Nuclear & Radioactive transport on Energy & Health Campus

Radioactive Isotopes

NRG PALLAS

Nuclear. For Life.

28-4-2025

<u>Unique Nuclear Infrastructure – NRG PALLAS</u>





High Flux Reactor (HFR)



Hot Cell Laboratories (HCL)



Molybdenium Production Facility (MPF)



Decommisioning and Waste Treatment Facility (DWT)



Radiological Laboratory Jaap Goedkoop Lab - JGL



NRG PALLAS - Fieldlab

Production of approved medical isotopes

Production of innovative Isotopes:

The demand for personalized 'nuclear medicine', for the treatment of cancer and cardiovascular diseases, is growing and *that* is why we focus on developing and adapting the production-chain of existing *and* new radiopharmaceutical products

<u>A selection from the many isotopes produced at NRG PALLAS in</u> <u>Petten:</u>

Molybdenium⁹⁹ Holmium¹⁶⁶

Iridium¹⁹²

Strontium⁸⁹

– For medical use (therapy) - treatment

– For medical use (therapy) - diagnostics

- Lutetium¹⁷⁷ (CA and NCA) For medical use (therapy) treatment
 - For industrial use and medical use (therapy)
 - For medical use (Pain relief in bone cancer)







On-Site, 'Transport & Logistics' team

Establishment of the 'transport & Logistics' department

- Before April 2020, transport-handlings were done by common reactor- and LAB-operators, and internal transport was outsourced.
- After April 2020, NRG PALLAS started their own transport organization.

The goals for starting this departement:

- To handle internal transports for NRG CURIUM.
- To manage all logistics with a dedicated team.
- To ensure smooth operations with a highly experienced logistics team.
- To reduce logistical errors.







Number of transports carried out each year

Average of 15 on-site transports each working day (24/7) Average of > 600 * external transports with loaded packages Mostly Type A, Type B(U)- packages and Type B(U)F Average of > 200 in-coming loaded packages Mostly Type A and B(F) & Full IP(F)-Package

* Note: The number of transport is increasing rapidly each year









B(U)F - Package

B(U) -Package

28-4-2025 5



Initial results of starting our dedicated logistics team

Because of ...

- Dedicated workers in 'Transport and Logistics' jobs
- More experienced and trained logistics workers
- Increased focus on logistics

Initial result:

A decrease of deviations each year by solving all possible issues at a basic level

- M.A.R.S. Notification System
- Registrations for (latent) deviations within NRG PALLAS

Still challenges to deal with:

- Addressing human errors
- Even though workers operate in pairs, human errors can still occur
- Routine experience may lead to overlooking small details







Training of employees for 'transports & logistics'



Number of directly trained persons: 18

Types of training:

- 5 Dangerous Goods Safety Advisors for advising NRG PALLAS on transport topics
- 18 persons ADR certified (minimum for general and class 7) for road transport
- 12 persons IATA trained for air transport
- 3 persons IMDG trained for sea transport
- 3 persons trained as Security Managers for airfreight,
- All persons involved in transport and logistics are trained and certified as 'radiation protection workers' under Dutch law.

In addition to this:

• All persons involved in transport (± 80), including common operators, an awareness training transports





Yearly increasing of external transport movements



Increase transports of isotopes usable for medical purposes each year

• In the years between 2013 and 2024, an increase by 1000% of external transportation has taken place.

Modality of transport

- Mostly in Type B packages
- Mainly by road and air

By air:

• From airports in whole Europe throughout the world.

What types of deviations occurred?

Human Errors:

- Incorrect information in documentation
- Documentation not matching labels and markings



• Last-minute process changes causing errors in package handling documentation

Actions Taken:

- Trained all workers to be aware of these potential errors
- Developed transport and logistics software that automatically adapts to changes and updates documentation
- Automated labels and markings linked to actual values in the process (e.g., dose rates, category, Ti, nuclides, activities, etc.)

Transport accidents:

• Fortunately, no (mayor or minor) accidents have occurred in the past two decades

Impact of increased transports on workers

Due to the increased of transports:

- The number of workers increased
- The annual dose, initially increased, because of more transports
- In 2021, we focused more on reducing doses

Result:

• The annual dose per worker decreased, yearly...





Some examples of protection measures applied



Protection measures applied:

- Rollable rain covers, to reduce the handling time in case of 'bad weather' (rain, snow).
- Pins to secure packages (prevent sliding), stowed with lashing belts (easy and fast tightening)





Protection measures applied, to reduce dose rates



- Providing in a 'long distance' between the loaded package and the driver of the Truck
- Purchase and development of 'new packages' with more shielding and which are easier to handle (less contact with radiation for the workers)
- Adding 'removable shielding' during preparing of packages, with high dose rates, for transport
- 'High-dose logistics activities' are in general distributed among several workers
- The ALARA principle is applied to all transport related handlings
- If a worker is unsure whether things are going well during work, the STAR principle is used to correct this (STAR: Stop, Think, Act, Review)
- Dose-rate prediction are made before all logistics handling
- Risk assessment conducted before common and special logistics work
- Risk evaluation conducted after the work

Risk assessment matrix



On site transport of bulk radioisotopes

Packages used for internal transport

- Current packaging is 7340 kgs and has 18 cm of lead-shielding.
- In future: replacement by 3500 kgs 22 cm lead- shielding.











On site transport of waste

Currently used packages for waste disposal on-site

• Waste - package (W-container)

NOTE:

 Keep in mind → More package to send means more packages on-site and more waste transports on- and of-site





End note:

"Remember, reducing the dose for everyone involved in transport and logistics requires continuous effort. Always look for better ways to lower the dose for the workers."

Any questions left?

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