orano

Test Instruction

Contamination and Dose Rate Measurements at the DN30-X Package

0045-PA-2021-002 Rev. 1

Prepared	Checked	Released
S. Fels	Y. van Wijk	M. Hennebach
DocuSigned by: S. Fels 02835D40D9DA498...	DocuSigned by: Yara van Wijk DAB62D815D30426...	DocuSigned by: Maik Hennebach 2E5D80577F834C6...
29.01.2025	12.02.2025	17.02.2025

Table of Contents

List of Revisions

Revision	Date of revision	Modifications
0	28.06.2021	Original
1	17.02.2025	• Change layout to Orano corporate design • Replacement of the term “health physics” with “radiation protection” to avoid possible misinterpretations • Addition of references to 10 CFR 71 and 49 CFR 173 in section 6.1 • Improvement of wording in sections 6.2.2.1 and 6.2.2.2 • Removal of duplicate information • Combination of separate dose rate measurement protocols for different numbers of packages into a single protocol

1 Objective and Scope

The objective of this test instruction is to specify the conditions for the contamination and dose rate measurements at DN30-X packages with UF_6 contents of grade HALEU before transport. This also includes the measurement of the non-fixed contamination at the outer surface of the DN30-X package. This test instruction ensures that the package meets the following regulations for the transport of radioactive material in the version valid at the time of transport:

- Regulations for the Safe Transport of Radioactive Material (IAEA SSR-6),
- European Agreement concerning the International Carriage of Dangerous Goods by road (ADR),
- European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN)
- European Agreement concerning the International Carriage of Dangerous Goods by Rail (RID)
- International Maritime Dangerous Goods Code (IMDG-Code)

2 Other Documents

The primary document to this test instruction is:

- Handling instruction 0045-HA-2021-001 - Use and handling of the DN30-X package

3 Date of Inspection

The measurements are performed on the loaded DN30-X package in accordance with the primary document.

4 Qualification of Personnel

Personnel will be appointed by the radiation protection department of the site where the DN30-X packages are handled, in accordance with their operating authorization and the radiation protection instructions. Personnel must be familiar with the test instruction.

5 Measuring Equipment

5.1 Contamination Measurement Equipment

Contamination measuring instruments must be adequate for performing the measurements. They must be calibrated with adequate test radiation sources, such as Am-241 for α-emitters and Cs-137 or Sr/Y-90 for β–emitters. Calibration must be carried out according to DIN ISO 7503-3 or an equivalent international standard.

Other test radiation sources are acceptable if such test radiation sources are generally used at the site of dispatch and if they are calibrated according to DIN ISO 7503-3 or an equivalent international standard.

The measuring instrument and the measurement method used must be appropriate to measure non-fixed contamination with the following minimal values:

- β– and γ-emitters as well as low toxicity α-emitters

  0.4 Bq/cm²

- All other α-emitters

  0.04 Bq/cm²

The used measuring instruments and their characteristic data are to be recorded in the attached measuring instrument protocol B.1.

5.2 Dose Rate Measurement Equipment

Dose rate measuring instruments must be adequate for performing the measurements, taking into account the type of radiation and the energy spectrum. The instruments must permit the detection of a minimum dose rate of 0.5 μSv/h. Measuring instruments for Gamma dose rates must be calibrated.

The used measuring instruments and their characteristic data are to be recorded in the attached measuring instrument protocol B.2.

6 Measuring Sequence

6.1 Determination of Contamination

Non-fixed contamination shall be determined by means of a wipe test according to DIN ISO 7503-2 or an equivalent international standard, taking into account ADR No. 4.1.9.1.2, IAEA SSR-6 para. 508, or 10 CFR §71.87(i) and 49 CFR §173.443.

Wipe test samples shall be carried out at least in those areas indicated in the attached measurement protocol C.1. Furthermore, wipe test samples have to be taken at all areas where contamination may occur because of loading and handling.

As a rule, the following boundary conditions must be observed:

Requirements for wipe test

Parameter	Requirement
Material for wipe test	Dry, round filter paper
Surface to be wiped	300 cm^2
Removal factor	0.1
Efficiency of the wipe test for beta and gamma emitters	0.5
Efficiency of the wipe test for alpha emitters	0.25

The contamination level is determined using the following formula:

$$A = \frac{n - n_b}{\varepsilon_i \cdot F \cdot S \cdot \varepsilon_s}$$

where

n = counting rate in s^{-1}

n_b = background in s^{-1}

ε_i = response characteristics of the measuring instrument

F = removal factor

S = wiped surface in cm^2

ε_s = efficiency of the wipe test

The measurement results shall be documented using the attached measurement protocol C.1.

The contamination measurement has to be performed before the dose rate measurement.

6.2 Determination of Dose Rates

Transport of packages containing commercial grade UF_6 with an enrichment of max. 5 % in U-235, either loaded or heels cylinders, has been carried out for decades in large numbers. The dose rates at the surface of such packages are on one hand well below the allowable dose rates and on the other hand the distribution of the dose rates is well known by experience.

The dose rates at the surfaces of packages containing a higher enrichment of U-235 are expected to be even lower as the concentration in U-238 is lower. The consideration of ALARA principles calls for the limitation of the number of measuring points for such packages to reduce the overall exposure of the radiation protection personnel.

The dose rate measurements shall be carried out after the contamination measurement.

6.2.1 Measurement of Dose Rates at the DN30-X Package

The dose rates shall be measured and recorded at least at the indicated measurement points 1 to 5 in the attached measurement protocol D.1. The surface measuring point with the maximum dose rate shall be retained as a reference point to determine the dose rate at a distance of 1 m of the package. From experience with UF_6 transport, the point of maximum dose rate at the surface is expected around measurement point 3; however, this has to be verified by the measurement.

The measuring range shall be selected insofar that the display will be in the upper third, if possible. Only gamma radiation is measured because of negligible neutron radiation. Background radiation at the point of measurement shall be subtracted from the measured result.

Neutron radiation is accounted for by multiplying the value of the maximum dose rate after subtracting the background radiation from the measured dose rate by a factor of 1.05.

In case the measurement of the gamma dose rate in 1 m distance (measurement point A1) is not possible because of geometrical constraints (i.e., the DN30-X package is mounted on a flatrack), the gamma dose rate at 1 m distance may be calculated by multiplying the maximum value at the surface with a factor of 0.25.

6.2.2 Measurement of Dose Rates at the Vehicle Loaded with DN30-X Packages

6.2.2.1 Vehicle Loaded with DN30-X Packages Oriented Laterally to the Direction of Travel

In case the vehicle is loaded with DN30-X packages oriented laterally (i.e., sideways) to the direction of travel, the lateral surfaces of the vehicle match the front surfaces of the DN30-X packages. Subject to ALARA principles, the dose rates need not to be measured twice but can be transcribed from the records for the DN30-X packages themselves.

In any case, the dose rate at measurement points 5, 6, 7 and 8 shall be measured and recorded for the surfaces of the vehicle as shown in the attached measurement protocol D.2.

Measurements for points A1, A2, and A3 shall be taken at a distance of 2 m from the vehicle surface at the location of the maximum dose rate on both side and rear surfaces of the vehicle, respectively. Generally, the measurement at 2 m distance at the front of the vehicle is not relevant, as the driver's cabin provides distance and shielding. Instead, measurement point C4 shall be measured and recorded.

6.2.2.2 Vehicle Loaded with DN30-X Packages Oriented Longitudinally to the Direction of Travel

In case the vehicle is loaded with the DN30-X packages oriented longitudinally to (i.e., along with) the direction of travel, the surfaces of the vehicle do not match the surfaces of the DN30-X packages.

The dose rates shall be measured and recorded as indicated in the attached measurement protocol D.3.

Measurements for points A1, A2, and A3 shall be taken at a distance of 2 m from the vehicle surface at the location of the maximum dose rate on both side and rear surfaces of the vehicle, respectively. Generally, the measurement at 2 m distance at the front is not relevant, as the driver's cabin provides distance and shielding. Instead, measurement point C4 shall be measured and recorded.

7 Admissible Limit Value

7.1 Non-Fixed Contamination

The following limit values for non-fixed contamination shall not be exceeded during the transport of the DN30-X package.

Non-Fixed External Radioactive Contamination Limits

Contaminant	Limit value in Bq/cm^2
Beta and gamma emitters and low toxicity alpha emitters	2.0
All other alpha emitting radionuclides	2.0

7.2 Dose Rate

The following limit values for dose rates (including neutron radiation contribution) shall not be exceeded during the transport of the DN30-X package.

Radiation level limitations

Measuring point	Limit value in mSv/h
Package surface	2.0
Exterior surfaces of vehicle	2.0
2 m distance from vehicle	0.1

8 Non-Conformances and Deviations

If values exceeding the admissible limits are found during the check, the procedures given in sections 8.1 and 8.2 shall be followed regarding contamination and dose rate, respectively.

8.1 Contamination

If contamination values exceed the limits, the DN30-X package shall be decontaminated so that the limits are met.

8.2 Dose Rate

DN30-X packages with dose rates exceeding the admissible limits must not be shipped outside the nuclear site.

9 Documentation

Test results shall be documented on the attached forms A.1 to D.3, or in site specific forms and records that contain at least the information required by the attached forms A.1 to D.3.

The attached records B.1 to D.3 have to be signed by the examiner performing the measurements and the person responsible for radiation protection of the site.

The attached test protocol A.1 has to be signed by the person responsible for radiation protection of the consignor and the consignee.

Attachments

Test Protocols

DN30-X Test Protocol A.1: Contamination and Dose Rate Measurements (1 Page)

Measuring Instrument Protocols

Measuring Instrument Protocol B.1: Contamination Measuring Instrument (1 Page)

Measuring Instrument Protocol B.2: Gamma Dose Rate Measuring Instrument (1 Page)

Measurement Protocols – Contamination

DN30-X Measurement Protocol C.1: Measurement of Non-Fixed Contamination (1 Page)

Measurement Protocols – Dose Rates

DN30-X Measurement Protocol D.1: Measurement of Dose Rates – UF_6 Grade HALEU, Filled and Heels Cylinders (1 Page)

DN30-X Measurement Protocol D.2: Measurement of Dose Rates – Vehicle with 1 to 4 Packages in Lateral Direction (2 Pages)

DN30-X Measurement Protocol D.3: Measurement of Dose Rates – Vehicle with 1 to 2 Packages in Longitudinal Direction (2 Pages)

orano

DN30-X Test Protocol A.1

Contamination and Dose Rate Measurements

Protocol no.	Test instruction 0045-PA-2021-002
Consignor/consignee	Plant
Transport date	Reference no.
DN30 PSP ID	Cylinder ID
30B-X cylinder Filled ☐ Heels ☐	Use Exclusive ☐ Non-exclusive ☐

1. Non fixed contamination

Measurements protocol no.		Date	
Measurement areas	**Unit**	**Limit**	**Max. value**
Beta/Gamma-rays and Alpha-rays low toxicity	Bq/cm^2	4.0	
All other Alpha-rays	Bq/cm^2	0.4	

2. Dose rate

Measurements protocol package no.		Date	
Measurements protocol vehicle no.		Date	
Measurement/calculation points	**Unit**	**Limit**	**Max. value**
Surface of package	mSv/h	2	
At 1 m distance from package (only if not under exclusive use)	mSv/h	0.1	
Vehicle surface	mSv/h	2	
At 2 m distance from vehicle	mSv/h	0.1	

Radiation protection			**Consignor**		
Date	Name	Signature	Date	Name	Signature

orano

Measuring Instrument Protocol B.1

Contamination Measuring Instrument

Protocol no.	Test instruction 0045-PA-2021-002
Consignor/consignee	Plant
Transport date	Reference no.
DN30 PSP ID	Cylinder ID
30B-X cylinder Filled ☐ Heels ☐	Use Exclusive ☐ Non-exclusive ☐

General information

Type	Serial no.
Manufacturer	

Calibration source

Nuclide	Radiation type
Designation	Current activity N(t)
Activity on reference date N(0)	

Measuring instrument data

Responsiveness for alpha-radiation
Responsiveness for beta-radiation
Calibration date

Comments

Tester			Radiation protection		
Date	Name	Signature	Date	Name	Signature

orano

Measuring Instrument Protocol B.2

Gamma Dose Rate Measuring Instrument

Protocol no.	Test instruction 0045-PA-2021-002
Consignor/consignee	Plant
Transport date	Reference no.
DN30 PSP ID	Cylinder ID
30B-X cylinder Filled ☐ Heels ☐	Use Exclusive ☐ Non-exclusive ☐
General information	
Type	Serial no.
Manufacturer	
Official calibration	
Calibration certificate no.	
Date	Validity
Measuring instrument data	
Dose measuring range in mSv/h	
Energy range in keV	
Tolerance in %	
Comments	

Tester			Radiation protection		
Date	Name	Signature	Date	Name	Signature

orano

DN30-X Measurement Protocol C.1

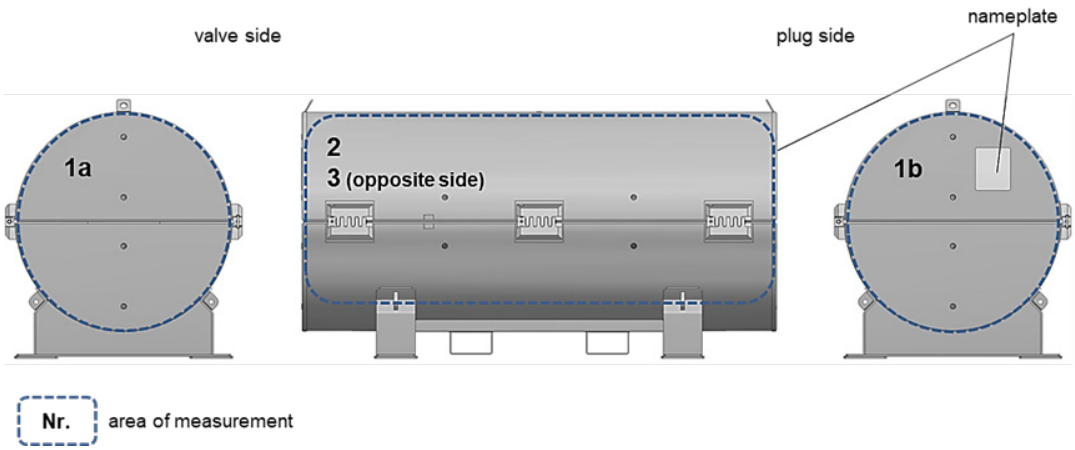
Measurement of Non-Fixed Contamination

Protocol no.	Test instruction 0045-PA-2021-002
Consignor/consignee	Plant
Transport date	Reference no.
DN30 PSP ID	Cylinder ID
30B-X cylinder Filled ☐ Heels ☐	Use Exclusive ☐ Non-exclusive ☐

General information

Instrument serial no.	Last calibration date
Wipe material dry ☐ wet ☐	Medium
Responsiveness alpha-radiation	beta-radiation

Measurements



Measuring area	Beta and Gamma (max value)				Alpha (max value)			
	N s^{-1}	N_0 s^{-1}	N-N_0 s^{-1}	Bq/cm^2	N s^{-1}	N_0 s^{-1}	N-N_0 s^{-1}	Bq/cm^2
1 (a+b)								
2								
3								

Measuring duration

Tester		Radiation protection		
Date	Signature	Date	Name	Signature

orano

DN30-X Measurement Protocol D.1

Measurement of Dose Rates

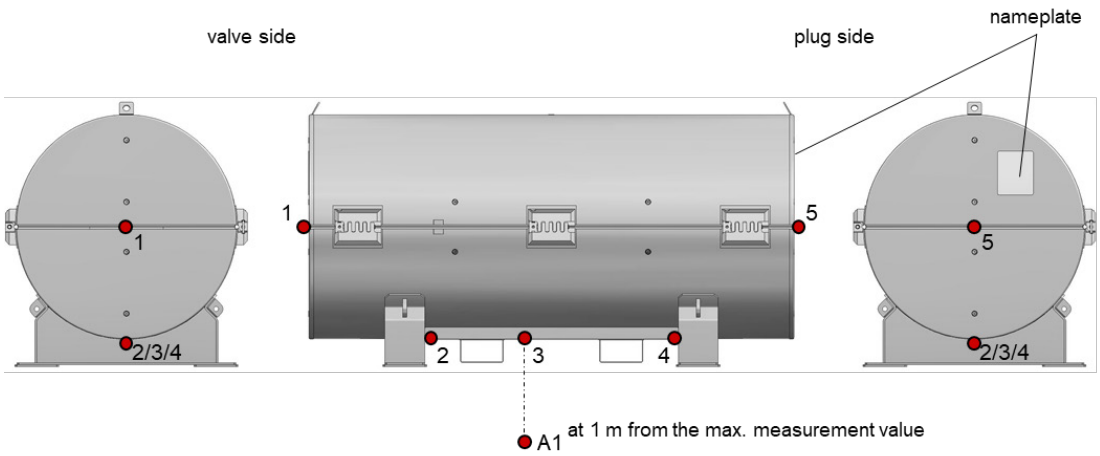
UF_6 Grade HALEU, Filled and Heels Cylinders

Protocol no.	Test instruction 0045-PA-2021-002
Consignor/consignee	Plant
Transport date	Reference no.
DN30 PSP ID	Cylinder ID
30B-X cylinder Filled ☐ Heels ☐	Use Exclusive ☐ Non-exclusive ☐

General information

Instrument serial no.	Last calibration date

Measurements



Unit: µSv/h		Measured value (M)	Background radiation (B)	Dose rate (M-B)
Package surface				
Measurement points < gamma >	1			
	2			
	3			
	4			
	5			
	max(1-5)			
< gamma and neutron radiation >		DR(DN30-X) = max(1-5) * 1.05		
1 m distance from the package (radial)				
DR(1m)	Determined by measurement ☐			
	Calculated: = DR(DN30-X) * 0.25 ☐			

Tester			Radiation protection		
Date	Name	Signature	Date	Name	Signature

orano

DN30-X Measurement Protocol D.2

Measurement of Dose Rates

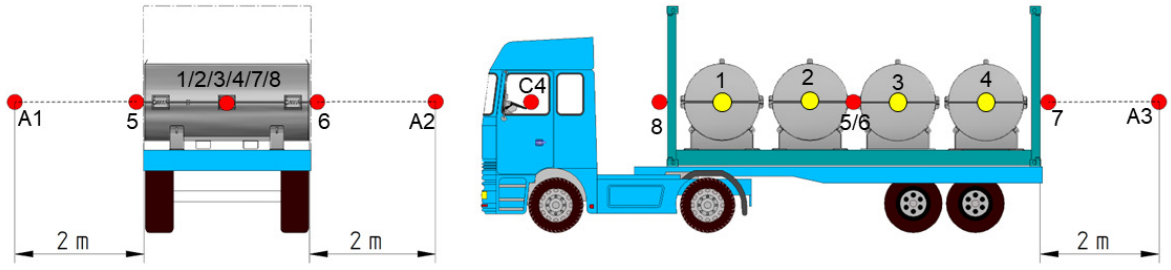
Vehicle with 1 to 4 Packages in Lateral Direction

Protocol no.	Test instruction 0045-PA-2021-002
Consignor/consignee	Plant
Transport date	Reference no.
DN30 PSP IDs _____	Cylinder IDs _____
30B-X cylinders Filled ☐ Heels ☐	Use Exclusive ☐ Non-exclusive ☐

General information

Vehicle no. plate	Flatrack no.
Instrument serial no.	Last calibration date

Measurements



Unit: µSv/h	Measured value (M)	Background radiation (B)	Dose rate (M-B)
Vehicle surface			
Transferred from the max. value from the protocols for packages 1-4 (marked in yellow) < gamma >		[1]	
		[2]	
		[3]	
		[4]	

orano

DN30-X Measurement Protocol D.2

Measurement of Dose Rates

Vehicle with 1 to 4 Packages in Lateral Direction

Protocol no.	Test instruction 0045-PA-2021-002
Consignor/consignee	Plant
Transport date	Reference no.
DN30 PSP IDs _____	Cylinder IDs _____
30B-X cylinder Filled ☐ Heels ☐	Use Exclusive ☐ Non-exclusive ☐

Measurement points < gamma >	5			
	6			
	7			
	8			
	max(1-8)			
< gamma and neutron radiation >		DR(veh) = max(1-8) * 1.05		

2 m distance from the vehicle

Measurement points < gamma > driver's cabin	A1			
	A2			
	A3			
	C4			
	max(A1-A3, C4)			
< gamma and neutron radiation >		DR(2m) = DR(veh) * 1.05		

Tester			Radiation protection		
Date	Name	Signature	Date	Name	Signature

orano

DN30-X Measurement Protocol D.3

Measurement of Dose Rates

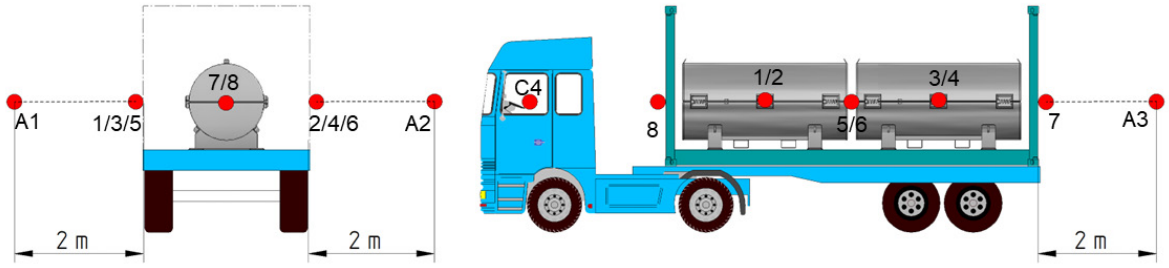
Vehicle with 1 to 2 Packages in Longitudinal Direction

Protocol no.	Test instruction 0045-PA-2021-002
Consignor/consignee	Plant
Transport date	Reference no.
DN30 PSP IDs _____ _____	Cylinder IDs _____ _____
30B-X cylinders Filled ☐ Heels ☐	Use Exclusive ☐ Non-exclusive ☐

General information

Vehicle no. plate	Flatrack no.
Instrument serial no.	Last calibration date

Measurements



Unit: µSv/h		Measured value (M)	Background radiation (B)	Dose rate (M-B)
Vehicle surface				
Measurement points < gamma >	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	max(1-8)			

orano

DN30-X Measurement Protocol D.3

Measurement of Dose Rates

Vehicle with 1 to 2 Packages in Longitudinal Direction

Protocol no.	Test instruction 0045-PA-2021-002
Consignor/consignee	Plant
Transport date	Reference no.
DN30 PSP IDs ----------	Cylinder IDs ----------
30B-X cylinders Filled ☐ Heels ☐	Use Exclusive ☐ Non-exclusive ☐

< gamma and neutron radiation >			DR(veh) = max(1-8) * 1.05	
2 m distance from the vehicle				
Measurement points < gamma > driver's cabin	A1			
	A2			
	A3			
	C4			
	max(A1-A3, C4)			
< gamma and neutron radiation >			DR(2m) = DR(veh) * 1.05	

Tester			**Radiation protection**		
Date	Name	Signature	Date	Name	Signature