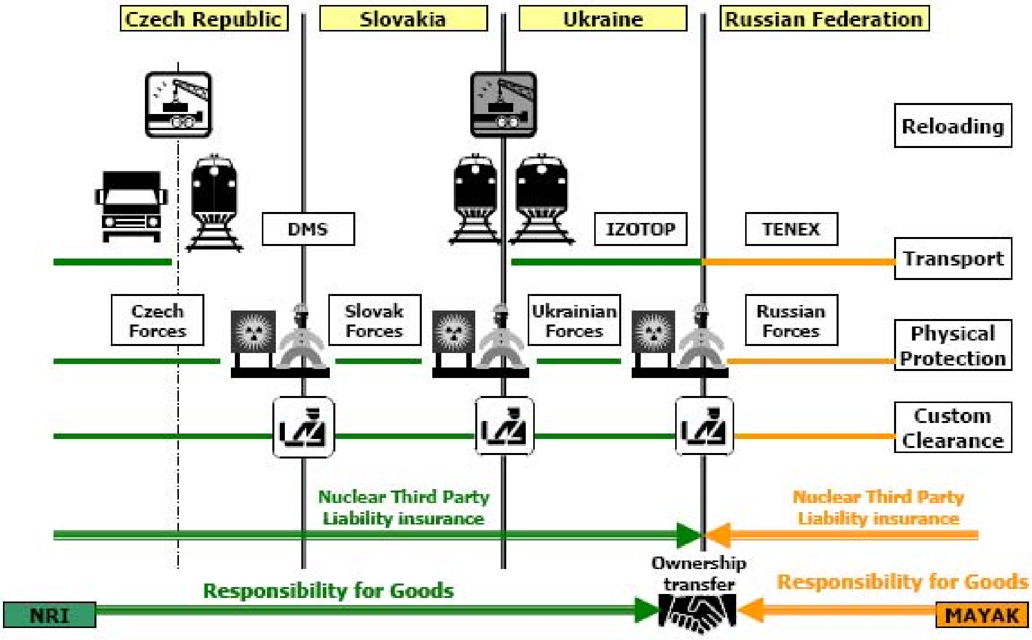
Transport, as a whole, occurred smoothly and safely, and all conditions set out in the decision of SONS and the Slovak Nuclear Regulatory Authority, both of whom issued permission for transport, were met.

All bodies and organizations concerned proceeded in absolute conformance with permits from relevant authorities, planning documentation, their commitments, and with directives.

Unfortunately, because of the special confidential regime of the transport through the territory of the Russian Federation and Ukraine and of the organizations also involved, NRI has no detailed information about transport preparation and realization cross these countries.

VIII.4. SHIPMENT SUMMARY OF HUNGARY

Reactor Name and Operator: Budapest research reactor
Hungarian Academy of Sciences KFKI Atomic Energy Research Institute (AEKI)
Dates of shipment: 17 September 17 – 22 October, 2008



VIII.4.1. Introduction

Reactor background

The Budapest Research reactor (BRR) is a tank-type reactor, moderated and cooled by light water. The reactor, which went critical in 1959, is of Soviet origin. The initial thermal power was 2 MW. The first upgrade took place in 1967 when the power was increased from 2 MW to 5 MW, using a new type of fuel and a beryllium reflector. A full-scale reactor reconstruction and upgrading project began in 1986, following 27 years of operation since initial criticality. The upgraded 10 MW reactor received the operation license in November 1993. In line with Hungarian safety regulations a periodic safety review (PSR) was conducted in 2002-2003, as a result of which the operation license was renewed in November 2003. The current license is now valid until further notice.

Timeline (first meeting to shipment completion)

The first meeting: January, 2005.
Contract Signed: December 2005
Facility Modifications Begun June 2007
Facility Modifications Complete November 2007
Fuel Loading July – August 2008
Shipment September-October 2008

Quantities shipped

HEU	154 kg	798 VVR Assemblies
LEU	104 kg	82 EK-10 Assemblies

VIII.4.2. Organizations involved and responsibilities

- KFKI Atomic Energy Research Institute (AEKI) – Responsible for all facility preparations, shipment preparations, cask loading, and all subcontracts.
- Pinter Works – Responsible for construction of the Service Hall, transfer trolley, and un-canning machine to support cask loading.
- IZITNA – Responsible for supporting the licensing and placarding of the shipment within Hungary.
- Federal Center for Nuclear and Radiation Safety (FC NRS) – Responsible for preparation of the Unified Project for import of SNF to the Russian Federation.
- SOSNY – Responsible for support of the Unified Project development, preparation of the Russian shipment license, and responsible for coordination of the licensing of the sea shipment and receipt at Murmansk.
- Nuclear Research Institute Řež – Responsible for delivery of Škoda casks and auxiliary equipment and their return to NRI upon completion of the shipment. Also responsible for vacuum drying and leak testing of the Škoda casks prior to shipment.
- BILK Kombiterminal – Responsible for truck transport of half the casks from the AEKI facility to the railhead and transfer of all casks to rail.
- DMS Dukovny – Responsible for truck transport of half the casks from the AEKI facility to the railhead.
- Volga-Dnepr – Responsible for air shipment of three empty Škoda casks from the Mayak facility to the Budapest airport.
- Máv Cargo – Responsible for rail shipment of the casks from the BILK railhead to the Port of Koper.
- Hungarian National Police – Responsible for physical security of the shipment from the AEKI facility to the Slovenian border.
- TRANSING – Responsible for licensing and execution of SNF shipment within Slovenia.
- ASPOL Baltic – Responsible for sea transport from the Port of Koper to the Port of Murmansk, including subcontracting the vessel Lynx from Edlow International.

VIII.4.3. Legal Framework

Country and Russian Federation

A Hungary/Russian Federation Government to Government Agreement was negotiated to support the shipment of SNF. The agreement was signed in July, 2008.

Country and the United States of America

A Diplomatic Note was prepared and exchanged between Hungary and the USA providing the basis for an Implementing Agreement between the Hungarian Academy of Sciences and the Department of Energy. The Implementing Agreement was signed in June, 2008.

Country and transit countries (if applicable)

The shipment was routed through Hungary and Slovenia, and then by ship to the Russian Federation.

Casks used/special licensing requirements:

The Škoda cask was used for the shipment, with 13 used for HEU fuel and 3 used for LEU fuel. Cask Certifications were required for Hungary, Slovenia, and the Russian Federation. In addition, the license for the vessel LYNX was revised to include the Škoda cask.

VIII.4.4. Transit arrangements

The shipment was routed through Hungary on rail. At the border, the physical and radiological protections were transferred to Slovenia. At the Port of Koper, the cargo was transferred to the vessel Lynx. Following arrival in Murmansk, the cargo was transferred to Russian authority.

Facility preparations (unique)

The existing Away From Reactor (AFR) spent fuel pool was not suitable for loading of the Škoda cask, having a crane with insufficient capacity and no room for management of the 16 casks to be used. For this reason, a new Service Hall was erected on the site of the AFR pool.

The license for the AFR spent fuel pool prohibited movement of casks over the pool. For this reason, a transfer trolley was developed that allows the building crane to load the Škoda cask on the trolley and then move the cask over the spent fuel pool.

Approximately half of the Hungarian fuel was canned in the 2000-2004 timeframe in order to mitigate corrosion. A chipless cropping machine was developed to remotely remove the top of the can in the spent fuel storage pool. This machine was also mounted on the transfer trolley.

Shipment logistics summary (unique experiences):

This was the first shipment to use aircraft to transport (empty) Škoda casks. The unloading of these casks was very quick, similar to truck to rail inter-modal transfer. The casks must be loaded in the ISO containers singly, however, which limits the number of casks that can be transported by this mode to nine (assuming the cargo capacity is not limiting).

This was also the first shipment to utilize sea transport, and thus demonstrated the feasibility of this option. This must be an option of last resort, however, as the cost and duration is significantly higher than rail transport.

VIII.4.5. Lessons learned (major differences from previous shipments)

Air transport - The typical truck trailers used for transport of ISO containers have a raised gooseneck near the tongue, which can interfere with the opening of the end doors on a 20’ ISO container such as are used for the Škoda cask. This results in the need to lift the cask over the top of the ISO, for which some cranes may not have sufficient vertical capacity. It is important to ensure that the doors of the ISO face forward in the aircraft so that when they are unloaded from the plane onto a trailer, the doors will then face rearward.

Sea shipment – the scheduling of sea vessels is much more difficult than truck or train transport due to the uncertainty associated with the wind, weather, and currents. Realistic average speed values should be used for planning durations, rather than the maximum speed of the vessel. Speed of the vessel can be from 50-110% of the normal vessel maximum speed due to wind and weather. Future shipments should consider the use of extra ballast in order to allow the ship to ride at a normal height in the water. Riding high in the water makes the ship much more vulnerable to high winds and storms.

VIII.5. SHIPMENT SUMMARY OF BULGARIA

Reactor Name and Operator: IRT-2000 research reactor; Institute for Nuclear Research and Nuclear Energy (INRNE), Bulgarian Academy of Sciences

Dates of shipment: July 5-17, 2008

VIII.5.1. Introduction

Reactor background

The IRT-2000 Research reactor in Sofia is the basic facility in the Nuclear Scientific and Experimental Centre of the Institute for Nuclear Research and Nuclear Energy (INRNE) of the Bulgarian Academy of Sciences. The IRT-2000 Research reactor was designed and built in compliance with the widely adopted norms and standards in force in the 1950s in the former USSR and was put into operation in 1961. At that time the reactor site was outside the city of Sofia, whereas now the Mladost residential district has built up adjacent to the site.

Seal Check in ISO Container

Cask Loading

Railcar Loading at Izmail

Casks on Barge

The IRT-2000 is a heterogeneous water-water pool-type reactor with a maximum thermal capacity of 2000 kW, operating on thermal neutrons. Distillate water under atmospheric pressure is used as neutron moderator, coolant and protection over the reactor core. The reactor core is parallelogram shaped with a base of 57×43 cm and height of 50 cm. It is placed at the bottom of a deep-water pool and can contain up to 48 aluminium fuel assemblies of type EK-10 or S-36 with 15-16 fuel elements each. The fuel elements are cylindrical rods 1 cm in diameter and 50 cm in length. Their core is made of pressed uranium dioxide enriched with 10% or 36% Uranium-235. The aluminium cladding is 1 mm thick. The pool water and the 2 m thick concrete walls of the reactor vessel provide radiation protection from the reactor core. There is continuous air ventilation at all working places.

The Reactor is equipped with 11 horizontal and 11 vertical experimental channels. Measurements of the mixed neutron and gamma field parameters (thermal and fast fluxes, spectra) were carried out in different points of the reactor core and the baffle, as well as in the vertical and horizontal experimental channels by means of the activation, ionization and other radiometric methods and devices developed by INRNE specialists. Based on these measurements, optimal conditions were chosen for carrying out scientific and applied reactor experiments.

A radiochemical laboratory is also included in the overall complex of the Research reactor. Because of its unique facilities - hot chambers, radiochemical and measuring boxes - the Laboratory is able to work with radioisotopes, produced in the Reactor or imported from abroad, to produce radiopharmaceuticals for medical applications, specimens for analyses in geology, chemistry, metallurgy, agriculture, and other applications.

A technical project for the reconstruction and upgrading of the facility was developed in 1986 to step up the experimental capabilities of the reactor by increasing its power up to 5 MW. IRT-2000 was temporarily shut down in 1989 to increase the level of nuclear and radiation safety in accordance with the Regulation of the Inspectorate on the Safe Use of Atomic Energy of the Bulgarian Nuclear Safety Authority.

In accordance with the requirements of the Vienna Convention on Civil Liability for Nuclear Damage, the Bulgarian Council of Ministers, by Resolution No. 106/23.01.1997, defined the IRT-2000 Research reactor as a 'nuclear facility of another kind' and the Institute for Nuclear Research and Nuclear Energy of the Bulgarian Academy of Sciences as the operator of this nuclear facility.

The Bulgarian Nuclear Safety Authority and INRNE proposed a programme of alternatives for the future development of the IRT-2000 research reactor. Upon detailed consideration of this document by a number of authorities, the Council of Ministers of Bulgaria issued Resolution No. 332/17.05.1999 on starting a large-scale programme. As a result, subsequent Resolution No. 552/06.07.2001 was passed in 2001 enacting the reconstruction the IRT-2000 research reactor into a low power reactor up to 200 kW. This resolution enables the reinstatement and expansion of the National Centre for Scientific and Applied Investigations. The research reactor is now in the process of this reconstruction.

VIII.5.2. Timeline (first meeting to shipment completion)

INRNE shipped 17 kg of HEU fresh fuel from IRT-2000 on 23 December 2003 in accordance with an IAEA contract and with RRRFR support.

The spent fuel shipment planning began in October 2004 at the IAEA office in Vienna, Austria. Facility modifications were performed without moving the fuel while waiting for a Bulgaria-USA government-to-government agreement to be signed. After signing, the spent fuel was physically inspected to prepare data for the passports required for importation into the Russian Federation. Cask handling training was provided by NRI and Skoda in May 2008 and loading of the casks began one week after the training. Loading was witnessed by IAEA and Euratom safeguards inspectors who applied tamper indicating seals on each cask. The loaded and sealed casks were loaded into ISO container on 4 July 2008 and the truck convoy left the next morning for Kozloduy. The casks were loaded onto a barge at Kozloduy on the same day they arrived. Customs paperwork was completed on the morning of 6 July and the barge left for Izmail on the Danube River. The shipment cleared Romanian Customs a few days later, then continued to Izmail where they cleared Ukrainian Customs and were loaded onto railcars provided by Mayak. Title to the spent fuel was transferred from INRNE to Mayak when the rail convoy reached the Ukraine-Russian border on 13 July. The shipment was received and accepted at Mayak on 17 July. The casks were unloaded and shipped by air on 21 August from the Balandino airport in Chelyabinsk to the airport in Budapest, Hungary, to support the schedule for the Hungarian RRRFR shipment.

VIII.5.3. Spent fuel shipment timeline

Date	**Location**	**Topic**
2004		
October 21-22, 2004	Vienna, Austria: IAEA Office	Shipping Spent Fuel from IRT-2000
December 14-16, 2004	Bucharest, Romania: CNCAN Office	Joint Bulgaria-Romania Project Planning Meeting
2005		
March 17-18, 2005	Sofia, Bulgaria: INRNE Office	Joint Bulgaria-Romania Project Planning Meeting
June 21-24, 2005	Sofia, Bulgaria: INRNE Office	Project Planning Meeting
June 28, 2005	Moscow, the Russian Federation: Rosatom Office	Bulgaria and Romania preparations work prior to signed government-to-government agreements
September 20-23, 2005	Varna, Bulgaria: Riviera Beach Hotel	Transport Options Workshop
December 14-15, 2005	Sofia, Bulgaria: INRNE Office	Project Planning Meeting
2006		
March 8-10, 2006	Sofia, Bulgaria: INRNE Office	Project Planning Meeting
October 2-3, 2006	Belgrade, Serbia: Hotel M	Project Planning Meeting
December 12-14, 2006	Sofia, Bulgaria: INRNE Office	Project Planning Meeting
2007		
February 17, 2007	Sofia, Bulgaria: INRNE Office & Mountain Resort Borovetz, Bulgaria: Hotel Samokov	VPVR/M Cask Air Shipment Option Meeting
February 17-21, 2007	Sofia, Bulgaria: INRNE Office	Project Planning Meeting
July 23-27, 2007	Idaho Falls, Idaho: INL Office	Project Planning Meeting
August 28-29, 2007	Dimitrovgrad, the Russian Federation: Sosny Office	Project Planning Meeting
December 4-6, 2007	Bansko, Bulgaria: Hotel Perun	Joint Bulgaria-Romania Project Planning Meeting

Date	Location	Topic
2008		
March 11-12, 2008	Rez, Czech Republic: NRI Office	VPVR/M cask logistic planning meeting
March 13, 2008	Moscow, the Russian Federation: Rosatom Office	Technical Working Group Meeting
March 17-20, 2008	Sofia, Bulgaria: INRNE Office	Project Planning Meeting
March, 27-28, 2008	Kiev, Ukraine:	Bulgaria-Ukraine-RF Transport Conditions meeting
May 5-12, 2008	Sofia, Bulgaria: INRNE Office	Project Planning Meeting
May 21-23, 2008	Rez, Czech Republic: NRI Office	IAEA Workshop on Czech Republic Shipment Lessons Learned
May 26-28, 2008	Sofia, Bulgaria: INRNE Office	Project Planning Meeting
May 29-June 2, 2008	Sofia, Bulgaria: IRT-2000 Reactor	VPVR/M Cask Handling Training
June 9-18, 2008	Sofia, Bulgaria: IRT-2000 Reactor	Cask Loading in Reactor Hall
July 1-3, 2008	Sofia, Bulgaria: INRNE Office	Project Planning Meeting
July 4, 2008	Sofia, Bulgaria: IRT-2000 Reactor	Casks Loaded Onto Trucks
July 5, 2008	Sofia & Kozloduy, Bulgaria: IRT-2000 reactor and Kozloduy Nuclear Power Plant	Transport from IRT-2000 to Kozloduy NPP port on Danube River, loaded onto barge
July 6, 2008	Kozloduy, Bulgaria: Kozloduy Nuclear Power Plant	Left Kozloduy NPP port
July 13, 2008	Ukraine-Russian Border	Transferred spent fuel title from INRNE to Mayak
July 17, 2008	Ozersk, the Russian Federation: PA Mayak Facility	Spent fuel received and accepted at Mayak
August 21, 2008	Chelyabinsk, the Russian Federation: Balandino Airport	Air shipped empty VPVR/M casks to Budapest, Hungary

Quantities shipped (spent fuel)

HEU: 6.44 kg - 16 type C-36 fuel assemblies
LEU: 72.48 kg - 58 type EK-10 fuel assemblies

VIII.5.4. Organizations involved and responsibilities

- Institute for Nuclear Research and Nuclear Energy (INRNE), Sofia, Bulgaria. Manages and operates the IRT-2000 reactor and responsible for implementing the RRRFR programme.
- US Department of Energy (DOE)/National Nuclear Security Administration (NNSA) Service Center, Albuquerque, New Mexico, USA. Funds and manages the RRRFR programme.
- Idaho National Laboratory (INL), Idaho Falls, Idaho, USA. Provides technical management of the RRRFR programme in Bulgaria.
- International Atomic Energy Agency (IAEA). Provided assisted with the RRRFR programme and provided safeguards inspections.
- Euratom. Provided safeguards inspections and concluded contracts for the Foreign Trade Contract (shipment of SNF) and the replacement fresh fuel supply contract.

- Bulgarian Nuclear Regulatory Agency (NRA). State regulator responsible for the safe use of nuclear energy and ionizing radiation, the safety of radioactive waste management and the safety of spent fuel management.
- Kozloduy Nuclear Power Plant (NPP). Provided shipment transportation and security services.
- State Corporation Rosatom. Provided Russian Government Agreements, cask and transport requirements, certificates and licenses.
- Federal Center for Nuclear and Radiation Safety (FCNRS). Provided management of the Unified Project and the Foreign Trade Contract (2007 to present).
- R&D Company Sosny. Provided Russian transport licenses and arrangements, cost estimates, engineering design, radiation safety reviews and project management.
- Techsnabexport (TENEX). Provided support and planning for shipping and the Unified Project (2004-2007).
- Production Association Mayak. Provided review of spent fuel inspection data and provided transportation arrangements in RF. Will provide temporary technological storage, reprocessing of irradiated fuel assemblies and its components, temporary technological storage of radioactive wastes, and final disposal of radioactive wastes in the Russian Federation.
- Romanian National Commission for Nuclear Activities Control (CNCAN). Provided transport authorization, shipment certificate and validation of type approval of transport package for radioactive materials transit of Romania.
- Nuclear Research Institute (NRI), Rez, Czech Republic. Provided VPVR/M casks and cask management and training.
- Izotop. Provided Ukraine transit licenses and transport arrangements.

VIII.6. Legal framework

Country and Russian Federation

Agreement between the Government of the Russian Federation and the Government of Bulgaria on cooperation in importation of the irradiated research reactor fuel into the Russian Federation, dated January 18, 2008.

Country and the United States of America

Agreement Between The Government Of The United States Of America And The Government Of The Republic Of Bulgaria To Facilitate The Provision Of Assistance For Nuclear Nonproliferation Purposes, dated March 25, 2008.

Country and transit countries (if applicable)

- Agreement between the Government of the Russian Federation, the Government of Bulgaria and the Cabinet of Ministers of Ukraine on transportation nuclear materials between the Russian Federation and Republic of Bulgaria through territory of the Ukraine, dated April 27, 2006.
- Conditions for organizing and implementation of the SNF shipment from the research reactor between Republic of Bulgaria and Russian Federation transited through Ukraine.
- A Romania transit agreement was not required.

Casks used: Three (3) Skoda VPVR/M casks in 3 ISO containers.

Special licensing requirements:

- Certificate – Permission CZ/048/B(U)F–96 (Rev.1);
- Certificate of Approval for Transport of Transport Package Kit Skoda VPVR/M with C-36 and EK-10 Type Spent Fuel Assemblies and EK-10 Type Fuel Rods – RUS/3065B(U)F-96T;
- Certificate Permission for the Construction of Transportation Package Kit Skoda VPVR/M with Spent Fuel Assemblies from research reactors RUS/3065B(U)F-96;
- Certificate for Validation of Type Approval of Transport Package for Radioactive Materials – N.C.N.A.C R/393/B(U)F–96;
- Approval of the SKODA VPVR/M Cask Design Certificate CZ/048/B(U)F–96 (Rev.1) by the Ukrainian National Nuclear Regulator.

VIII.6.1. Transit arrangements

Romania transit arrangements were made directly with CNCAN and in accordance with procedures routinely used by the Kozloduy Nuclear Power Plant for the twice yearly shipment of their commercial spent nuclear fuel to the Russian Federation.

Ukraine transit arrangements were made by an INRNE subcontractor, the Ukrainian company UGPP 'Izotop', based on the legal framework listed in article 5.3.

The following Ukraine permits and approvals were obtained:

- Approval of the SKODA VPVR/M Cask Design Certificate by the Ukrainian National Nuclear Regulator;
- Permission for transportation of radioactive materials on the territory of Ukraine;
- Nuclear Damage Insurance Certificate;
- Conclusion of the National Sanitary and Epidemiological Service of the Ukraine Health Ministry;
- Permit of the Ukraine National Service for Export Control.

Facility preparations (unique):

- The existing 10 tonne capacity crane in the reactor hall of the IRT-2000 facility was replaced with a new 12.5 tonne capacity bridge crane;
- The reactor building access pavement was replaced;
- A positioning platform was designed and used to position the ŠKODA VPVR/M cask over the reactor pool for loading with spent fuel. The platform was mounted on metal-rubber laminated bearings;
- Weight distribution frames were designed and built to distribute loads on the reactor hall floor. This avoided structural modifications to the building to support the cask and truck weights in the reactor hall. The following frames were built and used:
  - A steel frame used on the reactor hall floor to support the VPVR/M cask handling frame;

- Steel frames used on the reactor hall floor below each of the VPVR/M casks;
  - A transport vehicle entrance load distribution steel track;
  - A steel frame used on top of the reactor shielding to support the VPVR/M cask handling frame.
- An underwater camera was mounted in the reactor pool;
- Portable underwater lighting was built for the reactor pool;
- The existing power supply in the reactor hall was upgraded;
- Special ventilation air-ducts were built to exhaust air over the reactor pool during cask loading.

Shipment logistics summary (unique experiences)

The Bulgarian spent fuel was transported by truck, river barge, and rail. The spent fuel casks were loaded into ISO containers and transported from the IRT-2000 facility to the Kozloduy NPP by truck on public highways. At Kozloduy, the casks were transferred into a licensed barge owned by the Kozloduy NPP and transported down the Danube River to the river port at Izmail, Ukraine. The casks were transferred onto Russian railcars at Izmail for rail transport across Ukraine and the Russian Federation to the Mayak facility.

VIII.6.2. Lessons learned (major differences from previous shipments)

- The use of an experienced carrier (Kozloduy NPP) with experience in shipping nuclear materials to and from the Russian Federation was a great advantage and avoided problems;
- Signing road and river carriers and security contracts in advance minimized last-minute delays at shipment time;
- Shipping papers that were drafted and reviewed in advance with the help of representatives from Kozloduy NPP and PA ‘Mayak’ avoided last-minute delays;
- Have all permits and licenses in place as far in advance as possible;
- Procure nuclear liability, cargo, and personnel insurance in advance of the shipment;
- Provide a senior technical person with the authority to resolve issues en-route to accompany the shipment;
- Pre-arrange a method for 24-hour monitoring and reporting during shipment to provide ‘Need-to-Know’ information to the appropriate personnel to provide immediate additional technical support, if needed;
- Develop a coded tracking system in advance to allow monitoring reports to DOE without compromising security;
- Having communications equipment, a laptop computer and a printer on the barge was very useful for the technical person accompanying the shipment;
- Very good cooperation with the Bulgarian nuclear safety authorities helped with planning and implementation;
- Very good cooperation with other important partners in Bulgaria - Kozloduy NPP, Bulgarian Police and Gendarme, Bulgarian Fire and Rescue Corps, helped with shipment planning and provided appropriate support during the shipment;
- Assure that all interested and involved organizations have a sufficient security level (Secret and Confidential level) for their main points of contact personnel.

REFERENCES

[1] 'Agreement Between the Government of the United States of America and the Government of the Russian Federation Concerning Cooperation for the Transfer of Russian-Produced Research Reactor Nuclear Fuel to the Russian Federation', signed May 2004.

[2] 'Agreement Between the United States of America and Kazakhstan Concerning the Destruction of Silo Launchers of Intercontinental Ballistic Missiles, Emergency Response, and the Prevention of Proliferation on Nuclear Weapons,' signed 13 December, 1993, as amended. Implementing Agreement for BN-350 work.

[3] Decree #418, 'Government of the Russian Federation on the Procedure for Importation of Irradiated Nuclear Reactor Fuel Assemblies Into the Russian Federation', July 11, 2003.

[4] Lebedev, A.E., 'Unified Project, Importation of Irradiated Fuel Assemblies (IFA) from Foreign Research Reactors to Russian Federation', presented at the RRRFR Transport Options Workshop, Varna, Bulgaria, September 21, 2005.

[5] PVSR-92, 'On the Procedure for Issuing Certificates/Permits for Special Type Radioactive Substances, and For the Design and Transportation of Packing Sets with Radioactive Substances' (modified based on Amendment 2 and Amendment 3 established by the Orders No. 448 of 07/17/98 and No. 663 of 10/25/99).

[6] Decree #587, 'Government of the Russian Federation on Cost Approval Process for Handling of Irradiated Fuel Assemblies of Nuclear Reactors and Products of their Reprocessing', September 22, 2003.

[7] Decree #421, 'Government of the Russian Federation on Approval of Provisions for the Development of Special Ecological Programmes for the Rehabilitation of Radiation-contaminated Regions of the Territory', June 14, 2002.

[8] Decree #588, 'Government of the Russian Federation on Funding for Special Ecological Programmes to Rehabilitate Radiation-contaminated Regions of the Territory', 2003.

[9] Apostolov T.,Institute for Nuclear Research and Nuclear Energy and Kanashov B., Sosny, 'Transport Plan for IRT-2000 Research Reactor Spent Nuclear Fuel Repatriation from Bulgaria to the Russian Federation', 2006.

[10] Apostolov T., Institute for Nuclear Research and Nuclear Energy and Kanashov B., Sosny, 'Fuel and Cask Acceptance Requirements for Shipment of Spent Nuclear Fuel from the Bulgarian IRT-2000 Reactor to the Russian Federation', Revision 2.0, 2006.

ABBREVIATIONS

CO	Contracting Officer
CPO	Country Project Officer
DOE	Department of Energy (United States of America)
FCNRS	Federal Center for Nuclear and Radiation Safety
GTGA	Government-to-Government Agreement
HEU	Highly Enriched Uranium
HLW	High Level Waste
JCC	Joint Coordinating Committee
KATEP	Joint Stock Company – KATEP-AE
LEU	Low Enriched Uranium
NNSA	National Nuclear Security Administration
OC	Originating Country
ORFC	Oak Ridge Finance Center
Rosatom	State Atomic Energy Corporation Rosatom
Rostechnadzor	Federal Agency for Technical, Ecological, and Nuclear Supervision
RRRFR	Russian Research Reactor Fuel Return Programme
SC	Service Center
SEER	State Ecological Expert Review
SEP	Special Ecological Programme
SFA	Spent Fuel Assembly
SNF	Spent Nuclear Fuel
TC	Transit Country
TENEX	Techsnabexport
TS	Technical Specification

CONTRIBUTORS TO DRAFTING AND REVIEW

Adelfang, P.	Research Reactor Group (RRG), International Atomic Energy Agency
Allen, K.	Idaho National Laboratory (INL), United States of America
Bieniawski, A.	National Nuclear Security Administration (NNSA), US Department of Energy (USDOE), USA
Bolshinsky, I.	Idaho National Laboratory (INL), United States of America
Dewes, J.	Savannah River Site, United States of America
Moses, S.	Oak Ridge National Laboratory (ORNL), United States of America
Smirnov, A.	Sosny Enterprise, Russian Federation
Thomas, J.	Savannah River Site, United States of America
Tyacke, M.	Idaho National Laboratory, United States of America
Yuldashev, B.	Research Reactor Group (RRG), International Atomic Energy Agency
Yungerova, L.	Rosatom, Russian Federation

No. 21, July 2006

IAEA
International Atomic Energy Agency

Where to order IAEA publications

In the following countries IAEA publications may be purchased from the sources listed below, or from major local booksellers. Payment may be made in local currency or with UNESCO coupons.

Australia
DA Information Services, 648 Whitehorse Road, Mitcham Victoria 3132
Telephone: +61 3 9210 7777 • Fax: +61 3 9210 7788
Email: service@dadirect.com.au • Web site: http://www.dadirect.com.au

Belgium
Jean de Lannoy, avenue du Roi 202, B-1190 Brussels
Telephone: +32 2 538 43 08 • Fax: +32 2 538 08 41
Email: jean.de.lannoy@infoboard.be • Web site: http://www.jean-de-lannoy.be

Canada
Bernan Associates, 4611-F Assembly Drive, Lanham, MD 20706-4391, USA
Telephone: 1-800-865-3457 • Fax: 1-800-865-3450
Email: order@bernan.com • Web site: http://www.bernan.com

Renouf Publishing Company Ltd., 1-5369 Canotek Rd., Ottawa, Ontario, K1J 9J3
Telephone: +613 745 2665 • Fax: +613 745 7660
Email: order.dept@renoufbooks.com • Web site: http://www.renoufbooks.com

China
IAEA Publications in Chinese: China Nuclear Energy Industry Corporation, Translation Section, P.O. Box 2103, Beijing

Czech Republic
Suweco CZ, S.R.O. Klecakova 347, 180 21 Praha 9
Telephone: +420 26603 5364 • Fax: +420 28482 1646
Email: nakup@suweco.cz • Web site: http://www.suweco.cz

Finland
Akateeminen Kirjakauppa, PL 128 (Keskuskatu 1), FIN-00101 Helsinki
Telephone: +358 9 121 41 • Fax: +358 9 121 4450
Email: akatilaus@akateeminen.com • Web site: http://www.akateeminen.com

France
Form-Edit, 5, rue Janssen, P.O. Box 25, F-75921 Paris Cedex 19
Telephone: +33 1 42 01 49 49 • Fax: +33 1 42 01 90 90 • Email: formedit@formedit.fr

Lavoisier SAS, 14 rue de Provigny, 94236 Cachan Cedex
Telephone: + 33 1 47 40 67 00 • Fax +33 1 47 40 67 02
Email: livres@lavoisier.fr • Web site: http://www.lavoisier.fr

Germany
UNO-Verlag, Vertriebs- und Verlags GmbH, August-Bebel-Allee 6, D-53175 Bonn
Telephone: +49 02 28 949 02-0 • Fax: +49 02 28 949 02-22
Email: info@uno-verlag.de • Web site: http://www.uno-verlag.de

Hungary
Librotrade Ltd., Book Import, P.O. Box 126, H-1656 Budapest
Telephone: +36 1 257 7777 • Fax: +36 1 257 7472 • Email: books@librotrade.hu

India
Allied Publishers Group, 1st Floor, Dubash House, 15, J. N. Heredia Marg, Ballard Estate, Mumbai 400 001,
Telephone: +91 22 22617926/27 • Fax: +91 22 22617928
Email: alliedpl@vsnl.com • Web site: http://www.alliedpublishers.com

Bookwell, 24/4800, Ansari Road, Darya Ganj, New Delhi 110002
Telephone: +91 11 23268786, +91 11 23257264 • Fax: +91 11 23281315
Email: bookwell@vsnl.net • Web site: http://www.bookwellindia.com

Italy
Libreria Scientifica Dott. Lucio di Biasio "AEIOU", Via Coronelli 6, I-20146 Milan
Telephone: +39 02 48 95 45 52 or 48 95 45 62 • Fax: +39 02 48 95 45 48

Japan
Maruzen Company, Ltd., 13-6 Nihonbashi, 3 chome, Chuo-ku, Tokyo 103-0027
Telephone: +81 3 3275 8582 • Fax: +81 3 3275 9072
Email: journal@maruzen.co.jp • Web site: http://www.maruzen.co.jp

Korea, Republic of
KINS Inc., Information Business Dept. Samho Bldg. 2nd Floor, 275-1 Yang Jae-dong SeoCho-G, Seoul 137-130
Telephone: +02 589 1740 • Fax: +02 589 1746
Email: sj8142@kins.co.kr • Web site: http://www.kins.co.kr

Netherlands
Martinus Nijhoff International, Koraalrood 50, P.O. Box 1853, 2700 CZ Zoetermeer
Telephone: +31 793 684 400 • Fax: +31 793 615 698 • Email: info@nijhoff.nl • Web site: http://www.nijhoff.nl

Swets and Zeitlinger b.v., P.O. Box 830, 2160 SZ Lisse
Telephone: +31 252 435 111 • Fax: +31 252 415 888 • Email: infoho@swets.nl • Web site: http://www.swets.nl

New Zealand
DA Information Services, 648 Whitehorse Road, MITCHAM 3132, Australia
Telephone: +61 3 9210 7777 • Fax: +61 3 9210 7788
Email: service@dadirect.com.au • Web site: http://www.dadirect.com.au

Slovenia
Cankarjeva Zalozba d.d., Kopitarjeva 2, SI-1512 Ljubljana
Telephone: +386 1 432 31 44 • Fax: +386 1 230 14 35
Email: import.books@cankarjeva-z.si • Web site: http://www.cankarjeva-z.si/uvoz

Spain
Díaz de Santos, S.A., c/ Juan Bravo, 3A, E-28006 Madrid
Telephone: +34 91 781 94 80 • Fax: +34 91 575 55 63 • Email: compras@diazdesantos.es
carmela@diazdesantos.es • barcelona@diazdesantos.es • julio@diazdesantos.es
Web site: http://www.diazdesantos.es

United Kingdom
The Stationery Office Ltd, International Sales Agency, PO Box 29, Norwich, NR3 1 GN
Telephone (orders): +44 870 600 5552 • (enquiries): +44 207 873 8372 • Fax: +44 207 873 8203
Email (orders): book.orders@tso.co.uk • (enquiries): book.enquiries@tso.co.uk • Web site: http://www.tso.co.uk

On-line orders:
DELTA Int. Book Wholesalers Ltd., 39 Alexandra Road, Addlestone, Surrey, KT15 2PQ
Email: info@profbooks.com • Web site: http://www.profbooks.com

Books on the Environment:
Earthprint Ltd., P.O. Box 119, Stevenage SG1 4TP
Telephone: +44 1438748111 • Fax: +44 1438748844
Email: orders@earthprint.com • Web site: http://www.earthprint.com

United Nations (UN)
Dept. I004, Room DC2-0853, First Avenue at 46th Street, New York, N.Y. 10017, USA
Telephone: +800 253-9646 or +212 963-8302 • Fax: +212 963-3489
Email: publications@un.org • Web site: http://www.un.org

United States of America
Bernan Associates, 4611-F Assembly Drive, Lanham, MD 20706-4391
Telephone: 1-800-865-3457 • Fax: 1-800-865-3450
Email: order@bernan.com • Web site: http://www.bernan.com

Renouf Publishing Company Ltd., 812 Proctor Ave., Ogdensburg, NY, 13669
Telephone: +888 551 7470 (toll-free) • Fax: +888 568 8546 (toll-free)
Email: order.dept@renoufbooks.com • Web site: http://www.renoufbooks.com

Orders and requests for information may also be addressed directly to:

Sales and Promotion Unit, International Atomic Energy Agency
Vienna International Centre, PO Box 100, 1400 Vienna, Austria
Telephone: +43 1 2600 22529 (or 22530) • Fax: +43 1 2600 29302
Email: sales.publications@iaea.org • Web site: http://www.iaea.org/books

09-37231