Safe Transport of Radioactive Materials

GUIDELINES

KP-SERAW-008

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Foreword

In 2021, the European Commission (EC) adopted a new proposal for a Council Regulation[1] establishing a dedicated financial programme for decommissioning nuclear facilities and managing radioactive waste. This instrument covers the co-funding of the decommissioning programmes of Bulgaria, Slovakia, and the decommissioning of the Joint Research Centre (JRC). A separate Council Regulation[2] was adopted for the decommissioning programme of Lithuania.

The EC JRC is mandated to foster the spread of decommissioning knowledge across all the European Union Member States and facilitate knowledge sharing arising from implementing the above-mentioned decommissioning programmes, funded by the Nuclear Decommissioning Assistance Programme (NDAP).

The decommissioning operators from the NDAP (NDAP Operators) implemented and tested a knowledge management methodology in 2021 through Project ENER/D2/2020-273. Using this methodology, the NDAP Operators can develop Knowledge Products that are currently available to share with other European stakeholders. In addition, this methodology is being implemented by the JRC Nuclear Decommissioning and Waste Management Directorate (NDWMD), which has become a knowledge generator extracting the knowledge from the ongoing decommissioning activities across the JRC´s four different sites (Geel, Ispra, Karlsruhe and Petten.

The JRC´s NDWMD aims to become a Centre of Excellence in nuclear decommissioning knowledge management and to develop a decommissioning knowledge platform which allows exchanging information building on EU best practices through executing the multi-annual financial framework (2021 – 2027) strategy. The operational phase of the project started in 2024 with the objectives to: develop ties and exchanges among EU stakeholders, document explicit knowledge and make it available through multi-lateral knowledge transfers on decommissioning and waste management governance issues, managerial best practices, technological challenges, and decommissioning processes at both operational and organisational level, as well as to develop potential EU synergies.

This is a Knowledge Product prepared by SERAW for Nuclear Decommissioning and Waste Management Directorate (NDWMD) – Directorate J of the Joint Research Centre.

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[1] Council Regulation (EURATOM) 2021/100 of 25 January 2021 establishing a dedicated financial program for the decommissioning of nuclear facilities and the management of radioactive waste, and repealing Regulation (EURATOM) No 1368/2013

[2] Council Regulation (EU) 2021/101 of 25 January 2021 establishing the nuclear decommissioning assistance programme of the Ignalina NPP in Lithuania and repealing Regulation (EU) No 1369/2013

PRODUCT DESCRIPTION

This Knowledge Product (KP) provides the end user with an overview of the established system and deployment thereof within State Enterprise Radioactive Waste (SERAW) for safe transport of radioactive materials, as well as the technical and human resources required to implement the activity. Thereafter, specific cases that do not fit into the standard framework of routine radioactive material (RAM) carriages have been presented.

ABSTRACT

This KP outlines SERAW's expertise in the safe transportation of RAM, particularly during the decommissioning of nuclear facilities. The transported RAM varies widely in composition, activity and physical state, presenting significant challenges that demand thorough preliminary preparation to satisfy safety regulations. In non-standard scenarios, innovative, legally compliant approaches are essential, leveraging SERAW's accumulated experience in handling complex transport issues under the Agreement concerning the International Carriage of Dangerous Goods by Road (ADR). The established framework within SERAW encompasses the deployment of necessary technical and human resources. Critical elements include securing a RAM transport license, training and retaining ADR-qualified safety advisers and escorts, utilising specialised vehicles and employing advanced equipment for RAM preparation and handling. Certified packages and biological shielding are adapted to ensure containment and radiation protection tailored to the material's properties. Case studies illustrate specific challenges and solutions. For example, transporting scrap metal contaminated with a high-dose-rate Cesium-137 (Cs-137) sources involved custom shielding and optimised routing to reduce exposure risks.

DISCLAIMER

This KP is provided solely as a non-binding reference guide and should not be interpreted as official legal advice, comprehensive regulatory requirements or a substitute for professional expertise. It is designed to offer general orientation on best practices for the safe transport of radioactive materials (i.e. Class 7 dangerous goods) but does not cover all possible scenarios, updates or jurisdiction-specific nuances.

The ADR, administered by the United Nations Economic Commission for Europe (UNECE), undergoes regular revisions. Due to these ongoing changes, relying solely on this KP could lead to non-compliance, increased risks to human health, property or the environment and potential legal liabilities.

Therefore, it is imperative for the reader, whether a transport operator, shipper, carrier or other stakeholder, to consult a certified Dangerous Goods Safety Adviser (DGSA) before planning, executing or participating in any transport activities involving Class 7 goods. The DGSA can provide tailored advice based on the specific consignment, route, packaging, labelling, documentation and emergency response requirements, ensuring alignment with the most current ADR provisions and any transitional arrangements.

OBJECTIVE

To record, convey and explain the knowledge gained during the safe transport of radioactive materials in non-standard scenarios.

APPROACH

This KP was developed through referring to the following knowledge inputs: safe transport of radioactive materials in non-standard scenarios (based on SERAW's experience), as a contribution to the JRC´s Nuclear Decommissioning Knowledge Management (NDKM) Initiative.

The following main points are conveyed in this KP:

- descriptions of safe transport activities,
- RAM transport license, safety advisors & escorts,
- specialised vehicles,
- technical equipment,
- packages & shielding equipment,
- case studies & technical solutions,
- key takeaways & recommendations.

RESULTS, FINDINGS AND INSIGHTS

Over the past years, SERAW has acquired extensive experience in the safe transportation of radioactive materials, particularly in non-standard scenarios. Strict schedules and tight deadlines often necessitate prompt and innovative solutions. The transportation of materials whose characteristics (e.g., high dose rates) do not comply with regulations for safe transport has prompted the development of additional overpacking and shielding measures. Furthermore, non-standard dimensions and excessive weights exacerbate the challenges. In this context, SERAW has implemented practices to address regulatory non-compliances by utilising domestically manufactured shielding, which is more cost-effective and customisable, followed by overpacking with packages approved for safe transport.

TARGET USERS

This KP is a valuable contribution to entities involved in safe transport of radioactive materials.

APPLICATION, VALUE AND USE

The information contained herein offers insights into safe transport of radioactive materials according to internationally accepted requirements stipulated in the (ADR) and national regulations in Bulgaria.

KEYWORDS

Decommissioning, management of materials, waste management, safe transport, radioactive materials, non-standard scenarios, ADR.

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ACRONYMS

ADR	Agreement concerning the International Carriage of Dangerous Goods by Road
ASUNE	Act on the Safe Use of Nuclear Energy
BNRA	Bulgarian Nuclear Regulatory Agency
CSI	Criticality Safety Index
DGSA	Dangerous Goods Safety Adviser
DKM	Decommissioning Knowledge Management
EIA	Environmental Impact Assessments
IAEA	International Atomic Energy Agency
JRC	Joint Research Centre (of the European Commission)
KM	Knowledge Management
KP	Knowledge Product
KPI	Key Performance Indicator
NDAP	Nuclear Decommissioning Assistance Programme
NDKM	Nuclear Decommissioning Knowledge Management
NDWM	Nuclear Decommissioning and Waste Management
NRRAW	National Repository for Radioactive Waste
PRRAW	Permanent Repository for Radioactive Waste
RAM	Radioactive material
RAW	Radioactive waste
RTA	Executive Agency "Road Transport Administration"
SD	Specialised division
SERAW	State Enterprise Radioactive Waste
SNF	Spent Nuclear Fuel
SSR-6	(IAEA) Regulations for the Safe Transport of Radioactive Material
TI	Transport Index
TS-G-1.2	(IAEA) Safety Guide on Planning and Preparing for Emergency Response to Transport Accidents Involving Radioactive Material

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1. INTRODUCTION

1.1. Background and Context

The **Nuclear Decommissioning and Waste Management Directorate** (**NDWMD**) of the **JRC** is running the Nuclear Decommissioning and Waste Management (NDWM) Programme for the nuclear sites of the European Commission (EC), with most of the activities currently focused on dormant facilities situated on the Ispra site (located in northern Italy).

In 2020 the Council of the European Union (EU) issued **Council Regulations 100** and **101** in which they provided co-funding to the decommissioning programmes in three EU Member States (Slovakia, Bulgaria and Lithuania), this initiative is now commonly known as the **Nuclear Decommissioning Assistance Programme** (**NDAP**), as well as full funding to the internal NDWM Programme of the EC, run by the JRC.

The same regulations also mandated the JRC to initiate a project on knowledge management in NDWM, which is commonly referred to as the **NDKM Initiative**, based on the experiences and lessons learnt running the JRC and NDAP. The primary products of the NDKM Initiative, referred to as KPs, will be disseminated to European stakeholders in order to support new operators entering NDWM activities, enabling them to profit from knowledge generated by previous experience and programmes.

Figure 1. Location of SERAW's facility in Bulgaria: aerial views of entrance, site and storage area

This KP builds on the progress made by the NDWM in the past years. **SERAW**, as an operator, **has made significant contributions to the development of practices for the safe transportation of radioactive materials in non-standard scenarios**. This KP builds upon past contributions through conveying the integrated innovative solutions utilised during their works, such as the development of additional shielding and overpacking, to address regulatory non-compliances, non-standard dimensions and excessive weight of the materials, thereby enhancing overall efficiency and compliance with standards.

1.2. Scope of the Guidelines

The main aspects of the transportation of RAM in the Republic of Bulgaria is covered by this KP. **Due to Bulgaria's membership of the EU**, as well as the fact that the country has signed the "**European Agreement concerning the International Carriage of Dangerous Goods by Road**" a significant portion of RAM transport and the latter agreement coincides with the process of preparation and execution of transits of radioactive materials between the countries participating in this program.

However, considering differences in local legislation, there could be variations in both the licensing process for carriers and in certain traffic rules, such as average speed, prohibited substances for transport and/or other types of restrictions. Therefore, such **complex** and **nuanced differences in legislation** and **practicalities at the Member State level are not detailed** in this document.

1.3. Description of Safe Transport Activities

The transportation of RAM in Bulgaria is carried out in accordance with national and international standards for safety and the protection of the population and the environment. The transportation of RAM is regulated by several state institutions that ensure the safety and control of these activities. The main bodies responsible for controlling the transportation of radioactive materials are:

1. Bulgarian Nuclear Regulatory Agency (**BNRA**)**.** This institution is responsible for implementing regulations related to the use of nuclear energy and ionising radiation, as well as the management of radioactive waste and spent nuclear fuel. It issues licenses for the transportation of radioactive materials and supervises compliance with safety standards.

2. Ministry of Interior (**MoI**). Specialised structures within the MoI, such as the Traffic Police and Border Police, also have responsibilities for controlling and securing transports, ensuring adherence to safety rules and conducting roadside inspections.

3. Ministry of Transport, Information Technologies and Communications (**MTITC**)**. The MTITC** is responsible for transport infrastructure and safety in transportation, including RAMs. This includes relevant rules for loading, marking and transporting such materials.

4. Ministry of Environment and Water (**MoEW**)**:** the role of the MoEW is to define national policies, develop strategies, prepare standards and determine priorities for environmental protection.

In addition to these institutions, all carriers of RAMs should comply with international standards and conventions, such as those of the International Atomic Energy Agency (IAEA), to ensure the safety and security of such operations.

Legislative and Regulatory Framework in Bulgaria

- **ADR European Agreement** concerning the International Carriage of Dangerous Goods by Road
- **IAEA** Regulations for the Safe Transport of Radioactive Material **SSR-6**, 2018 Edition, Rev. 1
- **Ordinance 40** on the Conditions and Procedure for Carrying Out Road Transport of Dangerous Goods (dated 14.01.2004)
- **Ordinance on the Conditions and Procedure for the Transport of Radioactive Substances** (supplemented, amended as of February 14, 2014)
- **Ordinance on Emergency Planning and Emergency Preparedness in Case of Nuclear and Radiation Accidents** (supplemented, amended as of 07.07.2017)
- **Ordinance on Ensuring the Physical Protection of Nuclear Facilities, Nuclear Material and Radioactive Substances** (supplemented, amended as of 05.07.2019)
- **Safety Guides on the Application of Normative Requirements**: **pp-14/2016** Safe Transport of Radioactive Materials – Management of Non-Conformities and **pp-19/2017** Application of Requirements for Safe Transport of Radioactive Materials
- **IAEA Safety Guide TS-G-1.2** Planning and Preparing for Emergency Response to Transport Accidents Involving Radioactive Material

1.3.1. Overview of Safe Transport Activities for Radioactive Materials

The safe transportation of RAMs, classified as Class 7 dangerous goods under international standards, involves a comprehensive set of activities designed to minimise risks to human health, the environment and public safety. As already alluded to, these activities are governed by stringent domestic and international regulations, including the European ADR and relevant IAEA regulations (SSR-6, 2018 Edition, Rev. 1).

In Bulgaria, additional oversight is provided by ordinances such as **Ordinance No. 40** on Road Transport of Dangerous Goods and the **Ordinance on the Transport of Radioactive Substances**. Five key activities are detailed below in relation to regulatory, technical, organisational and emergency measures in order to emphasise the core components which ensure safe transport activities.

1. Regulatory Compliance and Licensing

Safe transport begins with adherence to normative frameworks. Operators should obtain licenses from the BNRA, which enforces standards for packaging, labelling and transport conditions. This includes verifying compliance with IAEA safety guides, such as TS-G-1.2, for emergency planning. Institutions like the Ministry of Interior (for security checks) and the Ministry of Transport (for infrastructure safety) conduct inspections to ensure alignment with ADR requirements.

2. Packaging and Containment

Selecting appropriate packaging is fundamental to containing radioactive materials and shielding against radiation. Five primary types are utilised, the hierarchy of technical requirements of which can also be seen below in Figure 2, including:

- **Exempt packages**: For low-risk items like limited quantities of radioactive materials (e.g., sealed sources or instruments), with activity limits specified in Bulgarian ordinances.
- **Industrial packages** (**IP-1**, **IP-2**, **IP-3**): For low specific activity materials, such as uranium ores, emphasizing inherent safety of contents rather than package strength.
- **Type A packages**: For moderate-activity materials, designed to withstand normal transport incidents like drops or water exposure.
- **Type B packages**: For high-activity substances, tested against severe accidents including 9-meter drops, fire and immersion.
- **Type C packages**: For air transport of large quantities, though not yet widely certified.

Packages undergo rigorous testing for integrity to prevent excessive exposure and release of radioactive materials to the environment.

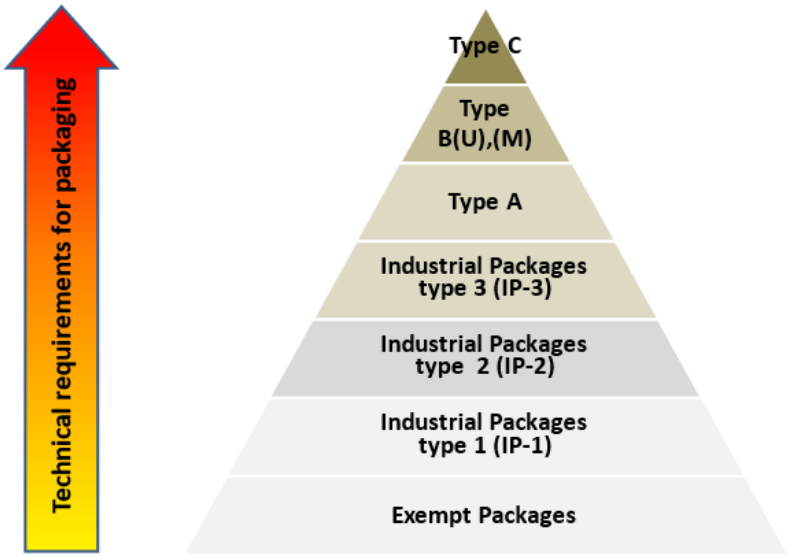


Figure 2. Hierarchy of technical requirements for packaging

3. Marking, Labelling and Vehicle Preparation

Vehicles should be equipped and marked to indicate hazards:

- **Labelling**: Radiation symbols and transport indices (TI) on packages and vehicles, with TI thresholds dictating exposure limits (e.g., TI ≤ 10 corresponds to ≤ 2 mSv/h at 1 meter).
- **Onboard equipment**: Personal protective gear (e.g., gloves, masks, eye wash), general safety items (e.g., fire extinguishers, warning cones) and dosimetry instruments for radiation monitoring.
- **Dosimetry controls**: Regular measurements ensure compliance with limits, such as ≤ 10 μSv/h in the driver's cabin and ≤ 100 μSv/h at 2 meters from the vehicle.

4. Operational and Security Measures

- **Supervision and parking**: Vehicles carrying Class 7 goods require constant oversight or secure parking in isolated areas, per ADR Chapter 8.4, to prevent unauthorised access.
- **Physical protection**: Under the Ordinance on Physical Protection, basic or enhanced levels apply based on material category. Enhanced measures for high-risk items (e.g., Category 1–2 radionuclides) include personnel verification, tracking systems and communication protocols to deter theft or sabotage.
- **Isolation**: Materials should be separated from public areas during transport, aligning with ADR CV33 to protect critical population groups.

5. Emergency Preparedness and Response

In the event of incidents, protocols from **IAEA TS-G-1.2** guide the following actions:

- Immediate steps include activating brakes, evacuating the vehicle and notifying emergency services (e.g., via 112 in Bulgaria).
- Prioritise medical aid first, then assess radiological hazards using dosimeters.
- For fires or spills: use onboard extinguishers for minor incidents; establish emergency zones and contain materials to avoid environmental contamination.
- Coordinate responses involving carriers, police and agencies like the BNRA, ensuring prompt containment and decontamination.

These activities collectively form a **layered defence strategy**, **integrating prevention**, **mitigation** and **recovery**. Strict implementation, as mandated by regulatory bodies, ensures that risks associated with radioactive transport, such as exposure or malicious use, are effectively managed, fostering operational reliability and public confidence.

1.3.2. Importance of Strict Compliance with Regulatory Requirements

Strict adherence to domestic and international regulations, such as the ADR, is vital for protecting human health, environmental integrity and public security in the transportation of RAMs. The following points highlight and explain the importance of such compliance:

Risk Mitigation and Public Safety

RAMs present hazards like radiation exposure and contamination. ADR and IAEA SSR-6 standards ensure packaging durability (e.g., tests for Type B packages) to maintain containment during accidents. Non-compliance risks uncontrolled releases, endangering personnel and populations, while dose limits (e.g., 10 µSv/h in the driver's cabin) align with IAEA guidelines to minimise exposure.

Standardisation and Cross-Border Consistency

As an EU member and ADR signatory, Bulgaria's compliance promotes uniform practices across nations, easing international transport. IAEA guides like TS-G-1.2 support coordinated emergency responses, reducing discrepancies and enhancing efficiency.

Legal and Operational Accountability

Regulations mandate documentation, equipment and training (e.g., ADR Chapters 8.1 and 8.2). Violations may incur penalties or disruptions. References to Ordinance No. 40 and physical protection protocols ensure accountability, preventing theft or sabotage of high-risk goods.

Environmental Protection and Emergency Preparedness

Compliance enables measures like public isolation and emergency zones to contain spills and limit contamination. IAEA TS-G-1.2 frameworks, integrated into Bulgarian ordinances (amended 2017), facilitate prompt responses and minimise ecological impacts.

Economic and Reputational Benefits

Adherence builds stakeholder trust, averts costly incidents and encourages safety innovations, improving efficiency and sustainability in the nuclear sector.

In essence, compliance forms the core of a safety culture, ensuring precise operations and alignment with global standards and best practice.

1.4. SERAW Transport System

The transportation system of SERAW encompasses all specialised divisions. It handles the transport of RAW and RAM from various activities involved in their management. Currently, SERAW has 4 specialised vehicles licensed for transporting radioactive substances, with two of them being heavy-duty trucks authorised for transport with a Transport Index (TI) = 10.

Transport packaging used by SERAW complies with ADR requirements. In addition to this, new designs are developed as needs arise in order to ensure safe transportation of RAM. SERAW ensures and maintains the following as part of its safe and secure activities:

- **All technical equipment undergoes regular inspections** to guarantee high levels of safety.
- **Three safety advisors**, licensed to perform such tasks, are responsible for ensuring safe transport within the company.
- **A sufficient number of certified drivers** trained to operate vehicles transporting RAM under ADR regulations.
- **A license** issued by the BNRA **for transporting** RAM and RAW.

Maintaining a high level of qualified employees is of paramount importance. All certified staff undergo periodic training, which concludes with an assessment of their acquired knowledge. This training occurs every five years.

The following diagram, displayed in Figure 3, illustrates pathways for RAM transportation within SERAW. Special attention is given to a specific group of RAW originating from nuclear applications in the country. Accordingly, SERAW conducts regular transports of RAW from various generators to the SD "PRRAW – Novi han," where they are processed prior to proceeding to the remaining divisions of SERAW.

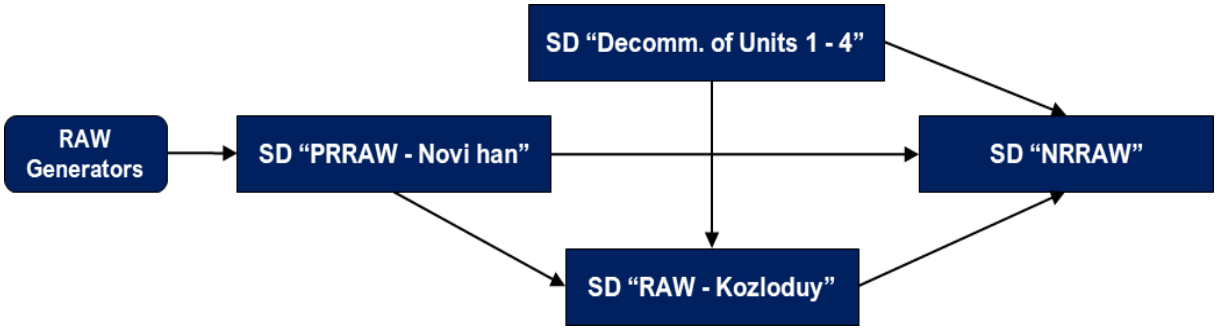


Figure 3. RAM Transport pathways within SERAW

2. GUIDELINES ON SAFE TRANSPORT ACTIVITIES

2.1. RAM Transport License, Safety Advisors & Escorts

The initial condition for carrying out the transportation of RAM is obtaining a license issued by the Nuclear Regulatory Agency in Bulgaria. The process begins with submitting an application to the agency along with required documents that confirm compliance with legal conditions set forth in the Law on Safe Use of Nuclear Energy, the Order on Conditions and Rules for RAM Transportation, as well as the requirements outlined in the Order on Licensing and Authorization for Safe Use of Nuclear Energy.

One of the key requirements is that **the organisation** applying for a license **should demonstrate possession of necessary technical equipment** and **human resources** to safely perform all transportation operations.

This includes **safety advisors**, **notification officers** responsible for informing BNRA, **dosimetrists**, **drivers of transport vehicles** and, if needed, **security personnel**. Proper selection, training and preparation of staff are crucial for ensuring safety, particularly in various incident scenarios.

In Bulgaria, **both drivers** and **safety advisors** are legally required to complete **specific training according to Chapter 8.2** of the **ADR regulations** and **pass an exam administered** by the **Executive Agency** "Road Transport Administration". Their certifications remain valid for a period of five years.

2.1.1. RAM Transport Licensing Process

As referred to previously, the transport of RAM is regulated to ensure safety, security and compliance with international standards. **In Bulgaria**, this is governed primarily by the **Regulation on the Conditions and Procedure for Transport of Radioactive Material**, which aligns with IAEA SSR-6 and relevant EU directives. This regulation falls under the broader **Act on the Safe Use of Nuclear Energy** administered by the BNRA.

The implementation of the authorisation process and license amendment requirements, with a focus on Bulgarian practices as the primary reference, are outlined below.

2.1.1.1. Authorisation Process

The authorisation process requires obtaining a license or permit from the BNRA, which acts as the independent regulatory authority. This process applies to all transport activities, including domestic, import, export, transit, as well as emphasises nuclear safety, radiation protection, physical security and emergency preparedness.

The three main steps of the authorisation process are shown below:

1. Application Submission

- Legal entities (e.g., operators or carriers) should submit a formal application to the BNRA. The application should include comprehensive documentation demonstrating compliance with safety standards.
- Key elements include:
  - proof of adherence to radiation protection limits (e.g., public dose limits of 1 mSv/year),
  - details on transport routes, vehicles, packaging and handling procedures,
  - emergency response plans for potential incidents,
  - qualifications and training certificates for personnel involved,
  - financial assurances for covering transport costs, including potential returns or emergencies.
- For international or transboundary transport, additional consents from destination and transit countries are required, along with contracts between consignors, consignees and carriers.

2. Review and Assessment

- The BNRA conducts a thorough evaluation, including preventive controls to verify the applicant's capability to maintain safety. This may involve site inspections, review of safety analyses, and confirmation of packaging approvals (e.g., Type A, B(U), or B(M) packages per IAEA standards).
- For higher-risk materials like spent nuclear fuel (SNF) or high-level radioactive waste (HLW), the review includes environmental impact assessments (EIA) and coordination with other authorities, such as the Ministry of Environment and Water.
- If the transport involves exports outside the EU (e.g., SNF to a non-EU Member State for reprocessing), EURATOM Supply Agency approval and the verification of the recipient's compliance with international standards are mandatory.

3. Issuance

Licenses are issued only if all criteria are met, typically for a defined scope and duration. Denials can be appealed through administrative courts. The BNRA maintains a public register of all issued licenses for transparency.

The process is graded based on the material's hazard level, i.e., low-activity materials may have simpler requirements, while fissile or high-activity items demand more stringent scrutiny.

2.1.1.2. Implementation

Once authorised, the license should be strictly followed during operations, with **ongoing regulatory oversight** to prevent radiological risks. The regulatory oversight is described in subdivisions below:

1. **Operational Compliance**:
   - Transport should use approved packaging, labelling and vehicles compliant with international agreements like the ADR (road) and others like RID (rail), ADN (inland waterways), ICAO (air) and IMDG (maritime).
   - Personnel should hold valid competency certificates and physical protection measures (e.g., armed escorts for high-risk shipments) are enforced per the Regulation on Physical Protection of Nuclear Material.
   - Records of shipments, including routes, cargo details and monitoring data, should be maintained and reported to the BNRA.
2. **Monitoring and Inspections**:
   - The BNRA performs ongoing and extraordinary inspections to ensure adherence. License holders should report any incidents or deviations promptly, classified per the IAEA's International Nuclear and Radiological Event Scale (INES).
   - Emergency plans are integrated into national disaster frameworks.
3. **Specific Implementation for Certain Materials**:
   - For SNF, transport often uses specialised casks (e.g., CONSTOR 440/84) and may involve multimodal routes (e.g., river, rail, sea). Implementation includes subcriticality checks and heat removal provisions.
   - For RAW, including disused sealed sources, transport should align with waste categorisation (e.g., very low-level vs. high-level) and conditioning methods like cementation.

Non-compliance can result in penalties, license suspension or revocation under the Act on the Safe Use of Nuclear Energy.

2.1.1.3. Amendments to the License

Amendments are required when changes could impact safety and they follow a similar review process to initial authorisation. The **BNRA should approve all modifications before they take effect**. This includes:

1. **Triggers for Amendments**
   - Changes in transport routes, packaging designs, personnel or operational conditions.
   - Updates to emergency plans or physical protection measures.
   - Alterations due to regulatory changes or incidents.
2. **Process**
   - Submission of a request / notification to the BNRA with updated documentation, such as revised safety analyses or impact studies.
   - The agency evaluates the potential risks and may impose new conditions or require additional assessments.
3. **Requirements for Certain Types of Material**
   - **Spent nuclear fuel** (**SNF**): Amendments are often needed for route changes or destination shifts (e.g., from non-EU states to EU Member States reprocessing). They require reverification of EURATOM agreements and recipient capabilities, especially if declared as waste by the Council of Ministers.
   - **High-Level or long-lived radioactive waste**: Changes in waste category, conditioning (e.g., from compaction to vitrification) or storage prior to transport trigger amendments. This ensures compliance with acceptance criteria for disposal facilities.
   - **Disused sealed sources** (**DSS**) **or orphan sources**: Amendments may be required for returns to manufacturers or transfers to state enterprises like SERAW, with simplified processes for low-level exempt waste but still needing BNRA verification.
   - **Fissile materials**: Amendments should address criticality safety and may involve updated radiological impact studies.

In all cases, amendments prioritise the As Low As Reasonably Achievable (ALARA) principle for radiation exposure and align with international obligations, such as prohibiting shipments to certain latitudes under the Joint Convention.

This framework ensures RAM transport is conducted safely and transparently, with the BNRA's role central to enforcement.

2.1.2. Qualifications & Maintaining ADR Compliant Safety Advisers & Escorts

In Bulgaria, the BNRA issues transport licenses and oversees nuclear-specific aspects, while the Executive Agency “Road Transport Administration (RTA)” handles ADR compliance, including certification for Dangerous Goods Safety Advisers (DGSAs), commonly referred to as safety advisers.

Escorts are primarily addressed under security provisions for higher-risk shipments, drawing from ADR Chapter 1.10 and the Ordinance for the Provision of Physical Protection of Nuclear Facilities, Nuclear Material, and Radioactive Substances.

The following subsection explains the qualifications, appointment processes and approaches to maintaining the required numbers for both roles.

2.1.2.1. Qualifications for ADR-Compliant Safety Advisers (DGSAs)

Safety advisers are mandatory for undertakings involved in the transport, packing, loading or unloading of dangerous goods, including RAM, unless operations are limited to exempt or limited quantities under ADR. **Their role includes advising on compliance**, **monitoring practices**, **investigating incidents** and **preparing annual reports on dangerous goods activities**. They should satisfy the following prerequisites:

Educational and Training Requirements

- Candidates should complete vocational training covering ADR regulations, with a focus on health, safety, environmental protection, and specific Class 7 (RAM) complexities such as radiation protection, packaging, labelling and emergency response.
- Training courses, typically 2-5 days long, are offered by approved providers and emphasize practical skills like risk assessment and audit procedures.
- For RAM-specific expertise, additional modules on radiation safety are recommended, and there is ongoing discussion in ADR contexts about specialized Class 7 certification due to its unique regulatory demands.

Examination and Certification

- To qualify, individuals should pass an examination approved by the competent authority, in Bulgaria, this is the RTA exam.
- The RTA administers these exams and issues certificates, ensuring alignment with EU directives.
- The exam covers ADR core topics, road regulations and may include case studies.
- Successful candidates receive a certificate valid for 5 years, renewable only by passing a refresher exam.

Other Prerequisites

Applicants should demonstrate relevant professional experience in dangerous goods handling. For RAM transport, knowledge of BNRA-specific requirements, such as dose limits and incident reporting, is essential.

2.1.2.2. Approach to Maintaining the Required Number of Safety Advisers

Under ADR 1.8.1.3, safe transport undertakings should appoint **at least one DGSA** and the number should be sufficient to effectively cover all activities without gaps in oversight. In Bulgaria, this is enforced through BNRA licensing for RAM transport and RTA oversight for ADR compliance.

Appointment and Coverage

The DGSA can be an internal employee, external consultant or the head of the undertaking if qualified. For multi-site or high-volume operations (e.g., frequent RAM shipments), multiple DGSAs may be needed to ensure continuous monitoring and reporting. If a DGSA ceases employment, a replacement should be appointed immediately, with notification to the competent authority (RTA) if there is a gap exceeding 1 month.

Ongoing Maintenance

DGSAs should be supported with resources to adequately perform their duties, including training and updates on regulatory changes (e.g., biennial ADR revisions). Continued Professional Development (CPD) is encouraged, involving on-the-job learning, seminars and memberships to professional bodies. Annual audits and reports help verify effectiveness, with BNRA inspections ensuring compliance for RAM-specific transports. Non-compliance can lead to license suspension or fines.

2.1.2.3. Qualifications for Escorts

Escorts are required for high-consequence RAM shipments (e.g., those exceeding transport security thresholds under ADR 1.10.3.1) such as high-activity sources or nuclear material categorised under IAEA standards. They provide physical protection against theft, sabotage or unauthorised access during transit, often as part of a BNRA-approved security plan. For nuclear material (e.g., Category I under the Ordinance on Physical Protection) armed escorts may be mandatory.

Educational and Training Requirements

Escorts should undergo specialised training in radiation protection, emergency procedures, handling of sealed/unsealed sources and security protocols. This includes knowledge of ADR security provisions, BNRA reporting requirements (e.g., for loss or exposure) and IAEA recommended practices for tamper-evident seals and route planning. Training is periodic, with emphasis on scenarios like accidents or theft.

Certification and Other Prerequisites

Personnel should be professionally qualified, often with certifications from BNRA approved programs. For armed escorts, additional security clearances, firearms training and background checks are required under the Ordinance on Physical Protection. Fitness for duty, including medical evaluations for radiation exposure risks, is mandatory.

2.1.2.4. Approach to Maintaining the Required Number of Escorts

The number of escorts is determined on a graded basis per shipment, based on material category, route risks and security plan assessments, e.g., at least one escort for lower-risk transits, multiple (including armed) for high-consequence loads. BNRA licenses specify these for each transport.

Appointment and Coverage

Undertakings should include escort provisions in their BNRA-submitted transport plans, coordinating with licensed security providers if needed. For ongoing operations, a pool of qualified escorts ensures availability, with backups for shifts or multi-leg journeys.

Ongoing Maintenance

Regular training and requalification (e.g., annual or as per BNRA directives) maintain competency. Undertakings should conduct inventories, drills and audits to verify numbers and readiness, reporting to BNRA. If personnel shortages arise, transports are delayed until resolved, with physical protection measures like secure storage enforced in the interim.

2.2. Specialised Vehicles

SERAW has four licensed vehicles authorised to carry out the transport of RAM. They include two minibuses and two trucks (one of which has high off-road capability and an onboard crane). The second truck is a tractor with the capability to attach various platforms and trailers. Three of the vehicles are housed in SD “PRRAW – Novi Han”, and the tractor is stationed at SD “Decommissioning of Units 1 - 4”.

The four vehicles authorised to carry out the transport of RAM can be seen in Figure 4 to Figure 6 below.

Figure 4. Images of Volkswagen Transporters

Table 1. Volkswagen Transporter technical data

Technical Data	
Type	Cargo truck
Model	Volkswagen Transporter
TI*	5.0
Allowable maximum weight	3,200 kg
Distribution of allowable maximum weight across axles	1. 1710 kg 2. 1720 kg

Figure 5. Image of Renault Midliner

Table 2. Renault Midliner technical data

Technical Data	
Type	Cargo truck
Model	Renault Midliner
TI*	10.0
Allowable maximum weight	16,000 kg
Distribution of allowable maximum weight across axles	1. 8,000 kg 2. 2,800 kg
Load capacity of the crane	1,300 kg

Figure 6. Image of Ford cargo truck

Table 3. Ford cargo truck with semi-trailer technical data

Technical Data	
Truck	
Type	Cargo truck with semi-trailer
Model	Ford Cargo
TI*	10.0
Allowable maximum weight	19,000 kg
Distribution of allowable maximum weight across axles	1. 7,100 kg 2. 12,600 kg
Semi-trailer	
Allowable maximum weight	37,000 kg
Distribution of allowable maximum weight across axles:	1. 8,300 kg 2. 8,350 kg 3. 8,350 kg

It should be noted that the asterisk (*) on the Tis in the above tables denotes the “maximum permitted total transport index of the cargo” and that all vehicles are equipped with tracking systems.

2.3. Technical Equipment

The ADR outlines mandatory safety equipment for vehicles transporting hazardous materials to ensure the protection of crews, the public and the environment. These requirements are detailed in **Part 8.1** of **ADR 2025**, which covers vehicle crews, equipment, operation and documentation. The provisions apply to transport units (e.g., a single vehicle, articulated lorry or drawbar combination) carrying dangerous goods, with some exemptions for limited or excepted quantities.

Equipment should be readily accessible, properly maintained and compliant with relevant standards.

2.3.1. Fire-Fighting Equipment

All transport units should, based on **ADR 8.1.4**, **carry portable fire extinguishers** suitable for flammability classes A (solids), B (liquids) and C (gases). Dry powder extinguishers are commonly specified due to their versatility, but equivalents are allowed if they meet or exceed performance standards (e.g., EN 3 series). **Fire extinguishers should**:

- be sealed to indicate if used,
- bear marks of compliance with a recognised standard and the next inspection date (month/year),
- be installed to protect against weather while remaining accessible to the crew,
- not expire during carriage.

If the vehicle has a fixed automatic extinguisher for engine fires, the portable one does not need to cover engine fires.

2.3.2. Miscellaneous Equipment and Personal Protection Equipment

The following items, based on **ADR 8.1.5**, **should be carried on the transport unit** for general safety and emergency response:

- **Wheel chock(s):** At least one per vehicle in the transport unit, sized to the maximum mass and wheel diameter (e.g., two for articulated lorries).
- **Warning signs:** Two self-standing signs (e.g., reflective triangles or cones) for roadside warnings.
- **Eye rinsing liquid:** For immediate decontamination.

For each vehicle crew member:

- **Warning vest:** High-visibility clothing (e.g., compliant with EN ISO 20471).
- **Portable lighting apparatus:** Handheld, non-sparking and without open flames.
- **Protective gloves:** A pair for handling hazards.
- **Eye protection:** Such as goggles.

Additional equipment is required based on the class of dangerous goods:

- **For most classes** (e.g., 3, 4.1, 4.3, 8, 9): An emergency escape mask for each crew member if at risk of being exposed to fumes.
- **For spill-prone goods** (e.g., solids or liquids in classes other than 1, 2, 6.2, 7): A shovel, drain seal and plastic collecting container.
- These items ensure quick response to incidents like spills, fires or exposures.

Examples of personal protective equipment (PPE) and miscellaneous equipment are shown in Figure 7 and Figure 8 below.

Emergency escape mask compliant with EN 136 or 137

Rubber flashlight

Eye protection devices

Eye rinsing liquid

Protective gloves

High-visibility warning vest compliant with EN ISO 20471 Class 2 or eq.

Protective clothing

Figure 7. PPE and miscellaneous equipment

Figure 8. Other examples of equipment in common use

2.3.3. Dosimetry Equipment in ADR Transport

Under ADR 2025, there is no mandatory requirement for dosimetry equipment as part of the general on-board vehicle equipment listed in Part 8 (e.g., 8.1.5 for miscellaneous items like wheel chocks, warning vests or protective gear). However, for Class 7 (radioactive materials), specific provisions in Part 7 and 8 imply the need for monitoring to ensure compliance with radiation limits, though not explicitly as "on-board" items. These align with IAEA SSR-6 standards incorporated in ADR for Class 7.

Key ADR provisions for Class 7

- **Radiation level monitoring** (**7.5.11 CV33** (**3.3 - 3.5**)): The carrier should ensure dose rates do not exceed 2 mSv/h at any external surface of the vehicle and 0.1 mSv/h at 2 m from the surface.
    - This **requires radiation survey meters to verify levels** during loading, transport and unloading, although ADR does not mandate them as standard vehicle equipment, responsibility falls on the carrier for compliance.
- **Crew Exposure** (1.7.2): If occupational doses are likely to exceed 1 mSv/year, a radiation protection program (including personal dosimetry) is required. Crew members may need to wear personal dosimeters if exposure risks warrant it, based on the consignor's assessment.

In Bulgaria, enforcement by the BNRA and Executive Agency RTA follows ADR as well as adds national emphasis on radiation protection. The **BNRA regulations stipulate the following** with respect to personal dosimeters, radiation monitoring systems and general monitoring:

- **Personal Dosimeters:** Required for all personnel involved in Class 7 transport events, including drivers and handlers.
- **Radiation Monitoring Systems:** Transport programs should include radiation monitoring (e.g., dose rates, contamination checks).
- **General Monitoring:** Under the Regulation on Radiation Protection (SG No. 16/2018, amended 2020), Category A workers (>6 mSv/year risk) need systematic individual dosimetry with approved devices. This applies to transport workers, with records maintained and reported to BNRA.

Table 4. Summary of transport types with respect to dosimetry requirements and notes

Transport Type	Dosimetry Requirement	Notes
General Dangerous Goods (Non-Class 7)	None	ADR focuses on firefighting and PPE (8.1.4-8.1.5).
Class 7 (Radioactive) - Standard	Personal dosimeters for crew if >1 mSv/year expected; survey meters for level checks.	Carrier ensures via protection program; practical necessity for CV33 compliance.
Class 7 - High-Risk/ Exclusive Use	Radiation detection system on vehicle for contamination.	BNRA mandates personal dosimeters for all involved personnel.
Emergency/Incident	Immediate monitoring instrumentation and PPE.	Part of contingency plans; notify BNRA promptly.

Gamma-spectrometric analyzers and radiometers

For surface contamination

Figure 9. Examples of dosimetry equipment

2.3.4. Communication Equipment in ADR Transport

Communication equipment (e.g., radios, phones or tracking systems) **is not listed as mandatory on-board equipment** in ADR 2025 Part 8. ADR emphasises documentation (e.g., instructions in writing for emergencies, 8.1.2) and operational procedures rather than specific communication tools. However, **for security** and **emergency response** the ADR provides provisions for:

- **High-Consequence Dangerous Goods** (**1.10.3**): For goods like certain Class 7 materials posing high security risks (e.g., theft for malicious use), a security plan should include "a system of communication that allows all staff to report anything suspicious." This may imply reliable communication devices (e.g., two-way radios or satellite phones) for incident reporting, but ADR does not specify types or mandate them on vehicles. Drivers should have means to notify authorities in the event of accidents, but no equipment requirement; it is assumed standard vehicle/mobile phones suffice.
- **Emergency Notification** (**5.4.3**): As an aid during an accident emergency situation that may occur or arise during carriage.
- **Class 7 Specific**: No additional communication mandates beyond general security plans. In incidents involving loss/theft of sources, immediate notification to the BNRA is required, via any reliable means.

In Bulgaria:

- The BNRA and RTA enforce ADR without adding specific communication equipment requirements for vehicles. However, emergency plans (under radiation protection regulation) require "reliable means of communication" for coordination in accidents, including warning populations and authorities. Transport permits mandate contingency plans with notification procedures.
- For nuclear/radioactive transport, there is a strict emphasis on security measures against trafficking include shared information systems between the BNRA, Ministry of Interior and others, but no on-board vehicle specifics.

Overall, while practical for safety (e.g., coordinating in remote areas or tunnels), communication equipment is not a required ADR item and it is sufficient to rely on general mobile tech for compliance with reporting obligations.

2.3.5. Required Documents Onboard During Class 7 Transport

The **ADR 2025 specifies the documents that should be carried on the transport unit for all dangerous goods**, including Class 7. These requirements apply in Bulgaria through national legislation, primarily the **Act on the Safe Use of Nuclear Energy** (**ASUNE**) and related regulations administered by the BNRA and the Executive Agency RTA.

Documents should be readily available for inspection, in a language understood by the crew and compliant with ADR Part 8 (Requirements for Vehicle Crews, Equipment, Operation, and Documentation). For Class 7, additional specifics are outlined in Parts 5 (Consignment Procedures) and 7 (Provisions Concerning the Conditions of Carriage).

Exemptions apply for excepted packages (e.g., UN 2908–2911) or **limited quantities**, **where reduced documentation may suffice** (e.g., no full transport document required under ADR 1.1.3.6 or 1.7.1.5).

2.3.5.1. Class 7-Specific Documents (ADR 5.1.5)

Additional documents are required or are otherwise embedded in the transport document, based on package type or shipment risk **in the case of Class 7**:

- **Competent Authority Approval Certificates**: Copies of approvals from the BNRA (as Bulgaria's competent authority) for package designs (Type B(U), B(M), C), special form radioactive material, fissile material, or special arrangement shipments (ADR 5.1.5.4) should include multilateral approvals if transiting other countries. For low dispersible material or shipments under exclusive use, additional declarations should be expected.
- **BNRA Transport Permit**: Under Bulgarian law (ASUNE and Regulation on the Issuance of Licences and Permits), a permit is required for transporting radioactive materials exceeding excepted quantities. A copy should be carried on board. Applications to the BNRA include risk assessments, security plans and radiation protection programs. Validity varies (e.g., single-use or multi-year for routine shipments).
- **Security Plan Documentation**: For high-consequence Class 7 goods (e.g., Category I or II sources per ADR 1.10.3), elements of the security plan (e.g., threat assessment from the State Agency for National Security) should be accessible, though not fully carried (ADR 1.10.3.2). The BNRA coordinates with the Ministry of Interior for physical protection during transport.
- **Radiation Protection Program Details**: If occupational exposure exceeds 1 mSv/year, summary records or monitoring plans may be required indirectly (ADR 1.7.2), but not explicitly on board unless specified in the BNRA permit.

2.3.5.2. General Documents for All Dangerous Goods Transport (ADR 8.1.2.1)

The following general documents, unless exempted, as shown in Table 5, also apply to Class 7:

- transport document,
- instructions in writing,
- driver's ADR training certificate,
- vehicle approval certificate.

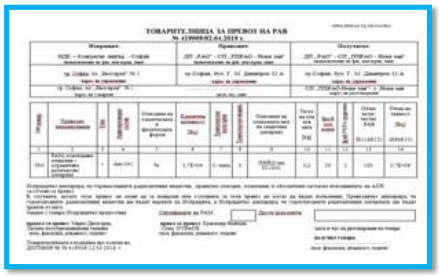
Table 5. General documents for all dangerous goods transport

Document	Description	Specifics for Class 7	Source
Transport Document (consignment note**)**	Details the dangerous goods being carried, including UN number, proper shipping name, quantity and consignor/consignee information (ADR 5.4.1). Should include a consignor's declaration confirming compliance.	Should specify: activity level (Bq), category (I-WHITE, II-YELLOW, III-YELLOW), TI, criticality safety index (CSI) if fissile, and any subsidiary hazards. For multilateral approvals, include approval references (ADR 5.4.1.2.5). If multiple consignments, details can be in separate documents.	ADR 8.1.2.1(a), 5.4.1; BNRA enforces via ASUNE Art. 35.
Instructions in Writing (emergency instructions**)**	A standardised 4-page form outlining actions in case of accidents or incidents (e.g., fire, spillage, exposure). Should be in the driver's language and readily accessible in the cab.	Includes Class 7-specific guidance on radiation hazards, such as avoiding contact and notifying authorities. From 2025, extends to limited quantities handlers (ADR 5.4.3).	ADR 8.1.2.1(b), 5.4.3; required by RTA for all ADR drivers.
Driver's ADR Training Certificate	Proof of ADR vocational training, valid for 5 years, covering general awareness, function-specific and safety training.	Should include Class 7 module for radioactive materials handling (ADR 8.2.1). Issued by RTA-approved centres after exam.	ADR 8.1.2.1(d), 8.2; RTA mandates for Bulgarian drivers (validity: 5 years).
Vehicle Approval Certificate	For specialised vehicles (e.g., EX/II or EX/III for certain Class 7 shipments), certifying compliance with construction and equipment standards.	Required if the vehicle design mandates it for high-TI or fissile shipments (ADR 9.1.3). Issued by RTA or equivalent.	ADR 8.1.2.1(c), 9.1.3; RTA oversees vehicle inspections.

2.3.5.3. Additional Bulgarian Requirements (RTA and General Road Transport)

While the ADR supersedes for dangerous goods, the RTA requires the below for all road vehicles, including those carrying Class 7:

- **Vehicle registration certificate**: Proof of vehicle ownership and roadworthiness.
- **Civil liability insurance policy** (including Green Card for international): Covers damages, mandatory for all transport (valid in EU; fines for absence).
- **Driver qualification card and psychological fitness certificate**: Valid for 5 years (qualification) and 2 – 3 years (fitness); required for professional drivers.
- **Journey form or bill of lading**: For tracking routes and loads, per RTA rules.
- **TIR carnet** (if applicable for international sealed shipments): Facilitates customs, though rare for Class 7 due to security.



Consignment Note

Written instructions

Emergency plan

License for transportation

Figure 10. Snapshot of additional Bulgarian requirements

Exemptions

For small quantities or excepted packages, only basic transport documents suffice (no ADR-specific). BNRA may waive certain permits for low-risk medical isotopes.

2.3.6. Marking of Vehicles and Labelling of Cargo for ADR Class 7 Transport

Requirements for marking of vehicles and labelling of cargo for Class 7 are detailed in ADR Part 5 (consignment procedures), focusing on hazard communication to protect crews, emergency responders and the public.

Exemptions apply to excepted packages (e.g., UN 2908–2911), where minimal or no labelling is needed if activity limits are met. All **markings should be durable**, **legible**, **weather resistant** and **not obscured**.

2.3.6.1. Labelling of Packages (ADR 5.2.2)

Packages containing radioactive materials should be labelled based on both the maximum radiation dose rate at the surface and the **TI**, the latter of which measures external radiation hazard.

TI = dose rate in mSv/h at 1 m from the surface, multiplied by 100, rounded up.

Labels are diamond-shaped (100 mm x 100 mm, on point) with a black trefoil symbol on a white or yellow background, divided horizontally. The word "RADIOACTIVE" appears in the lower half, along with category indicators (I, II or III). Labels **should be affixed to two opposite sides of the package**, **visible during handling**.

Additional markings include:

- **UN Number and proper shipping name**: Marked legibly on the outside (e.g., "UN 2915 RADIOACTIVE MATERIAL, TYPE A PACKAGE").
- **Contents and activity**: For most packages, specify the radionuclide (e.g., "Cs-137") and activity in becquerels (Bq) or multiples (e.g., GBq).
- **Criticality safety index** (**CSI**): For fissile materials (e.g., UN 3328), marked on the label if applicable.
- **Consignor / consignee identification**: Durable marking of names or identifiers.
- **Type IP-1/2/3** or **type A packages**: No label if surface dose <0.005 mSv/h and TI=0; otherwise, use categories below.

Table 6. Summary of different category indicators

Category	Background Colour	Border/Bar Colour	Maximum Surface Dose Rate	TI	Additional Requirements
I-WHITE	White	Red (vertical bar)	≤0.005 mSv/h	0	"CONTENTS" and "ACTIVITY" in black; no TI.
II-YELLOW	Upper yellow, lower white	Red (two vertical bars)	>0.005 to ≤0.5 mSv/h	>0 to ≤1	"CONTENTS", "ACTIVITY", and TI in black.
III-YELLOW	Upper yellow, lower white	Red (three vertical bars)	>0.5 to ≤2 mSv/h (or ≤10 mSv/h under exclusive use)	>1 to ≤10 (or >10 under exclusive use)	"CONTENTS", "ACTIVITY", and TI in black; "FISSILE" if applicable.

For overpacks, freight containers or tanks, enlarged labels (250 mm x 250 mm) or placards are used if packages are not visible. If multiple radionuclides are present then the restrictive should be listed. Labels should not cover other markings and removal is prohibited until decontamination.

2.3.6.2. Marking and Placarding of Vehicles (ADR 5.3)

Vehicles (including trailers or containers) **should display placards** and **markings** to indicate the presence of radioactive materials, ensuring visibility from all sides. **Placards are enlarged versions of the labels** (250 mm x 250 mm, diamond on point) with the Class 7 number in black at the bottom. They are **required for any transport unit carrying labelled packages** (excluding excepted ones).

Key Requirements for Placards

Placard placement: One on each side and one on the front and rear of the vehicle (four total). For tanks or containers, placard on all four sides.

Contents: Black trefoil on white or yellow background; include UN number in the lower corner (e.g., "UN 2915" in a black-bordered orange rectangle below the placard for certain shipments).

TI and CSI: Not displayed on vehicle placards but relevant for package labels.

Exclusive use or high TI shipments: III-YELLOW placards even if packages vary; additional "EXCLUSIVE USE" marking if applicable.

Orange plates: For tanks or vehicles with >3,000 kg net explosives or certain quantities, display orange plates with Hazard Identification Number (HIN) and UN number (e.g., "70" for radioactive non-fissile).

Visibility and durability: Placards should be rigid or affixed to holders, reflective if possible and clean. Remove or cover when no dangerous goods are present.

Placards are **not needed for excepted packages or if all packages are unlabelled** (low activity). In Bulgaria, **BNRA inspections** at borders or sites **verify compliance**, with RTA handling roadside checks.

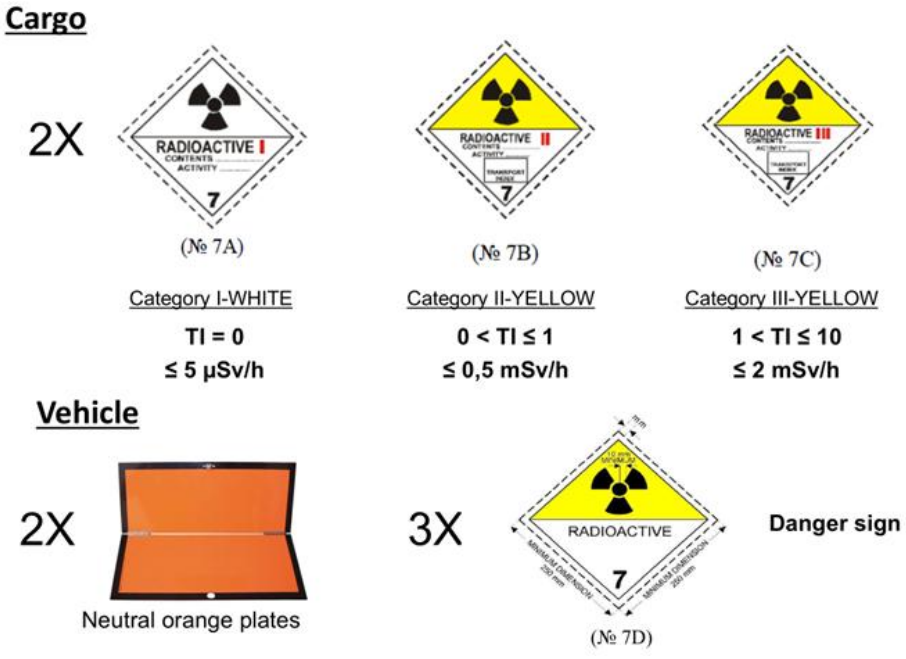


Figure 11. Examples of placards and markings

2.4. Packages & Shielding Equipment

Packages should contain, shield and protect radioactive contents, utilising a graded approach based on activity levels (A1 for special form, A2 for other forms) and material type (e.g., Low Specific Activity - LSA, Surface Contaminated Objects - SCO). All packages require BNRA approval for use in Bulgaria, including multilateral approvals for international transport.

As referred to previously, exemptions apply to excepted packages with very low activity. And it can be noted that no significant national deviations from ADR have been identified in the country to date. However, the BNRA mandates additional radiation protection programs and permits for shipments exceeding excepted quantities. **For fissile materials** (e.g., **UN 3328**), additional **Criticality Safety Index** (**CSI**) **requirements apply to prevent nuclear chain reactions**, with package limits on fissile mass.

Table 7. Summary of package types, descriptions, uses, key requirements and testing

Package Type	Description and Use	Key Requirements	Testing (ADR Part 6)
Exempted Packages (e.g., UN 2908–2911)	For very low-activity materials (e.g., instruments, medical isotopes) where risks are minimal. No BNRA permit needed if below limits.	Basic industrial packaging; no shielding required if dose rates <0.005 mSv/h at surface and TI=0. Contents limited to A1/A2 fractions.	No specific tests; should maintain integrity under normal handling.
Industrial Packages (IP-1, IP-2, IP-3)	For LSA (low specific activity) or SCO materials (e.g., contaminated equipment, ores). IP-1 for low-risk; IP-2/IP-3 for higher.	Robust design (e.g., drums, boxes); shielding not considered in activity calculations. External shielding optional but should withstand stresses. BNRA approves for SCO/LSA transport.	Normal conditions: water spray, free drop (0.3–1.2 m based on mass), stacking (24h), penetration. IP-3 adds accident simulation if needed.
Type A	For quantities up to A1 (special form) or A2 (normal form); common for medical/pharmaceutical shipments.	Designed to retain contents and shielding under normal transport; includes inner/outer components. BNRA requires documentation of tests.	As for IP-2 plus thermal insulation if needed; should limit dose increase <20%.
Type B(U)/B(M)	For higher activities (>A1/A2); B(U) unilateral approval, B(M) multilateral. Used for spent fuel, high-level sources.	Engineered with shielding (e.g., lead-lined); should survive accidents. BNRA issues approvals for Bulgarian designs.	Hypothetical accidents: 9m drop, puncture, fire (800°C/30min), water immersion. Retain shielding (dose at 1m ≤10 mSv/h post-accident).
Type C	For air transport of high-activity materials; rare for road but applicable if multimodal.	Similar to Type B but enhanced for air crashes.	Additional impact (90m/s) and fire tests.

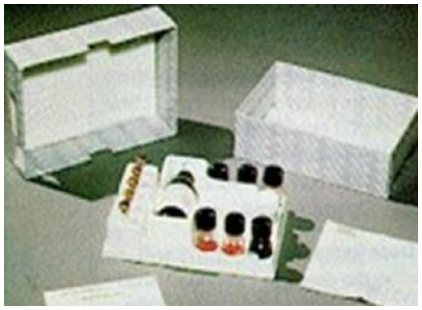
Examples of and additional information in relation to the different types of packages detailed above, can be seen in the ensuing figures (Figure 12 to Figure 16).

Exempt packages

are used for limited quantities of radioactive materials that would pose a very low risk if the integrity of the package is breached during an accident.

Exempt packages can be used to transport: SD, small sealed sources (reference sources), measuring instruments (clocks, compasses), empty contaminated packages, and others .

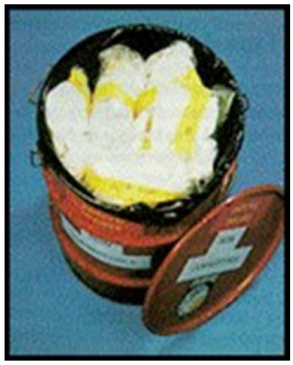
UN2908 UN2909 UN2910 UN2911



The restrictions on activity and dose rate are specified in **Article 14** of the Ordinance on the Conditions and Procedure for the Transport of Radioactive Substances.

Figure 12. Examples of and additional information on exempt packages

UN2912 UN2913 UN3321 UN3322



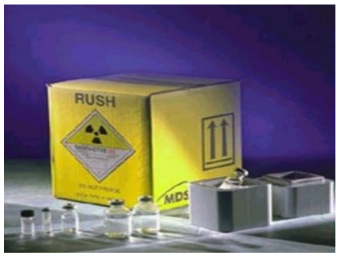
Metal, intermediate, bulk containers for bulk/liquid materials can be used as Type IP - 2 and IP-3 packages.

Figure 13. Examples of industrial packages (types IP-2 and IP-3)

Packages Type A

are used for transporting small quantities of radioactive materials, but with higher specific activity compared to materials in IP packages. .

The nature and form of Type A packages depend on the type and form of the contents. In some cases, the package itself may be an integral part of the mechanism for using the radioactive material.



UN2915
UN3332

The restrictions on quantity and dose rate are specified in **Article 16** of the Ordinance on the Conditions and Procedure for the Transport of Radioactive Substances.

Figure 14. Examples of and additional information on type A packages

Packages Type B

are designed for the transportation of highly radioactive substances, often in quantities and with activities that could pose a life -threatening danger if protective barriers are lost. .

The packages can be small containers with sources, such as gamma radiography devices, gamma irradiation devices, or containers for storing fresh or spent nuclear fuel.

UN2916
UN2917

The restrictions on quantity and dose rate are specified in **Article 17** of the Ordinance on the Conditions and Procedure for the Transport of Radioactive Substances

Figure 15. Examples of and additional information on type B packages

Packages Type C

In the IAEA Regulations of 1996 (TS -R-1), a new type of packaging, "Type C," is introduced.

This type of packaging is intended for the transportation of large quantities of radioactive material by air.

Such packages have not yet been developed and certified.

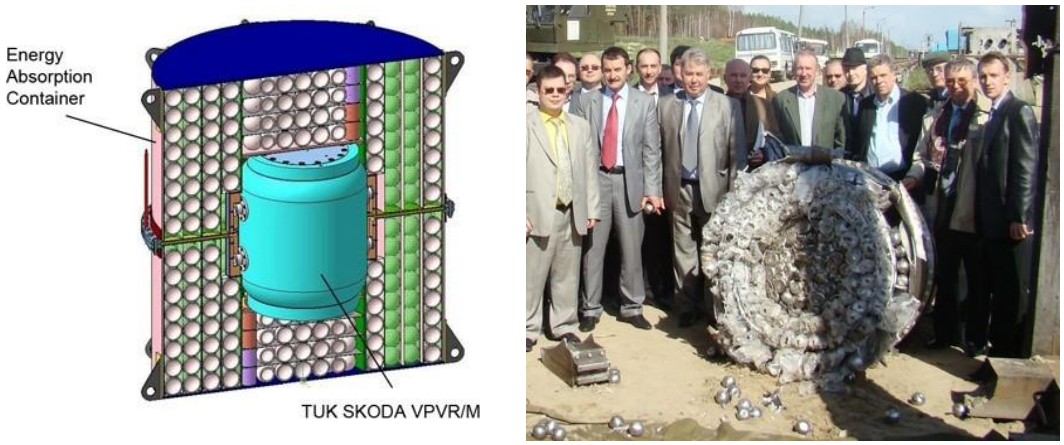


Figure 16. Examples of and additional information on type C packages

2.4.1. Shielding Equipment for Class 7 Transport

Shielding is integral to package design to reduce external radiation exposure, not a separate "equipment" item under ADR 8.1.5 (miscellaneous equipment). It ensures dose rates comply with limits during normal and accident conditions. Shielding materials (e.g., lead, depleted uranium, tungsten) surround contents, with thickness based on radionuclide energy and activity.

External vehicle shielding is not mandatory but may be used for exclusive-use shipments to meet dose limits (e.g., 2 mSv/h at vehicle surface, 0.1 mSv/h at 2 m).

Shielding integrity checks are required as part of radiation protection programs, including post-transport decontamination if contamination exceeds 0.4 Bq/cm² (alpha) or 4 Bq/cm² (beta / gamma). For high-consequence goods, security plans include shielding verification to prevent tampering.

Dose rate limits (**ADR 7.5.11 CV33**):

- **Packages**: ≤2 mSv/h at surface (10 mSv/h if the vehicle is equipped with enclosure inside and there is no loading or unloading during the shipment).
- **TI**: Dose at 1m × 100; max TI =10 per package (50 total per vehicle).
- **Vehicles**: ≤2 mSv/h at any point, ≤0.1 mSv/h at 2 m, except for consignments carried under exclusive use.

Testing for shielding (ADR 6.4.13) **evaluates post-test integrity**.

3. CASE STUDIES & TECHNICAL SOLUTIONS

Two non-standard case studies on the transport of RAM have been examined in this section. They cover the topics of transport of:

1. **scrap metal containing a Cs-137 source** with a high dose rate;
2. **disused sealed neutron radioactive sources**.

3.1. Transport of Scrap Metal Containing a Cs-137 Source with a High Dose Rate

In 2001, the “Permanent Repository for Radioactive Waste – Novi Han” accepted a bale of metal scrap containing a radioactive Cs-137 source for storage. The measured dose rate on the surface of the bale exceeded 20 mSv/h. The radioactive source was registered during the mandatory inspection of secondary raw materials at the entrance to a large metallurgical enterprise in Bulgaria.

The bale was placed in a metal crate specially constructed for it. The crate was placed in a concrete receptacle (see Figure 17), and additional biological shielding was constructed from lead blocks.

In 2020, a decision was taken to transfer the bale for management to one of the other divisions of SERAW – SD “Radioactive Waste – Kozloduy”.

Figure 17. The Cs containing bale in place in its engineered solution

3.1.1. Problems Resolved

Due to the high dose rate, it was necessary to find a solution for its transport, such that the requirements of the issued transport licence were fulfilled.

The concrete receptacle with biological shielding, in which the crate containing the bale was placed, was not suitable for loading and unloading operations. As a result, it could not be repackaged in appropriate transport packaging.

3.1.2. Technical Solution

The **proposed solution was to construct a replica of the concrete receptacle**, incorporating **built-in biological shielding** and equipped **with** the necessary **lifting attachments**.

> The subsequently prepared receptacle was placed in close proximity to the scrap bale. In a short time, the metal crate containing the bale was hooked up with a crane and transferred to the prepared transport receptacle (see Figure 18).

Figure 18. Positioning of the replica receptacle and positioning of crane

Additionally, **the receptacle was filled with lead blocks to reduce gamma radiation**, while ensuring that the total weight did not exceed the capabilities of the crane and the transport vehicle. The load was placed in a 20-foot ISO container and securely fastened (see Figure 19). The container had a removable roof, which facilitated the placement of the load inside it, as well as its manipulation with a crane.

Figure 19. The load being placed (left) and secured (right) in a 20-foot ISO container

The transport between the two divisions of SERAW was carried out using the licensed cargo truck with semi-trailer (Figure 20).

Figure 20. Licensed cargo truck bearing load with semi-trailer

3.1.3. Transport Documents

An example of a consignment note, akin to one used during the transport of the load, including the roles of sender (consignor), carrier (transporter) and recipient (consignee) are denoted in Figure 21 below.

CONSIGMENT NOTE FOR TRANSPORT OF RAM
№ AD-xxx/XX.XX.XXXX

Sender:	**Carrier:**	**Recipient:**
SERAW - Specialised Division "PRRAW – Novi Han" /name of an individual or legal entity//name of an individual or legal entity/	SERAW - Specialised Division PRRAW – Novi Han /name of an individual or legal entity/	Specialized Division "Radioactive Waste – Kozloduy" /name of an individual or legal entity/
Sofia, Blvd. G. M. Dimitrov 52 A /management address/	Sofia, Blvd. G. M. Dimitrov 52 A /management address/	Sofia, Blvd. G. M. Dimitrov 52 A /management address/
SERAW - Specialised Division "PRRAW – Novi Han" /loading address/	…….. */date, hour, minute/*	Specialized Division "Radioactive Waste – Kozloduy" /loading address/

UN	Shipping name	Class	Radionuclide	Description on chemical and physical form	Volume [m^3]	Transport category	Transport index	Packaging description	Weight [kg]	Number of packages	Numbers of RAW in package	Total amount of RAW (K11xK12)	Total volume [m3] (K6xK13)
1	2	3	4	5	6	7	8	9	10	11	12	13	14
3332	RADIOACTIVE MATERIAL, TAPE A PACAGE, SPECIAL FORM, non fissile	7	^{137}Cs	Solid	V=1.77m^3	III - YELLOW	3.5	20′ ISO Container	8500	1	1	1	V=1.77m^3

The Sender declares that the above-mentioned radioactive substances, properly described, packaged and marked in accordance with the requirements of ADR, are ready for transport.
In cases where this transport cannot be carried out or the conditions for this transport cannot be met, the Carrier declares that the above-described radioactive substances will be returned to the Sender, and the Sender declares that the above-described radioactive materials will be accepted by him.

Together with the cargo, the Sender provides: RAM Certificates: ☐ Other documents: ☐

Handed over for transportation:
.....
/name, surname, position, signature/

Accepted for transportation:
.....
/name, surname, position, signature/

.....
/date and time of unloading of the cargo/

Received by: .....

This document was issued based on: AD-xxx/XX.XX.XXXX.

.....
/name, surname, position, signature/

Figure 21. Example of an assignment note used for the transport of RAM

3.2. Transport of Disused Sealed Neutron Radioactive Sources

In 2024, as part of the preparation for decommissioning of the SD “PRRAW – Novi Han”, it was necessary to transfer a large quantity of disused sealed neutron radioactive sources to the SD “Radioactive Waste – Kozloduy” for management. The transported neutron sources are mainly of the plutonium (Pu) – beryllium (Be) type.

3.2.1. Problems Resolved

Although, most parts of the sources were placed in their factory packaging with biological shielding for neutron radiation, the large number presented an increased risk to the drivers.

Furthermore, because the transport time between the two points might have exceeded 4-5 hours, and due to the relatively complex assessment of individual doses from neutron radiation, the preparation of the transport and its execution had to be carefully prepared based on the ALARA principle.

The planned 20-foot ISO container did not have biological shielding for neutron radiation.

Figure 22. Unshielded 20-foot ISO container

3.2.2. Technical Solution

To solve the problems, a conservative approach was chosen, with **a decision made for the complete construction of additional biological shielding for neutrons**. The shielding had to be built on the internal surfaces of the container (as shown in Figure 23). The shielding ensured compliance with the dose rate norms defined for the receiving site.

Figure 23. Neutron shielding inside of 20-foot ISO container

The main technical solutions employed during the works are detailed below.

Protective Materials for Biological Shielding

Those with a high content of H-3, i.e., various types of polymers such as High-Density Polyethylene (HDPE), were used.

Modular Blocks with Special Shapes

These were used to build stable structures. The structures in turn are mounted to the internal walls using suitable adhesives and additionally mechanical fastening systems were used.

Mechanical Systems

These systems were necessary to ensure stability during transport, as it was deemed possible to have experienced some minimal deformation of the ISO container's metal walls. Such deformation could lead to partial detachment of the polyethylene blocks.

Figure 24. Containers with RAM in place on the destination site

Further guidance on the type of information to include in a consignment note can be seen in Annex 1.

4. KEY TAKEWAYS & RECOMMENDATIONS

The key takeaways provided below represent a holistic overview of the safe transport of RAM activity described in this guideline, primarily to act as a succinct summary as much as to highlight any areas of interest to end-users who can subsequently navigate to the respective part of the document to explore the topic in more depth.

Packaging, marking and labelling

In almost all cases, the RAW generators were not aware of the packaging, marking and labelling requirements and preparation of the required transport documents. And through the works taking place gained expertise and experience from safety advisors and other responsible personnel.

Proven safety record

The activities of transporting and transferring RAM were carried out without any incidents related to environmental contamination or overexposure of personnel and the public. Strict compliance with written documentation and safety requirements eliminated incidents and accidents.

Transits between separate divisions and external entities

During decommissioning, RAM needed to be transported between the different divisions within SERAW and SERAW also transported materials from and to external contractors.

Valuable experiences and learnings with respect to safety, security and necessitated creativity

In some cases, the equipment contained high level activity RAM so the experience gained was valuable in terms of satisfying both safety and security requirements. Furthermore, due to the range of compositions, activities and physical states of the RAM transported, sometimes a great deal of creativity was required to arrive at a legally acceptable and justifiable approach for the safe transport of RAM.

4.1. Recommendations

Four global recommendations (Rs) have been provided based on the experience of performing the safe transport of RAM with a view of informing future similar works.

#R-1 Non-standard situations

In non-standard situations where the RAM package does not meet safe transport requirements, certified overpacks can be used to ensure compliance with safety standards, as outlined in the ADR regulations.

#R-2 International and cross-border transport

For international and cross-border transport, special attention should be paid to the national regulations of each country traversed to ensure full compliance with local legal requirements.

#R-3 Communication

When the receiving organisation is required to provide an escort for international transport, clear communication with the transportation crew is essential. Language barriers between the transport and escort teams can create challenges, so proactive measures, such as translation support, should be implemented.

#R-4 A smooth transportation process

To ensure a smooth transportation process, all necessary documentation for the transportation crew, such as IDs, passports and permits, should be prepared in advance, particularly for passing security checkpoints at the receiving organisation.

ANNEX 1. TRANSPORT DOCMENTS

Table 8. Example of consignment note for transport of RAM

Sender:	**Carrier:**	**Recipient:**
SERAW - Specialised Division "PRRAW – Novi Han" /name of an individual or legal entity//name of an individual or legal entity/	SERAW - Specialised Division PRRAW – Novi Han /name of an individual or legal entity/	Specialized Division "Radioactive Waste – Kozloduy" /name of an individual or legal entity/
Sofia, Blvd. G. M. Dimitrov 52 A /management address/	Sofia, Blvd. G. M. Dimitrov 52 A /management address/	Sofia, Blvd. G. M. Dimitrov 52 A /management address/
SERAW - Specialised Division "PRRAW – Novi Han" /loading address/	…….. */date, hour, minute/*	Specialized Division "Radioactive Waste – Kozloduy" /loading address/

UN	**Shipping name**	**Class**	**Radionuclide**	**Description on chemical and physical form**	**Single activity [Bq]**	**Transport category**	**Transport index**	**Packaging description**	**Weight [kg]**	**Number of packages**	**Numbers of RAW in package**	**Total amounnu of RAW (K11xK12)**	**Total activity [Bq] (K6xK13)**
1	2	3	4	5	6	7	8	9	10	11	12	13	14
3333	RADIOACTIVE MATERIAL, TYPE A PACKAGE, SPECIAL FORM FISSILE	7	X	Solid	x	III-YELLOW	*	Shipping container	**	1	1	1	x
3333	RADIOACTIVE MATERIAL, TYPE A PACKAGE, SPECIAL FORM FISSILE	7	X	Solid	x	III-YELLOW	*	Container neutron hygrometer VPGR-1	**	1	1	1	x
3333	RADIOACTIVE MATERIAL, TYPE A PACKAGE, SPECIAL FORM FISSILE	7	X	Solid	x	III-YELLOW	*	Neutron moisture indicator type NSV	**	1	1	1	x
3333	RADIOACTIVE MATERIAL, TYPE A PACKAGE, SPECIAL FORM FISSILE	7	X	Solid	x	III-YELLOW	*	Neutron SIR IBN-11 in a spherical container	**	1	2	2	x

Together with the cargo, the Sender provides: RAM Certificates: [ ] Other documents: [ ]

Handed over for transportation:
.....
/name, surname, position, signature/

Accepted for transportation:
.....
/name, surname, position, signature/

.....
/date and time of unloading of the cargo/

Received by: .....

This document was issued based on: P-01-xxx/xx.xx.XXX.

.....
/name, surname, position, signature/

Total activity - x Bq.

*** TI of the entire package - x.**

**** Total mass - x kg.**

The Sender (consignor) declares that the above-mentioned radioactive substances, properly described, packaged and marked in accordance with the requirements of ADR, are ready for transport.

In cases where this transport activity cannot be carried out or the conditions for this transport cannot be met, the Carrier (transporter) declares that the above-described radioactive substances will be returned to the Sender (consignor), and the Sender (consignor) declares that the above-described radioactive materials will be accepted by him.