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**RADShip: A Tool for CERN Shipments of Radioactive Material
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ABSTRACT:

At CERN (the European Organization for Nuclear Research), physicists and engineers are researching the fundamental structure of the universe. They use the world's largest and most complex scientific instruments - particle accelerators and detectors - to study the basic constituents of matter: the fundamental particles. The particles are made to collide at velocities close to the speed of light. This process provides the physicists with evidence about how the particles interact and provides an insight into the fundamental laws of nature.

The operation of high-energy accelerators unavoidably leads to the production of radioactive material, ranging from small electronic cards to large accelerator components. At one point this material will have to be shipped outside CERN. At present, more than 300 institutes worldwide have been involved in shipping radioactive material with CERN.

A database and web interface, RADShip, was specifically designed and developed in order to guarantee a high level of safety for such shipments, to ensure their complete traceability and meet the special needs of the Organization.

This paper covers the functionalities of the database and presents the user statistics for the last 5 years, including the daily activities such as classification, packaging, and shipment. The tool, which is used for both export and import, also manages the institutes' acceptance requests and Dangerous Goods Declarations with a number of automatic notifications. Special system checks are used to keep track of the packages' certificates and the validity of the staff's training.

INTRODUCTION:

CERN was founded in 1954 under the name The European Council for Nuclear Research. Today it is known as the European Laboratory for Particle Physics, one of the world's largest particle physics laboratories. The main area of research is the study of the fundamental constituents of matter - finding out what makes our Universe work, where it came from and where it is going. At CERN, physicists and engineers are investigating the fundamental structure of the universe. They use the world's largest and most

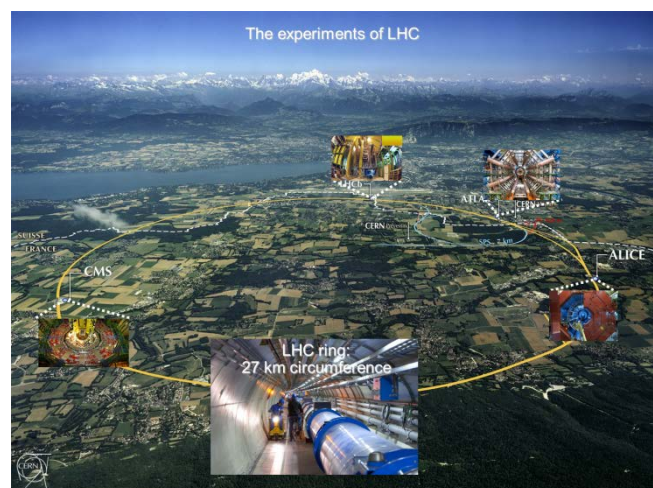


Figure 1 : The experiments of LHC

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complex scientific instruments to study the basic constituents of matter - the fundamental particles. The particles are made to collide at velocities close to the speed of light. This process provides the physicists with evidence about how the particles interact together and provides an insight into the fundamental laws of nature.

The operation of high-energy accelerators implies beam losses and unavoidably leads to the production of radioactive material, ranging from small electronic cards to large accelerator components [1]. These components can be removed due to changes in design and configuration, maintenance work or final dismantling. Besides activated material, radioactive isotopes are collected at CERN's ISOLDE facility. The on-line isotope mass separator ISOLDE is a facility dedicated to the production of a large variety of radioactive ion beams for many different experiments in the fields of nuclear and atomic physics, solid-state physics, materials science and life science. To track CERN's radioactive inventory, the TREC (Traceability of Radioactive Equipment at CERN) system [2] was developed and is presently used to trace potentially radioactive equipment from accelerators and experiments.

At one point, this potentially radioactive material will have to be shipped outside CERN.

SHIPMENT OF RADIOACTIVE GOODS AT CERN:

CERN ships radioactive material worldwide; from collections taken at the radioactive beam facility ISOLDE (25% of the shipments) to calibration sources (15% of the shipments) to various types of accelerator components (valves, pumps, magnets, collimators, targets, cables, klystrons, part of the LHC detector module), as well as radioactive waste and depleted uranium in solid, liquid or gaseous form. The average weight of the parcels is around 45 kg for 0.03 m³, not taking into account the heaviest parcels (large calorimeters or magnets). The statistics are shown in Figure 2 and Figure 3, the areas in red show an export or import occurring in the last 5 years.

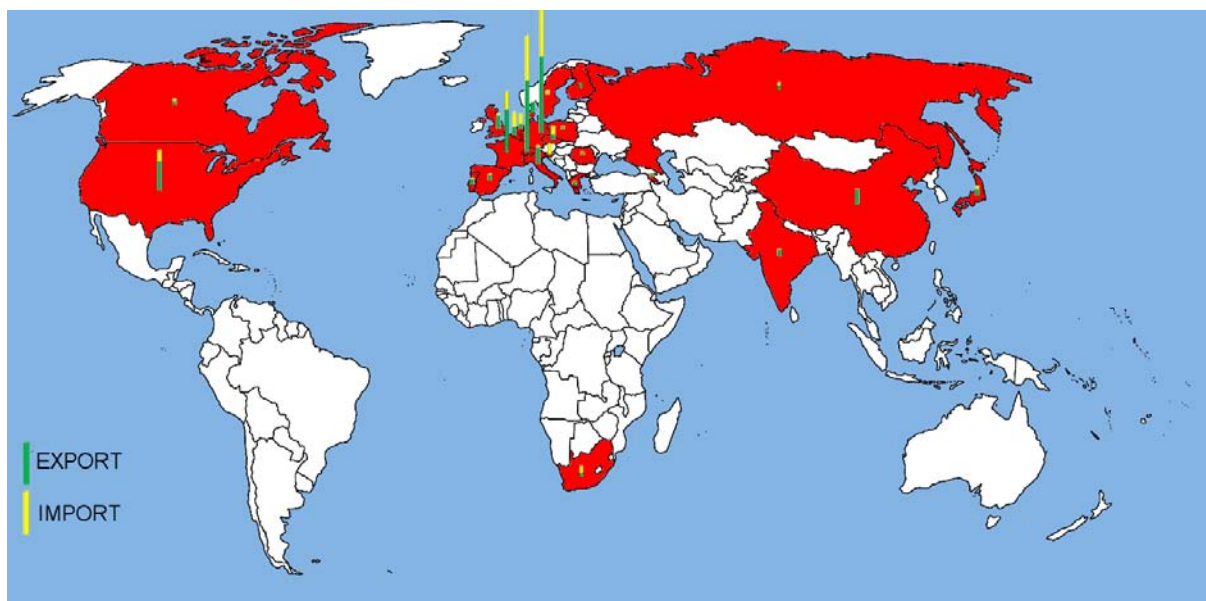


Figure 2 : Export/Import Statistics for the period 2008-2012 showing a relative balance between countries

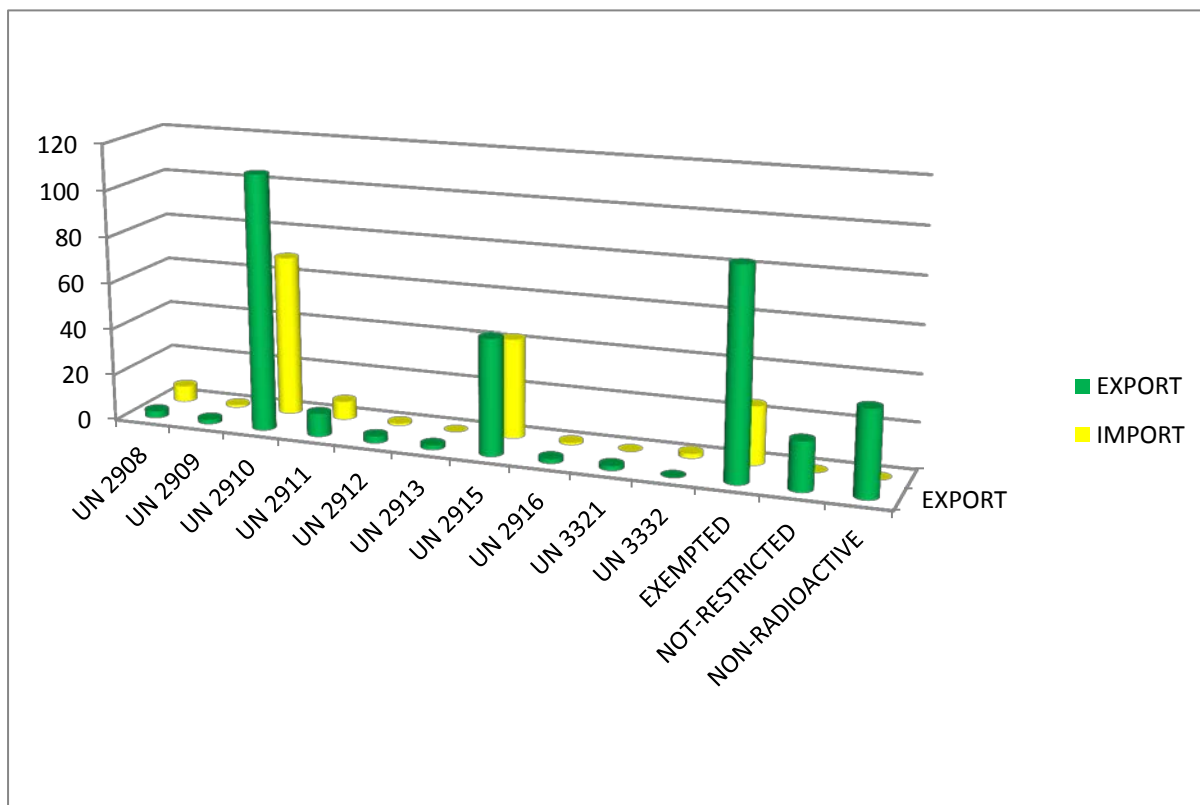


Figure 3 : Export/Import Statistics for the period 2008-2012 broken down by UN number

The most frequent shipments at CERN are “excepted package” and “Type A package”, but “exempted materialⁱ”, “not-restrictedⁱⁱ” and “non-radioactiveⁱⁱⁱ” are also tracked in CERN’s RADShip database. The not-restricted and exempted material is tracked as though it could be classified as radioactive according to the country’s national legislation but as non-radioactive according to the international transport regulations for dangerous goods. For example, a sealed radioactive source Am²⁴¹ of 10 kBq is not radioactive according to IAEA regulations for transport [3] and does not require any specific packaging, whilst the material is considered as a radioactive source in Switzerland according to the Swiss Radiation Protection legislation [4], as it exceeds by 5 times the authorization limit. The decision between non-radioactive or radioactive material is based on the result of gamma spectrometry and contamination measurements. Traceability of the material is ensured until its final delivery, to allow material sent from CERN to be traced back in case of any questions.

MANAGEMENT SYSTEM BASED ON REGULATORY REQUIREMENTS:

The safe and efficient shipment of such components is controlled by international regulations:

- IAEA provides Specific Safety Requirements SSR-6 [3];
- European countries are governed by UN Recommendations on the Transport of Dangerous Goods [5] and European Agreement concerning the International Carriage of Dangerous Goods by Road [6];
- US countries transport is governed by the Code of Federal Regulations Part. 49 [7];
- The International Civil Aviation Organization issues the Technical Instructions for the safe transport of Dangerous Goods by air [8], these are enforced through the Dangerous Goods Regulations from IATA [9]

The IAEA Specific Safety Requirements SSR-6 [3] state in paragraph 306 that: “A management system based on international, national or other standards acceptable to the competent authority shall be established and implemented for all activities within the scope of the Regulations, as identified in paragraph 106, to ensure compliance with the relevant provisions of these Regulations. {...}”. In particular, paragraph §309 (non-compliances), paragraphs § 311-315 (training), paragraphs §502-503 (requirements before each shipment) and paragraph § 546 (transport documents) enforce the need for a tool able to manage all these different aspects. For these reasons, CERN decided to launch the “RADShip” project which aimed to provide a central database repository and a web interface to manage all aspects of the shipment of radioactive goods^{iv}, in accordance with these regulations. The RADShip database is part of CERN’s overall management system for the shipping of dangerous goods.

The development of RADShip started in 2005. Initially, a homemade application based on a “Frontpage” database was implemented to study the suitability and the requirements of a user-friendly database for durable, daily operation. This tool was extensively used between 2005 and 2008 and the main requirements for an advanced database were identified. In 2008, the final specifications were defined and in April 2008 an order was placed for the next generation RADShip database. In August 2008, the first prototype was ready for testing, and after a short trial period the final system was declared operational in January 2009. RADShip provides a central database repository and web interface to manage all aspects of the shipment of radioactive goods.

RADSHIP, THE TOOL:

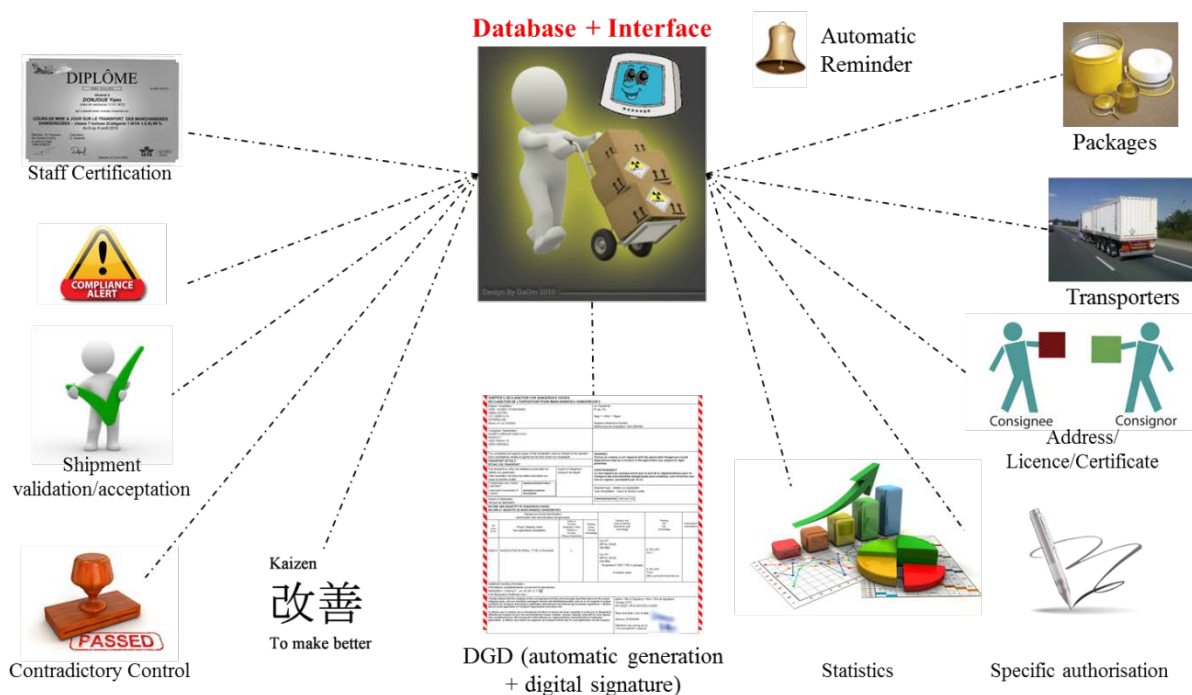


Figure 4 : Main features and functionalities of RADShip

For a non-registered user, the web interface permits to:

- list authorized institutes for exportation/importation to and from CERN
- register new institutes/transporters
- submit an importation of radioactive material
- validate an institute/transporter address modification
- upload a license/certificate

For a registered user and according to access rights, the web interface permits to:

- Manage institutes/transporters
- Manage exportation/importation
- Manage non compliances and “kaizen section”
- Sign the Dangerous Goods Declaration
- Approve/Refuse a shipment
- View non compliances

Institutes/Transporters:

The Institutes and transporters are registered in the database with all associated metadata like name, address, contact, private comment, etc... A link is provided to the CERN Electronic Data Handling system which deals with the logistical aspects of the shipment.

A separate part is dedicated to the license/certificate delivered by the national authorities and stating that the institute/transporter is allowed to export, import, handle, work or transport radioactive material or sources. The issue date and expiration date as well as the renewal date are used for the automatic notification process which sends a reminder to the assigned Radiation Safety Officer once the license/certificate has expired and at least every two years. A secured URL valid for 30 days is provided to the institute/transporter contact who should validate or update the data related to the license. If no answer is received, 2 reminders are sent. After three unsuccessful reminders (minimum 3 x 7 days), the license/certificate is changed to “inactivated status^{vi}”, which can be changed back to alive afterwards when the institute has validated/updated the information.

Finally, comments are added to the history and all actions are traced with actions and a login name.

The form is titled "To be approved" and is divided into several sections:

- Institut**: InstitutID, Name, Address, Zip code City, Country (SWITZERLAND), Phone, Fax, Web.
- RSO (Radiation Safety Officer) or Contact Person (if not Radioactive)**: First name RSO, Last name RSO, Email RSO, Phone RSO, Mobile phone RSO, Fax RSO.
- Various**: Emails to notify (separated by a semicolon), User comment, Exempted/Not Restricted (checkbox), Is a transporter (checkbox), Supplier code, Private comment.
- Certificate**: ID Certificate, Issue date (DD/MM/YYYY), Expiration date (DD/MM/YYYY), Last renewal date (DD/MM/YYYY), Restrictions (checkbox), Restrictions comment, Licence/Certificate (Browse...), Other file (short translation, ...) (Browse...), Last recall, Recall number.
- History - Comments**: A large text area for recording actions and comments.

At the bottom of the form are "Ok" and "Cancel" buttons.

Figure 5 : Institutes and transporters form

Exports:

Exports are dynamically linked to institutes already registered in the database. Exports can be linked to an inactivated institute/transporter but it is not possible to send the parcel without updating the missing or erroneous data. The consignor and consignee are selected in the CERN database, and this automatically updates the corresponding field accordingly, adding the Email address of the notified person. Several transport modes can be selected, whilst only ADR and IATA will provide a Dangerous Goods Declaration, unless it is an excepted, not-restricted or exempted consignment. Two fields can contain a file: one for gamma spectrometry results and one for the calculation results for classification purposes. It is possible to link an export with an import, provided the material to be shipped has previously been received. The shipping details are the data which will be used for establishing the Dangerous Goods Declaration (IATA or ADR). To fill in data, knowledge of IATA/ADR is mandatory and required by legislation beforehand. All kinds of classifications can be handled by the system, provided the users have the minimum necessary knowledge. Specificities like nuclear material are handled through a specific field and authorization. The packages are registered in the database and can be selected from a drop-down list providing all the information related to the package; from internal dimensions to maximum weight as well as permissible content, expiration date, certificate, etc... The maintenance and certificate for each package is checked for each shipment, and a reminder is sent 3 months prior to the expiration date.

Overpack is also part of the feature provided by RADShip, but limited to one overpack.

The screenshot displays the 'Exportation document' form in the RADShip system. The form is organized into several key sections:

- Exportation document:** Contains fields for 'ID document', 'Submitted on' (03/08/2013), 'Sender/Consignor' (with a 'Choose' button), 'Cargo Aircraft Only' (checkbox), 'Radioactive (ORaP)' (checked), and 'Content Description'. It also includes 'EDH No', 'Transportation Mode' (Air, Sea, Road, Rail), 'Consignee/Addressee' (with a 'Choose' button), 'Emails to notify', 'Experiment', 'File RP' (with a 'Browse...' button), and 'ID Importation'.
- Shipping details:** Includes 'UN', 'Dangerously Class (Subsidiary Risk)' (7), 'Packing Group', 'Quantity and type of packing', 'Packing Category', 'Transport Index' (0.0), 'Package', 'Packing Size', 'Weight', and 'Package description'. It also features 'ID Shipping detail' with fields for 'Fissile Excepted', 'Exclusive Use Shipment', 'Authorization', 'Dose Rate contact parcel', 'Dose Rate at 1m parcel', 'Dose Rate 10cm material', 'All packed in', 'CSI', 'INB No' (with 'Add New' button), and 'Source(s)' (with 'Add New' button). 'Ok' and 'Cancel' buttons are at the bottom right.
- Nature and Quantity of Dangerous Goods:** A table with columns: ID, UN, Proper Shipping name, Class or Division (Subsidiary Risk), Packing Group, Quantity and type of packing, Packing Inst., Authorization. Below the table are fields for 'Overpack Used', 'Overpack package', 'Overpack Size', 'Overpack Weight', 'Dose Rate contact overpack', 'Dose Rate at 1m overpack', 'Line Comment', and 'Carriage in accordance with 1.1.4.2.1'.
- Other:** Includes 'Risk of contamination' (with a warning message), 'Handling Information' (FOR RESEARCH PURPOSE ONLY), 'Emergency Contact' (EMERGENCY CONTACT outside USA and inside USA), 'INB Material' (No), 'BNM authorization' (BNM authorization needed), 'Signature and Date' (Place and Date: Geneva, 03 August 2013; Signatory; Signed checkbox), 'Radiological Informations' (Source(s), Spectro Number, Isotopes / Activities), 'Processing' (Contractor, Supervisor, Contradictory control, Control date), 'Non Compliances' (table with columns: Type, Date, Description, Regulatory reference, Followup date, Followup), and 'Kaizen' (table with columns: Date, Problem observed, Followup date, Followup).
- History - Comments:** A large empty text area at the bottom for recording shipment history.

Figure 6 : Export form

The 'other' part deals with the various details for the consignee, used in the generation of the automatic Email, as well as the Host State's authorization and the authorization for basic nuclear material.

The signature and date is reserved for generating the IATA and ADR Dangerous Goods Declaration, preventing the signatory from proceeding without a valid diploma. The validity is checked for each shipment, and a reminder is sent 3 months prior to the expiration date.

The radiological part concerns all measurements performed on the material, from gamma spectrometry to the results of the contamination measurements. Finally, the contradictory inspection, non-compliance and "kaizen" can also be logged for each shipment and a comment box is provided.

Imports:

The import form is similar to the one for exports, except that many fields have preselected values or a drop-down list. This is for essential information concerning the consignor, consignee, contents of the parcel as well as detailed information on the parcel, providing enough information to the RP Service to recover the radioactive material inside the parcel without taking unnecessary doses. The transporter is usually filled in at a later date, once the shipment process has started and after Radiation Protection approval.

Other fields provide additional details; for example the foreseen duration of use at CERN, a field for notifying any involved party, and another field for the Dangerous Goods Declaration to be attached or any other file of interest.

AUTOMATIC MECHANISM:

Multiple mechanisms are in place to simplify the task, prevent errors and enhance the users' experience.

Automatic reminders and notifications:

This mechanism simplifies the management of packages by providing advanced notification warnings 3 months before maintenance and/or the certificate's expiration date. The same applies to the license/institute/transporter registration which is systematically checked every 2 years or before the license's expiration date. Correct training of the staff is ensured by checking the validity for each person registered in the database and sending an Email 3 months prior to the certificate's expiration date.

Importation document (institute/company -> CERN) (Class 7)

Contact (sender)

First name

Last name

Email

Sender/Consignor

Sender/Consignor

First name

Last name

Phone

Email

Consignee/Addressee

CERN final addressee

First name

Last name

Phone

Email

Final destination at CERN

Contents of the parcel

Content Description

Isotopes and Activities with dates

Dose rate (corresponding date and distance)

Contamination risk

Nature

Sealed source / ISO classification

Parcel

UN

Packing Category

Transport Index

Fissile Excepted

Number of Package

Package size

Package weight

Transport

Transporter Existing New

Transportation Mode Air Sea Road Rail

Foreseen arrival date (DD/MM/YYYY)

Handling Information

Vehicle Driver

Vehicle Plate number

Other

Emails to notify (separated by a semicolon)

Foreseen duration of use at CERN (months)

Additional information

ID Exportation

Dangerous Goods Decl. or any other file of interest

At the end of use of the source/radioactive material at CERN, I will take care of the elimination of the source/material at my institute/company.

I agree*

Figure 7 : Import form

Lastly, an alert is displayed whenever an import/export uses a combination of transporter/institute which has already shown a non-compliance during any previous shipment.

LOCKING MECHANISM

In order to minimize errors and to fully meet regulatory requirements, some locking mechanisms have been implemented. It is not possible to:

- sign a DGD without a valid diploma
- use a package without a valid certificate and/or valid maintenance
- send a parcel without consignee electronic approval (all required information)
- send a parcel without a valid certificate/license for the institute's consignee
- send a consignment with missing data (radiological information, ...)
- send/accept a radioactive consignment without adequate/specific authorization

QUALITY ASSURANCE, TRACKING:

All actions are stamped with the date and time in the database, as well as the username and the actions performed. Based on the same principle, each authorization, signature and Email notification is recorded.

EXPORT FLOW:

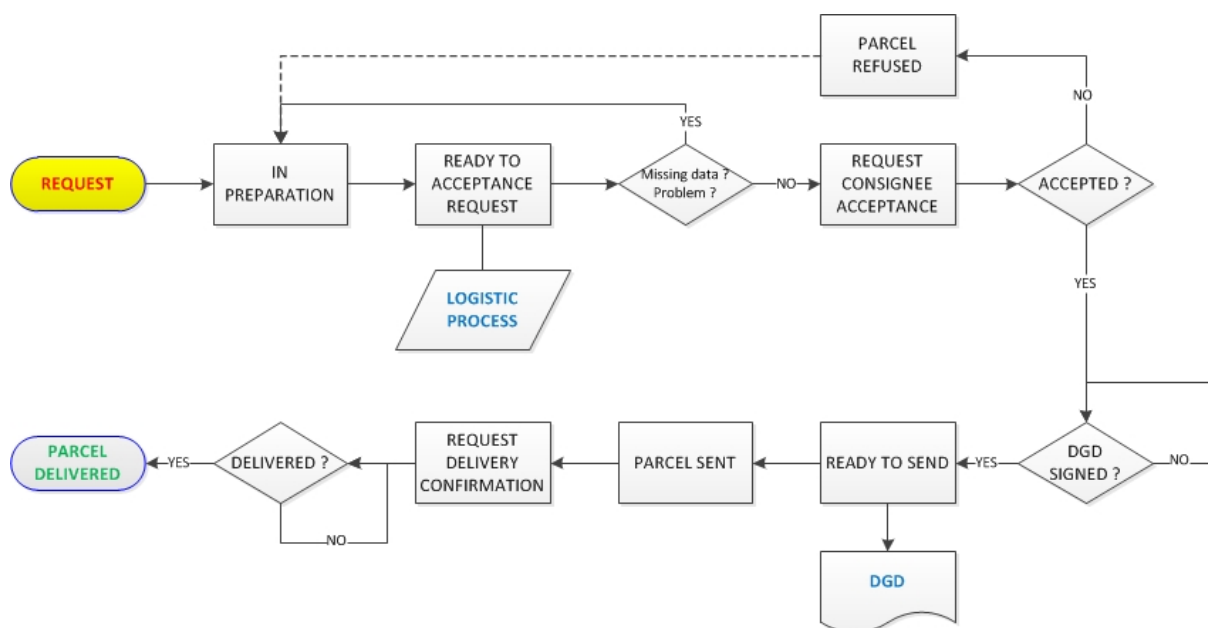


Figure 8 : simplified flow-chart which gives an overview of the document's status during the export process

IMPORT FLOW:

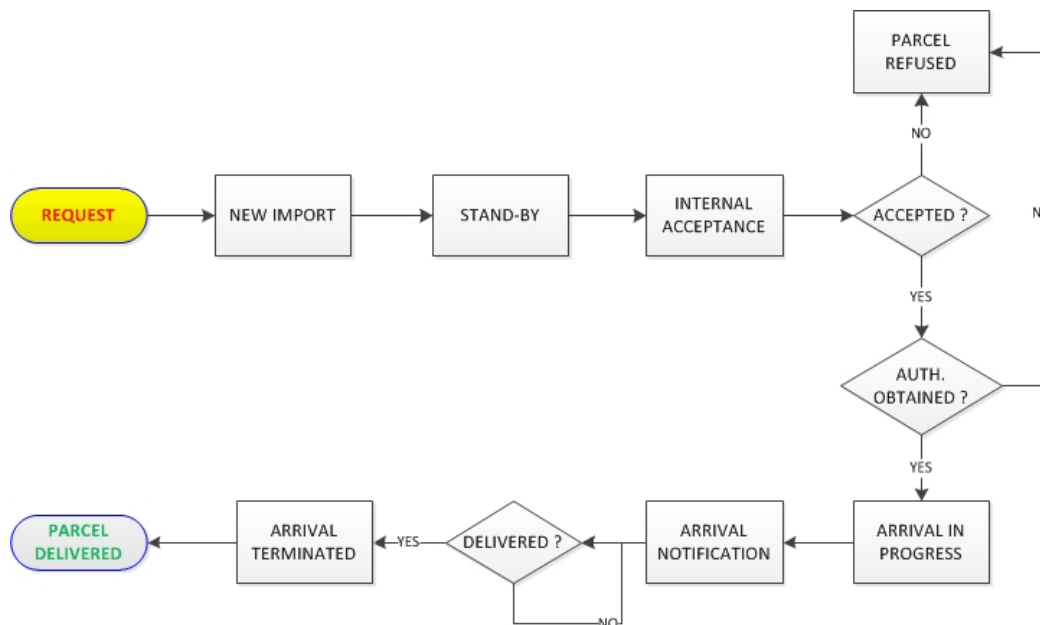


Figure 9 : simplified flow-chart which gives an overview of the document's status during the import process

CLASSIFICATION:

For package classification purposes and calculating the radiological characteristics for the shipment of radioactive material in accordance with ADR/IATA/IAEA transport regulations, the IAEA Transport Code is not very easy to understand. To address this problem a software tool called e-Ship (electronic shipment) was developed at CERN to assist in the classification of packages for the large number of radioactive sources annually transported by CERN. To make this software tool even more user-friendly, versatile, resilient and widely available, in 2012 CERN granted Nucleonica GmbH permission to transform its e-Ship software into a modern web-based application within the Nucleonica nuclear science portal (www.nucleonica.com). This new web-based application, e-Ship++, allows the user to

e-Ship: nuclear material transport report

Transport report generated for source: SHP11525.txt by magill on Aug 03, 2013 10:15:10
 Package name: SHP11525.txt
 Description:
 Source: Material, Other form, Solid
 Host material mass: 1 g
 Activity reported: Aug 03, 2013 08:15:08
 Subsidiary risk
 Chemical form:
 For the definition of the quantities used in this report see the [Nucleonica Glossary](#)

Source characterisation

| Nuclide | Half-life | Activity (Bq) | Heat (W) | Ambient dose rate H ₁₀ (µSv/h) at 10 cm | F _{ing} (mSv) | F _{inh} (mSv) | A(Bq)/LE(Bq) | A(Bq/kg)/LE(Bq/kg) | A(Bq)/LA(Bq) | Radioactive contents | Notes |
|-----------------|-----------|----------------|----------------|--|------------------------|------------------------|----------------|--------------------|----------------|----------------------|-------|
| Ba-140 | 12.765 d | 1.81e+6 | 1.42e-7 | 5.61e+0 | 4.71e+0 | 1.05e+1 | 4.53e+2 | 4.53e+5 | 6.03e-1 | (βγ) | a,b |
| K-40 | 1.26 Gy | 3.30e+5 | 3.22e-8 | 7.26e-1 | 2.05e+0 | 6.93e-1 | 1.65e+2 | 1.65e+5 | 1.65e-1 | (βγ) | |
| La-140 | 1.6785 d | 1.34e+6 | 6.11e-7 | 4.45e+1 | 2.68e+0 | 1.47e+0 | 2.68e+2 | 2.68e+5 | 4.47e-1 | (βγ) | |
| Total: 3 | | 3.48e+6 | 1.26e+0 | 7.85e-7 | 5.08e+1 | 9.43e+0 | 1.27e+1 | 8.86e+2 | 8.86e+5 | 1.22e+0 | |

(a) A₁ and/or A₂ values include contributions from daughter nuclides with half-lives less than 10 days.
 (b) Parent nuclides and their progeny included in secular equilibrium

Package characterisation

| Nuclide | Activity (Bq) | A ₂ (TBq) | Exempt (Bq) | Exempt (Bq/g) | Excepted (GBq) | A ₂ | A | A(Bq/g) | A |
|-----------------|----------------|----------------------|-------------|---------------|----------------|----------------|----------------|----------------|----------------|
| | | | | | | Exempt | Excepted | Exempt(Bq/g) | Excepted |
| Ba-140 | 1.81e+6 | 3.00e-1 | 1.00e+5 | 1.00e+1 | 3.00e-1 | 6.03e-6 | 1.81e+1 | 1.81e+5 | 6.03e-3 |
| K-40 | 3.30e+5 | 9.00e-1 | 1.00e+6 | 1.00e+2 | 9.00e-1 | 3.67e-7 | 3.30e-1 | 3.30e+3 | 3.67e-4 |
| La-140 | 1.34e+6 | 4.00e-1 | 1.00e+5 | 1.00e+1 | 4.00e-1 | 3.35e-6 | 1.34e+1 | 1.34e+5 | 3.35e-3 |
| Total: 3 | 3.48e+6 | | | | | 9.75e-6 | 3.18e+1 | 3.18e+5 | 9.75e-3 |

Exempt Package

The total dose rate at surface should be < 5µSv/h; **WARNING:** calculated ambient dose rate at 10 cm = 5.08e+1 µSv/h. If the surface ambient dose rate is ≥ 5µSv/h you should use a Type A package.

[PDF report](#)

Figure 10 : e-Ship++ report, screen capture

estimate the radiological impact of the shipment in the event of the release of radioactivity into the environment. For this purpose, data such as the inhalation dose, ingestion dose, external radiation dose (e.g. ambient dose equivalent rate, etc.) are provided. The program has been extended for daily use in the field of radiation protection for estimating additional quantities such as the authorization limit, exemption limit, etc. After intensive beta testing, a stable working version became available in mid-2012. The tool is currently undergoing further development to allow decay calculations taking daughter products into account.

The screenshot shows the main interface of the e-Ship++ web application. At the top, there is a navigation menu with options like 'Applications', 'Data', 'Knowledge', 'My Preferences', 'Print', 'Networking', 'Nuclear Science', 'Help', and 'New Browser Tab'. The page title is 'e-Ship++ radiological transport assistant'. Below the title, there are several tabs: 'My Packages', 'Edit', 'Options', 'Decay', 'Import', 'Activity limits', 'CERN file', 'Sample packages', and 'About e-Ship'. The main content area contains a form for entering shipment details, including fields for 'Name (new)', 'Chemical form', 'Description', and 'Activity reported'. To the right of the form, there are 'Package characteristics' options for 'Content' (Material, Instruments / Articles), 'Form' (Other, Special), and 'State' (Solid, Liquid, Gas). Below the form is a table of radionuclide data with columns for Nuclide, Activity A (Bq), Mass (g), Half-life, A₁ (TBq), A₂ (TBq), Excepted (GBq), Exempt (Bq), Exempt (Bq/g), A/A₂, A/Excepted, and A (Bq)/Exempt(Bq). At the bottom, there is a table with columns for Element, Mass, Property, Quantity, and Unit, with a dropdown menu for the unit (Becquerel) and an 'Update' button.

| Nuclide | Activity A (Bq) | Mass (g) | Half-life | A ₁ (TBq) | A ₂ (TBq) | Excepted (GBq) | Exempt (Bq) | Exempt (Bq/g) | A/A ₂ | A/Excepted | A (Bq)/Exempt(Bq) |
|----------|-----------------|----------|-----------|----------------------|----------------------|----------------|-------------|---------------|------------------|------------|-------------------|
| K-40 | 3.03e+5 | 1.16 | 1.26 Gy | 0.9 | 0.9 | 9.00 | 1.00E+06 | 1.00E+02 | 3.37e-7 | 3.37e-5 | 0.303 |
| Ba-140 | 1.81e+6 | 6.69e-10 | 12.765 d | 0.5 | 0.3 | 3.00 | 1.00E+05 | 1.00E+01 | 6.03e-6 | 6.03e-4 | 18.1 |
| La-140 | 1.34e+6 | 6.51e-11 | 1.6785 d | 0.4 | 0.4 | 4.00 | 1.00E+05 | 1.00E+01 | 3.35e-6 | 3.35e-4 | 13.4 |
| Total: 3 | 3.453e+6 | 1.160e+0 | | | | | | | 9.72e-6 | 9.72e-4 | 31.8 |

Figure 11 : e-Ship++ main interface, screen capture

TECHNICAL AND FINANCIAL ASPECTS:

The database relies on an ORACLE Server and the web interface has been developed using ASP.NET V2 technology. The interface is available worldwide, with any browser and is compatible with smartphones and tablets.

The total budget paid by CERN is around 70'000 US \$. The implementation of RADShip at any company or institute is estimated to take 1 man-month full-time (set-up, installation and customization).

CONCLUSIONS:

Since 2008 RADShip has been extensively and successfully used at CERN for managing radioactive shipments. It provides a reliable and resilient system with many QA features, automatic notifications and reminders, as well as ensuring complete traceability. It replaces paperwork by electronic data and manual phone calls by automatic Email notifications.

The tool provides a solution to the legal requirements, improving the efficiency and reliability of the service whilst saving time, ensuring reactivity and decreasing potential errors.

The implementation at another company or institute can be done easily and the required resources are estimated to be ~ 1 person for one month full-time (installation/customization).

ACKNOWLEDGMENTS:

I would like to thank my Group Leader Dr. D. Forkel-Wirth, who supported me in this project, our secretary J. Madden for the last minute cross-check and the Consultant G. Françon who was always willing to improve the interface and had a clear understanding of the problematic involved.

ANNEXES – Automatic Notification to consignee

From: Logistics Service
Sent: Tuesday, 14 May 2013 11:44
To: u.zimmermann@psi.ch
Cc: g.fahlguth@amg.rse@psi.ch
Subject: [RADSHIP-EXPORT] ID#323 ACCEPTANCE REQUEST / (CERN --> "Paul Scherrer Institut" - SWITZERLAND)

--> Attention, this mail requires an urgent response on your behalf <--

Dear Ulrich Zimmermann,

A parcel containing the following material must be dispatched to "Paul Scherrer Institut" from CERN. ONLY YOUR ACCEPTANCE to receive the material described below will allow the shipment of the parcel. Please respond by filling in the form at the following URL:

[Click to accept or refuse the arrival](#)

Logistic information:

- please note material will be shipped with CERN S2 packaging, it must be given back to carrier after unloading

Summary of the material being shipped:

Exportation ID #323

Submitted on (DD/MM/YYYY): 23/04/2013

SENDER/CONSIGNOR (CERN)
CERN - CHRISTOPH SEIFFERT
MailBox C24508
1211 GENEVA 23
SWITZERLAND
Phone +41 76 467 8728

**CONSIGNEE/ADRESSEE
(Institute / Company)**
PAUL SCHERRER INSTITUT
ATTN ULRICH ZIMMERMANN
DEPARTMENT RADIATION SAFETY AND SECURITY
GROUP HAZARDOUS GOODS SHIPMENTS
OFIC/10188
5232 VILLIGEN PSE
SWITZERLAND
PHONE +41 56 310 42 62

Global data

Radioactive Material (ORaP)? Yes
General description: ISOLDE T1-44 target
Transport type: Road
Cargo Aircraft? No
CERN EDH reference: [5276932](#)
Experiment: ISOLDE

Nature & Quantity of Goods

UN2915, RADIOACTIVE MATERIAL, TYPE A PACKAGE, Class 7
T1-44, METAL SOLID,, 1 TYPE A PACKAGE > 37.3 MBq,
II-YELLOW / TI 0.9
Package ID "CNMO S2 #223 (Road)"
Dim (L)54x(W)49x(H)47 cm
Weight: 42 kg
Sources: [4578](#)
Dose Rate contact parcel : 350 uSv/h
Dose Rate at 1m parcel : 9 uSv/h
Dose Rate 10cm material : 250 uSv/h

Overpack: No
Comments: -

Handling information: Loading, stowage and carriage conform to ADR. No supplementary requirements necessary as per ADR 5.4.1.2.5.2a.
EMERGENCY CONTACT: +41 22 767 3171
Name: [CHRISTOPH SEIFFERT](#)

Radioactive contamination Risk

Irradiated material / ISOLDE target
HIGH risk of contamination
Contamination may occur, take appropriate action to open the material

Radiation Protection information

(26/04/2013 - DD/MM/YYYY)

Activities [Bq]

T1-44 / 3.57E+07
T1-44 / 3.57E+07

Total activity (26.04.2013 08:00): 3.72E+07 Bq

Material controlled by radiation protection group (service-tp-shipping@cern.ch / Tel +41 22 767 3171).

Radioactive as per swiss legislation (ORaP 814.501 - Janv. 2013) - Art. 1 (1) - Annexe 2 (1) / Annexe 3

Spectrometry Reference: -

!WARNING!! These activity figures only refer to the parcel as a whole, for transportation purpose only.

Concerning the surface of the parcel, beta/gamma contamination and alpha emitters of low toxicity are below 4 Bq/cm², contamination for all other alpha emitters is below 0.4 Bq/cm².

For addressee: Please inform the Radiation Protection Group in your institute upon arrival of this package. They will give you more complete information on handling this material and precautions for its disposal.

If this e-mail reaches you by mistake, please forward this email to your institute's RSO (Radiation Safety Officer).

For all information concerning the contents of the parcel, please contact the sender directly.

For any radiological information, please contact: service-tp-shipping@cern.ch (Phone +41 22 7673171 / Fax +41 22 7648300).

For any logistic information, please contact: Logistics.Service@cern.ch (Phone +41 22 7674186 / Fax +41 22 7678546).

Yours sincerely,

Logistics.Service@cern.ch

Tel +41 22 7678546

Fax +41 22 7678546

<http://cern.ch/service-logistics/>

@utomatic email generated by RADSHIP database (Radioactive Shipping & Logistic database).
RADSHIP

REFERENCES:

- [1] Induced Radioactivity in and around High Energy Accelerators, H. Vincke, C. Theis, S. Roesler, Radiation Protection Dosimetry 2011, p.1
- [2] TREC: Traceability of Radioactive Equipment at CERN, M.P. Kepinski, L. Bruno, Ch. Delamare, S. Mallon Amerigo, P. Martel, S. Petit, T. Schmittler, M.J.S. Tavlet, D. Widegren, CERN, [EDMS 1272623](#)
- [3] Regulations for the Safe Transport of Radioactive Material, 2012 Edition, SSR-6, IAEA
- [4] Ordonnance sur la radioprotection (ORaP) du 22 Juin 1194, état du 1^{er} janvier 2013, OFSP
- [5] UN Recommendations on the Transport of Dangerous Goods, Model regulations, 2013 Edition, UNECE
- [6] European Agreement concerning the International Carriage of Dangerous Goods by Road, 2013 Edition, ADR
- [7] Code of Federal Regulations 49, Transportation, 2013, US Government
- [8] Technical Instructions for the Safe Transport of Dangerous Goods by Air, 2013-2014 Edition, ICAO
- [9] Dangerous Goods Regulations, 54th Editions 2013, IATA
- [10] Electronic Data Handling System, CERN, <https://edh.cern.ch>
- [11] Enterprise Resource Planning (ERP) Management Solution, Qualiacc, <http://195.6.221.123/us/>

RADShip, application developed by Hexperit, G. Françon, gf@hexperit.ch
<https://cern.ch/radship>

ⁱ Exempted material as per IAEA paragraph 214 and 236:

- contamination is below 0.4 Bq/cm² on a surface for beta and gamma emitters and low toxicity alpha emitters or 0.04 Bq/cm² for all other alpha emitters
- activity concentration and total activity in the consignment does not exceed the values specified in paragraphs 402–407 [2])

ⁱⁱ Not restricted material as per IAEA paragraph 107 item f: “Natural material and ores containing naturally occurring radionuclides, which may have been processed, provided the activity concentration of the material does not exceed 10 times the values specified in Table 2, or calculated in accordance with paragraphs 403(a) and 404–407. For natural materials and ores containing naturally occurring radionuclides that are not in secular equilibrium the calculation of the activity concentration shall be performed in accordance with paragraph. 405.”

ⁱⁱⁱ Non-radioactive material according to gamma spectrometry measurement and alpha/beta contamination measurements, showing no artificial radioactivity above minimum detection limit.

^{iv} Excluding the logistical aspects which are managed by a separate Enterprise Resource Planning (EPR) system called EDH [10] and QUALIAC [11]. EDH is an Electronic Document Handling application which provides a multilingual, web-based intelligent solution to CERN's business processes, providing a fast, efficient and streamlined organization-wide electronic workflow. Qualiacc is a specific logistic and financial tool, providing an integrated solution for emitting transport documents, pro-forma invoices, exportation declarations and labeling, all the necessary documents to perform the shipment.

^v Kaizen is the Japanese term for "improvement" or "change for the better", used by the CERN shipping service for radioactive goods for continuous improvements (each non-performance is logged and a modification is proposed).

^{vi} Under inactive status further shipments are not permitted until the data are updated.