Translation

Federal Office for Radiation Protection

Certificate of Approval

D/4347/B(U)F-96 (Rev. 2)

for a package design of type B(U) for fissile radioactive materials

Pursuant to the application filed by company Nuclear Cargo + Service GmbH, Hanau, on January 29, 2010 the package with the manufacturer's designation **NCS 45** is approved as a type B(U) package design for fissile radioactive materials according to the following regulations for transports by road, rail, sea and inland waterways:

Regulations for the Safe Transport of Radioactive Material, 2009 Edition, International Atomic Energy Agency (IAEA), No. TS-R-1,

European Agreement for International Transports of Dangerous Goods by Road (ADR) of 30 September 1957 (BGBl. 1969 II p. 1489),Enclosures A and B in the version of the publication dated November 25, 2010 (BGBl. 2010 II p. 1412), last amended by the 21st ADR-Amendment Order dated 7 October 2010 (BGBl. 2010 II p. 1134),

Regulations for International Transports of Dangerous Goods by Rail (RID) - Enclosure of Appendix C of the Agreement concerning International Railway Traffic (COTIF) of 9 May 1980 (BGBl. 1985 II, p. 130) in the version of the proclamation dated 16 May 2008 (BGBl. 2008 II p. 475), last amended by the 16th RID-Amendment Order dated 11 November 2010 (BGBl. 2010 II p. 127),

International Maritime Dangerous Goods Code (IMDG-Code). Amendment 35-10,

Enclosure to the European Agreement dated 26 May 2000 about the international Transport of Dangerous Goods on Inland-Waterways (ADN) (BGBl. 2007 II p. 1906), last amended by the 3. ADN-Amendment-Order dated 17 December 2010 (BGBl. 2010 II p. 1550, p. 1569),

Regulations for the Domestic and International Transport of Dangerous Goods by Road, Rail and Inland-Waterways (Dangerous Goods Regulations Road, Rail and Inland-Navigation - GGVSEB) in the version of the proclamation dated 16 December 2011 (BGBl. 2011 I p. 2733),

Regulations for the Transport of Dangerous Goods with Sea Going Vessels (Dangerous Goods Regulations Sea - GGVSee) in the version of the proclamation dated 16 December 2011 (BGBl. 2011 I p. 2784, 2012 I p. 122),

related to the Guidelines of the Federal Minister for Transport, Building and Urban Affairs (BMVBS) of 17 November, 2004 (VkBl. 2004 p. 594) and the proclamation of BMVBS to the Guidelines to the Dangerous Goods Regulations dated 1 July 2010 (VkBl 2010 p. 282).

It is certified that the Federal Office for Radiation Protection, Salzgitter, is the Competent Authority authorized by the Federal Ministery for Transport, Building and Urban Affairs according to Section 7.9 of the IMDG Code.

Holder of the Certificate: Nuclear Cargo + Service GmbH
Rodenbacher Chaussee 6
63457 Hanau

Documents:

1. Application of company Nuclear Cargo + Service GmbH of 29 January 2010 (by telefax).

2. Safety report of company Nuclear Cargo + Service GmbH no. NCS 0017 Rev. 11 dated 9 July 2012

3. BAM examination certificate of 11 June 2008 (Ref.: III.3/20837) with 1st amendment to the design examination certificate of the Federal Institute for Materials Research and Testing (BAM) Berlin, dated 22 March 2010 (Ref.: III.3/20837), 2nd amendment to the design examination certificate of the Federal Institute for Materials Research and Testing (BAM) Berlin, dated 23 November 2011 (Ref.: III.3/20837) and the supplementary letter of BAM to the 2nd amendment dated 17 July 2012.

As far as the verification of criticality safety is concerned, special reference is made to the report NCS 0017 chapter 8 "Criticality", Rev. 8 dated 15 February 2012 contained in the safety report.

Manufacturer designation: **Transport packaging NCS 45**

Identification of the package: **D/4347/B(U)F-96**

Validity of approval: **until 31 August 2015, included**

Criticality safety index (CSI): **0**

Allowable contents:

Content 1: Uranium oxide in the form of fuel rods, fuel rod sections, pellets as well as pellet scrap according to the general specification fixed in attachment 1, table 1. Based on the variation of parameters for the six fuel specifications of content 1 following specific data must be observed:

Content 1.1: Uranium oxide according to the data in attachment 1, table 1.1

Content 1.2: Uranium oxide according to the data in attachment 1, table 1.2

Content 1.3: Uranium oxide according to the data in attachment 1, table 1.3

Content 1.4: Uranium oxide according to the data in attachment 1, table 1.4

Content 1.5: Uranium oxide according to the data in attachment 1, table 1.5

Content 1.7: Uranium oxide according to the data in attachment 1, table 1.7

For the sub-contents 1.3a and 1.3b a mixed loading is possible which has to fulfill the following condition (B1):

$$\frac{m_{1.3a}\,(\text{present})}{m_{1.3a}\,(\text{allowed})} + \frac{m_{1.3b}\,(\text{present})}{m_{1.3b}\,(\text{allowed})} \leq 1 \qquad \text{B1}$$

with

$m_{1.3a}$ (present)	present mass according to specification in table 1.3
$m_{1.3a}$ (allowed)	allowed mass according to specification in table 1.3 and table 1.3a
$m_{1.3b}$ (present)	present mass according to specification in table 1.3
$m_{1.3b}$ (allowed)	allowed mass according to specification in table 1.3 and table 1.3b

For burn-up values of more than 62 GWd/t_U the content must be enclosed in tightly welded or brazed cans. Additionally, dose rate measurements with extended measurement scope according to collateral clause no. 9 have to be carried out.

Content 2: Mixed oxide resp. -carbide and mixtures of mixed oxide resp. –carbide and uranium oxide resp. –carbide in the form of fuel rods, fuel rod sections, pellets as well as pellet scrap according to the general specification fixed in attachment 1, table 2 and 2.15.

For burn-up values of more than 62 GWd/t_U the content must be enclosed in tightly welded or brazed cans. Additionally, dose rate measurements with extended measurement scope according to collateral clause no. 9 have to be carried out.

Content 5: Materials with a fissile content up to 15 g according to the general and specific data fixed in attachment 1, table 5 and table 5.1.

For all contents applies:

- A mixed loading of the fuel specifications of content 1 among each other as well as with content 2 or with content 5 is not admissible.
- For securing the radiological safety the contents mentioned above must be limited so that the following conditions are met:

$$\dot{D}_{OF} = S_\gamma \cdot w_{\gamma,OF} \cdot f_{\gamma,OF} + S_n \cdot w_{n,OF} \cdot f_{n,OF} \leq 2000\,\mu Sv/h \qquad \text{B2}$$

$$\dot{D}_{2m} = S_\gamma \cdot w_{\gamma,2m} \cdot f_{\gamma,2m} + S_n \cdot w_{n,2m} \cdot f_{n,2m} \leq 100\,\mu Sv/h \qquad \text{B3}$$

In this formulas are

$\dot{D}_{OF/2m}$ Dose rate in µSv/h at the surface (OF) of the package or in 2 m distance from the vehicle, respectively

$S_{\gamma/n}$ Source intensity in s^{-1} for gamma and neutron radiation, respectively.

The total source intensity of the gamma radiation S_γ is calculated according to following rule:

$$S_\gamma = \sum_{i=1}^{12} Q_\gamma^i \cdot s_i$$

In this the calculated gamma group source intensities s_i in s^{-1} for the energy groups i are groupwise multiplied with the factors Q_γ^i (dimensionless) from table 1 and added up.

The neutron source intensity S_n is taken directly from the output file of the calculation.

For the calculation of the source terms $S_{\gamma/n}$ the program system SCALE from version 5 upward has to be used (see collateral clause no. 10).

$f_{\gamma/n(OF/2m)}$ Correction factors (dimensionless) for gamma and neutron radiation, respectively, referring to the axial extension of the source in the packaging according to table 2 for the surface (OF) of the package and in 2 m distance from the transport vehicle.

$w_{\gamma/n(OF/2m)}$ Dose rate contribution in µSv/h s for gamma and neutron radiation according to table 3 for the surface (OF) of the package and in 2 m distance from the transport vehicle.

Table 1: Weighing factors for S_γ

Energy group i	Energy range	Q_γ^i
1	8 – 10 MeV	2.18
2	6.5 – 8 MeV	2.87
3	5 – 6.5 MeV	3.18
4	4 – 5 MeV	3.16
5	3 – 4 MeV	2.83
6	2.5 – 3 MeV	1.82
7	2 – 2.5 MeV	1
8	1.66 – 2 MeV	0.38
9	1.33 – 1.66 MeV	0.11
10	1 – 1.33 MeV	0.011
11	0.8 – 1 MeV	0.00033
12	0.6 – 0.8 MeV	0.000012

Table 2: Correction factors for the axial extension of the source

Place	Correction factor* with respect to	
	Gamma radiation	Neutron radiation
Surface of the package	$f_{\gamma,OF}(h) = 1.0 + 18 \cdot e^{-0.015 \cdot h}$	$f_{n,OF}(h) = 1.0 + 9 \cdot e^{-0.01 \cdot h}$
2 m distance from the transport vehicle	$f_{\gamma,2m}(h) = 1.8 - 0.0018 \cdot h$	$f_{n,2m}(h) = 1.32 - 0.0005 \cdot h$

*The factors $f_{\gamma/n(OF/2m)}$ refer always to the maximal source extension of 443.5 cm.
Extension h from 20 cm to 443.5 cm

Table 3: Dose rate contribution for each source particle

Place	Dose rate contribution with respect to	
	Gamma radiation [µSv/h s]	Neutron radiation [µSv/h s]
Surface of the package	$w_{\gamma,OF} = 1.31 \cdot 10^{-11}$	$w_{n,OF} = 1.37 \cdot 10^{-5}$
2 m distance from the transport vehicle	$w_{\gamma,2m} = 1.15 \cdot 10^{-12}$	$w_{n,2m} = 7.66 \cdot 10^{-7}$

Design of the packaging:

The design transport packaging NCS 45 fulfills with respect to the mechanical and thermal properties according to the above mentioned design examination certificate of BAM dated 11.06.2008 in connection with above mentioned 1. Amendment to the design examination certificate of BAM dated 22.03.2010, and the above mentioned 2. Amendment to the design examination certificate of BAM dated 23.11.2011 and with respect to criticality safety and radiation shielding according to the examination of BfS the requirements towards a type B(U) package for fissile radioactive material (IAEA-Regulations § 650 and § 671).

For the proof of criticality safety the inleakage of water into all voids of the packaging was assumed.

Description of the packaging:

The package design consists of the subassemblies packaging main body, lid plug, bottom plug, trunnions, shock absorbers and interior components. The packaging main body is a cylindrical austenitic welded design. The open ends of the packaging main body are closed with the lid and bottom plug with bolted flange connections.

The cylindrical inner cavity with a maximal length of 4625 mm (special design) and a diameter of 220 mm is designed for the accommodation of fuel rods, fuel rod sections, pellets, pellet scrap and powder in the inner components foreseen for this purpose.

At the outer mantle side of the packaging at each of the lid and bottom side two by 180° turned trunnions are fixed by bolts in welded trunnion support plates.

Both of the cylindrical shock absorbers filled with spruce and balsa wood are fixed to the ends of the packaging main body with 6 cylinder head screws each.

Schematic representations of the package in normal and special design (drawing no. 150-151-00, Rev. i and 150-151-01, Rev. g) are attached as attachment 3.

The "Containment" is constituted of following parts and elements, respectively:

- Inner tube, head piece and foot piece of the packaging main body as well as the connecting welding seams
- Flange of the lid plug with belonging inner gasket and bolts
- Rotary lock lid with belonging inner gasket and bolts
- Coupling lid with belonging inner gasket and bolts
- Rotary lock drive lid with belonging inner gasket and bolts
- Flange of the bottom plug with belonging inner gasket and bolts
- Push plug lid with belonging inner gasket and bolts

The "Confinement System" is constituted of the following parts and elements, respectively:

The "Confinement System" consists of the parts and elements of the "Containment". Depending on the content the following centering frames and the respectively belonging fissile material arrangements are to be added:

- Centering frame ZG-BSK-NA or ZG-BSK-SA; drawing no: 0-090-108-00-00
- Centering frame ZG-ZRS-NA or ZG-ZRS-SA; drawing no: 1-090-111-00-00
- Centering frame ZG-BS-NA or ZG-BS-SA; drawing no: 0-090-112-00-00
- Insert basket EK-CEA-NA or EK-CEA-SA drawing no: 1-090-113-00-00

Main dimensions of the transport packaging NCS 45:

Diameter with shock absorbers:	approx. 1630 mm
Diameter without shock absorbers:	approx. 730 mm
Height with shock absorbers:	approx. 6247 mm
Height without shock absorbers:	approx. 5307 mm
Maximal mass, package:	approx. 22660 kg

For the time being the packagings designated by the respective parts lists revisions in attachment 4 comply with the certificate of package approval at hand (see also collateral clause no. 7).

Collateral Clauses and Directives:

1. All quality assurance measures taken during planning, accompanying controls and operation must be in agreement with the BAM-Dangerous Goods-Regulation about Quality Assurance Measures of Packagings for Competent Authority Approved Package Designs for the Transport of Radioactive Material (BAM-GGR 011, Rev. 0).

2. The manufacture of new packagings is only allowed according to the parts list 150-151 with the highest revision index in attachment 4 including the changes according to collateral clause no. 7.

3. This certificate of package approval is only valid together with the belonging final acceptance certificate which must be sent to BAM and BfS without previous request. Deviations tolerated by BAM according to BAM-GGR 011, Rev. 0 as well as changes according to collateral clause no. 7 are to be documented in this final acceptance certificate. For serial packagings manufactured already the deviations tolerated by BAM and the changes according to collateral clause no. 7 must be documented in the documentation book.

4. It must be assured that every user of the packaging will register with BfS before using it for the first time, and that he proves reception of and compliance with the documentation book, which in particular contains the approval certificate, the handling and maintenance instruction and the instructions concerning periodical inspections. In this respect, the following must be specially mentioned:

   - Handling Instructions No. HA-02-06 Rev. 5
     "Handling of the Packaging NCS 45"

   - Inspection Instruction No. WP-02-02, Rev. 2
     "Periodic Inspections of the Packaging NCS 45"

   The use of documents with a higher revision index as specified in the safety analysis report is in connection with this certificate of package approval only allowed after release of BAM and approval of BfS. These therewith become integral part of the present certificate of package approval.

5. Each serial packaging must be submitted to periodic inspections in due time. For serial packagings which are only used outside the Federal Republic of Germany the periodic inspections may be performed and certified by inspection personnel which is authorized by the competent authority of the respective country. The certificates for the performed periodic inspections must be sent to BAM and BfS without previous request.

6. Each serial packaging must be durably marked with the above mentioned identification as well as with the date (month, year) of the next periodic inspection.

7. Modifications concerning parts lists and the therein mentioned drawings on which the certificate of package approval is based, require after release by BAM the approval by BfS in form of an agreement to the modification certificate or an extended type list (according to attachment 4). With this they become part of the present certificate of package approval.

8. The package has to be transported under exclusive use.

9. Before each transport of the package of the design NCS 45 with burn-up values of more than 62 GWd/t_U dose rate measurements with an extended measurement program with respect to test procedure no. PA-02-10 Rev. 2 have to be carried out. Additionally, information about the used fuel and the irradiation history must be documented. The extended measurement program must be agreed by BfS before beginning of the measurements. Based on the evaluation of the measurement results the revocation of this measurement program can be applied for at BfS.

10. Other programs as SCALE (from version 5 upward) may only be used after approval by BfS.

11. Before the first loading of the NCS 45 with brazed cans according to drawing 0004-090-001-00 Rev. c and specification SB-09-01 Rev. 3 a cold trial of 5 brazed cans with fuel dummies has to be performed in the presence of the authorized inspector of BAM. The quality of the brazing has to be proven by

helium leakage test and metallographic examinations. After passed cold trial the specification SB-09-01 Rev. 3 will be released by BAM. Furthermore BAM or the authorized expert of BAM has to be present during the brazing of the first 10 cans.

12. Certificate of approval D/4347/B(U)F-96 (Rev. 1) remains valid until 31 May 2013 included.

13. This approval does not exempt the consigner from the necessity to observe any regulations of the government of a country into or through which the package is transported.

Costs:

1. According to § 12 Section 1 and 2 of the Law for the Transport of Dangerous Goods (Gefahrgutbeförderungsgesetz – GGBefG) in the version of the proclamation dated 07 July 2009 (BGBl. 2009 I p. 1774, corrected p. 3975), in connection with Article 1 and Attachment (to Article 1), I. Part, Fee number 007 of the Directive concerning Costs for Measures to be taken during the Transport of Dangerous Goods (GGVKostV) of 13 November 1990 (BGBl. 1990 I p. 2490), last amended by the Third Order for the Amendment of Dangerous Goods Regulations dated 17 December 2004 (BGBl. 2004 I p. 3711), costs arising from this certificate - fees and expenses – will be charged.

2. According to § 12 Section 1 of the GGBefG related to § 13 Section 1 No. 1 of the Law concerning Administration Costs (VwKostG) of 23 June 1970 (BGBl. 1970 p. 821), amended for the last time through Article 3 of the Law concerning the Implementation of the Service Guide Line of the Gauging Law as well as of the Instrument and Product Safety Law and for the modification of the Administrative Costs Law, the Energy Industry Law and the Law for the Support of the Power Supply Lines dated 7 March 2011 (BGBl. 2011 I p. 338), the company Nuclear Cargo + Service GmbH must carry the costs.

3. The determination of costs will be communicated separately.

Statement of rights of appeal:

Objections against this certificate may be filed within one month after its issuing. Objections must be filed with the Federal Agency for Radiation Protection, Willy-Brandt-Straße 5, 38226 Salzgitter, either in written form, or to be written down.

Salzgitter, August 09, 2012

In representation

Thiele

Attachments

Appendix

Attachment 1: Specification for contents 1, 2 and 5
Attachment 2: Interior components
Attachment 3: Data sheets transport packaging NCS 45, drawing nos. 150-151-00, Rev. i (normal design), 150-151-01, Rev. g (special design)
Attachment 4: Type list

- Appendix to Certificate of Approval D/4347/B(U)F-96 (Rev. 2) -

Rev. No.	Date of publication	Period of validity	Reason for revision
0	04.12.2008	04.12.2013	First publication
1	25.03.2010	04.12.2013	Inclusion of new inventory, Content 1.7
2	09.08.2012	31.08.2015	Inclusion of new inventory, Content 2.15 as well as possible mixed loading of contents 1.3a and 1.3b

Content 1

Table 1: general specification for content 1

Property	Specification
Chemical composition of the active zone	- Uranium oxide - Gadolinium as Gd_2O_3 is acceptable
Fuel composition before irradiation	Enriched natural Uranium or enriched Uranium from reprocessing
Fuel composition after irradiation	Actinides, fission and activation products from irradiation in the reactor. The material can be irradiated or un-irradiated.
Geometry of pellets	arbitrary
Geometry of fuel rods	arbitrary
Geometry of fuel assemblies	arbitrary
Loading of non fissile materials	Loading of non fissile materials in solid form is acceptable
Cladding tube material	Stainless steel, Zirconium alloys, Aluminium
Not acceptable materials	Graphite or Beryllium are not allowed in the inner cask volume
Thermal power	Flooding of the inner cavity with Helium and transport without a closed container: max. 3000 W; max. 730 W / m; max. 380 W / 0.5 m Flooding of the inner cavity with Helium and transport in a closed container: max. 2500 W; max. 730 W / m; max. 380 W / 0.5 m Flooding of the inner cavity with air and transport with or without a closed container: max. 750 W; max. 580 W / m; max. 290 W / 0.5 m

Table 1.1: Specification for content 1.1

Property	Specification
Physical form	- Undamaged fuel rods - Fuel rods in welded or brazed cans - Fuel rod sections, pellets and pellet scraps in welded or brazed cans
Fuel composition before irradiation	Uranium oxide with enrichment of max. 5.3 wt. % of U-235 in Uranium
Hydrogen density in the fuel	Atom ratio H/U-235 ≤ 1
Burn-up	max. 120 GWd/Mg_U
Cooling time	min. 120 d, see Table 1.1a
Inner components	drawing 0-090-108-00-00: payload max. 100 kg drawing 0-090-112-00-00: payload max. 100 kg
Heavy metal mass before irradiation	see Table 1.1a
Thermal power for each guide tube	Inner components according to drawing nos. 0-090-108-00-00 and 0-090-112-00-00, see Table 1.1b
Activity inventory	max. $2 \cdot 10^4$ TBq, max. $2 \cdot 10^5$ A_2
Fissile material cross section	max. 380 cm^2 (equivalent diameter 22 cm = cavity diameter)
Fissile material height	max. cavity length
Mass of fissile material before irradiation	max. 16.4 g U-235 / cm length of the fissile material zone max. 4.0 kg U-235 total

Table 1.1a: Permissible heavy metal mass

Burn-up	GWd/Mg_U max.	33			62			120[3]		
Cooling time	days min.	120	730	3650	120	730	3650	120	730	3650
PWR-fuel rods	kg	75	75	75	75	75	75	35	46	59
BWR-fuel rods[1]	kg	75	75	75	75	75	75	35	46	59
BWR-fuel rods[2]	kg	47	53	54	26	28	29	12	13	13.8

[1] for a proven compliance of a surface contamination of ≤ $5.2 \cdot 10^6$ Bq/cm^2 (33 GWd/Mg_U), ≤ $9.8 \cdot 10^6$ Bq/cm^2 (62 GWd/Mg_U), ≤ $1.9 \cdot 10^7$ Bq/cm^2 (120 GWd/Mg_U)

[2] surface contamination not measured or surface contamination limits according to footnote [1] not met

[3] for enclosure of the fuel in welded or brazed cans

Table 1.1b: Permissible thermal power for each guide tube for the inner components according to drawings 0-090-108-00-00 and 0-090-112-00-00

Specification	Filled with	
	Helium	Air
maximal thermal power for each guide tube for max. 7 guide tubes, W	100	100
maximal thermal power for each guide tube for all other guide tubes, W	75	18.75
maximal thermal power for each guide tube for max. 7 guide tubes for each 500 mm loading length, W	30	30
maximal thermal power for each guide tube for all other guide tubes for each 500 mm loading length, W	9	7

Table 1.2: Specification for content 1.2

Property	Specification
Physical form	- Undamaged fuel rods - Fuel rods in welded or brazed cans - Fuel rod sections, pellets and pellet scraps in welded or brazed cans
Fuel composition before irradiation	Uranium oxide with enrichment of max. 5.3 wt. % of U-235 in Uranium
Hydrogen density in the fuel	Atom ratio H/U-235 ≤ 1
Burn-up	max. 120 GWd/Mg_U
Cooling time	min. 120 d, see Table 1.2a
Inner components	drawing 1-090-111-00-00 (18 cm diameter): payload max. 95 kg
Heavy metal mass before irradiation	see Table 1.2a
Activity inventory	max. $2 \cdot 10^4$ TBq, max. $2 \cdot 10^5$ A_2
Fissile material cross section	max. 254 cm^2 (equivalent diameter maximal 18 cm)
Height of fissile material	max. cavity length
Mass of fissile material before irradiation	max. 4.0 kg U-235 total

Table 1.2a: Permissible heavy metal mass

Burn-up	GWd/Mg_U max.	33			62			120[3]		
Cooling time	days min.	120	730	3650	120	730	3650	120	730	3650
PWR-fuel rods	kg	75	75	75	75	75	75	35	46	59
BWR-fuel rods[1]	kg	75	75	75	75	75	75	35	46	59
BWR-fuel rods[2]	kg	47	53	54	26	28	29	12	13	13.8

[1] for a proven compliance of a surface contamination of ≤ $5.2 \cdot 10^6$ Bq/cm^2 (33 GWd/Mg_U), ≤ $9.8 \cdot 10^6$ Bq/cm^2 (62 GWd/Mg_U), ≤ $1.9 \cdot 10^7$ Bq/cm^2 (120 GWd/Mg_U)

[2] surface contamination not measured or surface contamination limits according to footnote [1] not met

[3] for enclosure of the fuel in welded or brazed cans

Table 1.3: Specification for content 1.3

Property	Specification
Physical form	- Damaged or undamaged fuel rods - Fuel rods in welded or brazed cans - Fuel rod sections, pellets and pellet scraps in welded or brazed cans - Not welded or not brazed fuel rod sections - Pellets and pellet scraps in not welded or not brazed cans
Fuel composition before irradiation	Uranium oxide with enrichment of max. 5.3 wt. % of U-235 in Uranium
Hydrogen density in the fuel	Atom ratio H/U-235 ≤ 100
Burn-up	max. 120 GWd/Mg_U
Cooling time	min. 120 d, see Table 1.3a and 1.3b
Inner components	Drawing 0-090-108-00-00: payload max. 100 kg Drawing 1-090-109-00-00: payload max. 95 kg Drawing 1-090-110-00-00: payload max. 100 kg Drawing 1-090-111-00-00: payload max. 95 kg Drawing 0-090-112-00-00: payload max. 100 kg
Heavy metal mass before irradiation	see Table 1.3a and 1.3b
Thermal power for each guide tube	Inner components according to drawing nos. 0-090-108-00-00, 1-090-110-00-00 and 0-090-112-00-00 see Table 1.3c
Activity inventory	max. $2 \cdot 10^4$ TBq, max. $2 \cdot 10^5$ A_2
Fissile material cross section	max. 380 cm^2 (equivalent diameter 22 cm)
Height of fissile material	max. cavity length
Mass of fissile material before irradiation	max. 1380 g U-235 total

Table 1.3a: Permissible heavy metal mass for undamaged fuel rods and canned fuel

Burn-up	GWd/Mg_U max.	33			62			120[3]		
Cooling time	days min.	120	730	3650	120	730	3650	120	730	3650
PWR fuel rods[1]	kg	75	75	75	75	75	75	35	46	59
BWR fuel rods[1]	kg	75	75	75	75	75	75	35	46	59
BWR-fuel rods[2]	kg	47	53	54	26	28	29	12	13	13.8

[1] for a proven compliance of a surface contamination of ≤ $5.2 \cdot 10^6$ Bq/cm^2 (33 GWd/Mg_U), ≤ $9.8 \cdot 10^6$ Bq/cm^2 (62 GWd/Mg_U), ≤ $1.9 \cdot 10^7$ Bq/cm^2 (120 GWd/Mg_U)

[2] surface contamination not measured or surface contamination limits according to footnote [1] not met

[3] for enclosure of the fuel in welded or brazed cans

Table 1.3b: Permissible heavy metal mass for damaged fuel rods and non canned fuel

Burn-up	GWd/Mg_U max.	33			62		
Cooling time	days min.	120	730	3650	120	730	3650
PWR and BWR fuel rods	kg	6.5	12.4	17.1	4.1	6.5	8.7

Table 1.3c: Permissible thermal power for each guide tube for the inner components according to drawings 0-090-108-00-00, 0-090-110-00-00 (component part according to section C-C) and 0-090-112-00-00

Specification	Filled with	
	Helium	Air
maximal thermal power for each guide tube for max. 7 guide tubes, W	100	100
maximal thermal power for each guide tube for all other guide tubes, W	75	18.75
maximal thermal power for each guide tube for max. 7 guide tubes for each 500 mm loading length, W	30	30
maximal thermal power for each guide tube for all other guide tubes for each 500 mm loading length, W	9	7

Table 1.4: Specification for content 1.4

Property	Specification
Physical form	- Undamaged fuel assemblies - Undamaged fuel rods - Fuel rods in welded or brazed cans - Fuel rod sections, pellets und pellet scraps in welded or brazed cans The fuel rods have to have a minimum wall thickness of 0.25 mm to insure criticality safety.
Fuel composition before irradiation	Uranium oxide with enrichment of max. 3.4 wt. % of U-235 in Uranium
Hydrogen density in the fuel	Atom ratio H/U-235 ≤ 1
Burn-up	max. 62 GWd/Mg_U
Cooling time	min. 120 d, see Table 1.4a and 1.4b
Inner components	without inner components: payload max. 350 kg Drawing 0-090-108-00-00: payload max. 100 kg Drawing 1-090-109-00-00: payload max. 95 kg Drawing 1-090-110-00-00: payload max. 100 kg Drawing 1-090-111-00-00: payload max. 95 kg Drawing 0-090-112-00-00: payload max. 100 kg
Heavy metal mass before irradiation	see Table 1.4a and 1.4b
Thermal power for each guide tube	Inner components according to drawing nos. 0-090-108-00-00, 1-090-110-00-00 and 0-090-112-00-00 see Table 1.4c
Activity inventory	max. $3 \cdot 10^4$ TBq, max. $2 \cdot 10^5$ A_2
Fissile material cross section	max. 380 cm^2 (equivalent diameter 22 cm = cavity diameter)
Height of fissile material	max. cavity length
Mass of fissile material before irradiation	max. 6.5 kg U-235 total

Table 1.4a: Permissible heavy metal mass **in case** of use of inner components

Burn-up	GWd/Mg_U max.	33			62		
Cooling time	days min.	120	730	3650	120	730	3650
PWR fuel rods	kg	75	75	75	75	75	75
BWR fuel rods[1)]	kg	75	75	75	75	75	75
BWR-Fuel rods[2)]	kg	47	53	54	26	28	29

Table 1.4b: Permissible heavy metal mass **without** use of inner components

Burn-up	GWd/Mg_U max.	33			62		
Cooling time	days min.	120	730	3650	120	730	3650
PWR fuel rods	kg	167	260	275	100	137	164
BWR fuel rods[1)]	kg	167	260	275	100	137	164
BWR-Fuel rods[2)]	kg	47	53	54	26	28	29

[1)] for a proven compliance of a surface contamination of ≤ $5.2 \cdot 10^6$ Bq/cm^2 (33 GWd/Mg_U), ≤ $9.8 \cdot 10^6$ Bq/cm^2 (62 GWd/Mg_U)

[2)] surface contamination not measured or surface contamination limits according to footnote [1)] not met

Table 1.4c: Permissible thermal power for each guide tube for the inner components according to drawings 0-090-108-00-00, 1-090-110-00-00 (component part according to section C-C) and 0-090-112-00-00

Specification	Filled with	
	Helium	Air
maximal thermal power for each guide tube for max. 7 guide tubes, W	100	100
maximal thermal power for each guide tube for all other guide tubes, W	75	18.75
maximal thermal power for each guide tube for max. 7 guide tubes for each 500 mm loading length, W	30	30
maximal thermal power for each guide tube for all other guide tubes for each 500 mm loading length, W	9	7

Table 1.5: Specification for content 1.5

Property	Specification
Physical form	- Undamaged fuel rods - Fuel rods in welded or brazed cans - Fuel rod sections, pellets and pellet scraps in welded or brazed cans
Fuel composition before irradiation	Uranium oxide with enrichment of max. 7 wt. % of U-235 in Uranium
Hydrogen density in the fuel	Atom ratio H/U-235 ≤ 1
Burn-up	max. 120 GWd/Mg_U
Cooling time	min. 120 d, see Table 1.5a
Inner components	Drawing 0-090-112-00-00: payload max. 100 kg
Heavy metal mass before irradiation	see Table 1.5a
Thermal power for each guide tube	Inner components according to drawing no. 0-090-112-00-00 see Table 1.5b
Activity inventory	max. $2 \cdot 10^4$ TBq, max. $2 \cdot 10^5$ A_2
Fissile material cross section	max. 380 cm^2 (equivalent diameter 22 cm = cavity diameter)
Height of fissile material	max. cavity length
Mass of fissile material before irradiation	max. 5.25 kg U-235 total

Table 1.5a: Permissible heavy metal mass

Burn-up	GWd/Mg_U max.	33			62			120[3]		
Cooling time	days min.	120	730	3650	120	730	3650	120	730	3650
PWR fuel rods	kg	75	75	75	75	75	75	35	46	59
BWR fuel rods[1]	kg	75	75	75	75	75	75	35	46	59
BWR-Fuel rods[2]	kg	47	53	54	26	28	29	12	13	13.8

[1] for a proven compliance of a surface contamination of ≤ $5.2 \cdot 10^6$ Bq/cm^2 (33 GWd/Mg_U), ≤ $9.8 \cdot 10^6$ Bq/cm^2 (62 GWd/Mg_U), ≤ $1.9 \cdot 10^7$ Bq/cm^2 (120 GWd/Mg_U)

[2] surface contamination not measured or surface contamination limits according to footnote [1] not met

[3] for enclosure of the fuel in welded or brazed cans

Table 1.5b: Permissible thermal power for each guide tube for the inner components according to drawing 0-090-112-00-00

Specification	Filled with	
	Helium	Air
maximal thermal power for each guide tube for max. 7 guide tubes, W	100	100
maximal thermal power for each guide tube for all other guide tubes, W	75	18.75
maximal thermal power for each guide tube for max. 7 guide tubes for each 500 mm loading length, W	30	30
maximal thermal power for each guide tube for all other guide tubes for each 500 mm loading length, W	9	7

Table 1.7: Specification for content 1.7

Property	Specification
Physical form	- Damaged or undamaged fuel rods - Fuel rods in welded or brazed cans - Fuel rod sections, pellets und pellet scraps in welded or brazed cans - Not welded or not brazed fuel rod sections - Pellets and pellet scraps in not welded or not brazed cans
Fuel composition before irradiation	Uranium oxide with enrichment of max. 7.0 wt. % of U-235 in Uranium UB_4 is allowed in the Uranium
Hydrogen density in the fuel	Atom ratio H/U-235 ≤ 100
Burn-up	max. 120 GWd/Mg_U
Cooling time	min. 120 d, see Table 1.7a and 1.7b
Inner components	Drawing 1-090-111-00-00: payload max. 95 kg Drawing 1-090-114-00-00: payload max. 155 kg Drawing 1-090-115-00-00: payload max. 100 kg
Heavy metal mass before irradiation	see Table 1.7a and 1.7b
Activity inventory	max. $2 \cdot 10^4$ TBq, max. $2 \cdot 10^5$ A_2
Fissile material cross section	max. 326 cm^2 (equivalent diameter 20.4 cm)
Height of fissile material	max. cavity length
Mass of fissile material before irradiation	max. 1.25 kg U-235 total

Table 1.7a: Permissible heavy metal mass of undamaged fuel rods and canned fuel

Burn-up	GWd/Mg_U max.	33			62			120[3]		
Cooling time	days min.	120	730	3650	120	730	3650	120	730	3650
PWR fuel rods	kg	75	75	75	75	75	75	35	46	59
BWR fuel rods[1]	kg	75	75	75	75	75	75	35	46	59
BWR-Fuel rods[2]	kg	47	53	54	26	28	29	12	13	13.8

[1] for a proven compliance of a surface contamination of ≤ $5.2 \cdot 10^6$ Bq/cm^2 (33 GWd/Mg_U), ≤ $9.8 \cdot 10^6$ Bq/cm^2 (62 GWd/Mg_U), ≤ $1.9 \cdot 10^7$ Bq/cm^2 (120 GWd/Mg_U)

[2] surface contamination not measured or surface contamination limits according to footnote [1] not met

[3] for enclosure of the fuel in welded or brazed cans

Table 1.7b: Permissible heavy metal mass for damaged fuel rods and not canned fuel

Burn-up	GWd/Mg_U max.	33			62		
Cooling time	days min.	120	730	3650	120	730	3650
PWR and BWR fuel rods	kg	6.5	12.4	17.1	4.1	6.5	8.7

Content 2

Table 2: general specification for content 2

Property	Specification
Chemical composition of the active zone	- Uranium-Plutonium-Mixed-oxide and/or –carbide And/or - Uranium oxide and/or Uranium carbide - Gadolinium in form of Gd_2O_3 is allowed
Fuel composition before irradiation	- Mixture of Plutonium and depleted or natural Uranium or reprocessed Uranium or Uranium with an enrichment of maximum 1.0 wt.% U-235 in the Uranium and/or - Enriched natural Uranium or enriched Uranium from reprocessing and/or - natural Uranium or depleted natural Uranium or depleted reprocessed Uranium
Fuel composition after irradiation	Actinides, fission and activation products from irradiation in the reactor. The material can be irradiated or un-irradiated.
Geometry of pellets	arbitrary
Geometry of fuel rods	arbitrary
Geometry of fuel assemblies	arbitrary
Loading of non fissile materials	Loading of non fissile materials in solid form is acceptable
Cladding tube material	Stainless steel, Zirconium alloys, Aluminium
Not acceptable materials	Graphite or Beryllium are not allowed in the inner cask volume
Thermal power	Flooding of the inner cavity with Helium and transport without a closed container: max. 3000 W; max. 1340 W / 2 m; max. 730 W / m; max. 380 W / 0.5 m Flooding of the inner cavity with Helium and transport in a closed container: max. 2500 W; max. 1110 W / 2 m; max. 730 W / m; max. 380 W / 0.5 m Flooding of the inner cavity with air and transport with or without a closed container: max. 750 W; max. 580 W / 2 m; max. 580 W / m; max. 290 W / 0.5 m

Table 2.15: Specification for content 2.15

Property	Specification
Physical form	- Damaged or undamaged fuel rods - Fuel rods in welded or brazed cans - Fuel rod sections, pellets and pellet scraps in welded or brazed cans
Fuel composition before irradiation	1. Uranium-Plutonium-Mixed-oxide or Uranium-Plutonium-Mixed-carbide with: maximum 100.0 wt.% Pu_{tot} in heavy metal maximum 94.0 wt.% Pu_{fiss} in Pu_{tot} minimum 6.0 wt.% Pu-240 in Pu_{tot} maximum 15.0 wt.% Pu-241 in Pu_{fiss} maximum 94.0 wt.% U-235 in Uranium 2. Uranium oxide or Uranium carbide with an enrichment of maximum 94.0 wt. % of U-235 in Uranium
Hydrogen density in the fuel	Atom ratio $H/(Pu_{fiss} + U\text{-}235) \leq 1$
Burn-up	maximum 120 GWd/Mg_U
Cooling time	minimum 120 d, see Table 2.15a
Inner components	Drawing 1-090-111-00-00: payload max. 95 kg (maximum inner diameter 12 cm) Drawing 1-090-113-00-00: payload max. 103 kg
Heavy metal mass before irradiation	see Table 2.15a
Activity inventory	maximum $2 \cdot 10^4$ TBq, maximum $8 \cdot 10^5$ A_2
Fissile material cross section	maximum 113 cm^2 (equivalent diameter 12 cm)
Fissile material height	max. cavity length
Mass of fissile material before irradiation	Maximum 8250 g ($m_{Pufiss} + m_{U\text{-}235}$) total, from which: - maximum 8250 g in the form of Uranium-Plutonium-Mixed-oxide or - maximum 8250 g in the form of Uranium-carbide or - maximum 300 g in the form of Plutonium-carbide

Table 2.15a: Permissible heavy metal mass for undamaged fuel rods and canned fuel

Burn-up	GWd/Mg_U max.	33			62			120[3]		
Cooling time	days min.	120	730	3650	120	730	3650	120	730	3650
PWR-fuel rods	kg	17.5	20.5	21.0	16.0	18.5	19.5	11.5	13.5	15.0
BWR and fast breeder-fuel rods[1]	kg	17.5	20.5	21.0	16.0	18.5	19.5	11.5	13.5	15.0
BWR and fast breeder fuel rods[2]	kg	14.0	15.5	16.0	2611.0	12.0	12.5	7.0	7.8	8.2

[1] for a proven compliance of a surface contamination of $\leq 5.2 \cdot 10^6$ Bq/cm^2 (33 GWd/Mg_U), $\leq 9.8 \cdot 10^6$ Bq/cm^2 (62 GWd/Mg_U), $\leq 1.9 \cdot 10^7$ Bq/cm^2 (120 GWd/Mg_U)

[2] surface contamination not measured or surface contamination limits according to footnote [1] not met

[3] for enclosure of the fuel in welded or brazed cans

Content 5

Table 5: general specification for content 5

Property	Specification	
Chemical composition of the active zone	arbitrary The content must not have other dangerous properties. Organic materials are not allowed	
Physical form	solid	
Thermal power	Flooding of the inner cavity with Helium and transport without a closed container	max. 3000 W max. 730 W / m max. 380 W / 0.5 m
	Flooding of the inner cavity with Helium and transport in a closed container	max. 2500 W max. 730 W / m max. 380 W / 0.5 m
	Flooding of the inner cavity with air and transport with or without a closed container	max. 750 W max. 580 W / m max. 290 W / 0.5 m
Fissile mass	$m_{U\text{-}233} + m_{U\text{-}235} + m_{Pu\text{-}239} + m_{Pu\text{-}241} \leq 15$ g	

Table 5.1: Specification for content 5.1

Property	Specification
Physical form	- structural materials and cladding tubes of fuel assemblies - surface contaminated parts from hot cells
Fuel composition before irradiation	Uranium oxide with an enrichment of max. 7.0 wt% of U-235 in Uranium
Hydrogen density in the fuel	Atom ratio H/U-235 ≤ 1
Burnup	max. 120 GWd/Mg_U
Cooling time	min. 120 days
Inner components	without inner components: payload max. 350 kg drawing 0-090-108-00-00: payload max. 100 kg drawing 1-090-109-00-00: payload max. 95 kg drawing 1-090-110-00-00: payload max. 100 kg drawing 1-090-111-00-00: payload max. 95 kg drawing 0-090-112-00-00: payload max. 100 kg
Mass of structural material	see Table 5.1a
Mass of heavy metal before irradiation	see Table 5.1b
Activity inventory	max. 3000 A_2 (fission products and actinides)

Table 5.1a: Permissible mass of structural materials

Burnup	GWd/Mg_U max.	33			62			120[3]		
cooling time	days min.	120	730	3650	120	730	3650	120	730	3650
PWR fuel rods	kg	126	138	140	54	63	66	7.0	13.5	19
BWR fuel rods[1]	kg	126	138	140	54	63	66	7.0	13.5	19
BWR fuel rods[2]	kg	14	15	15.5	6.0	7.0	7.3	0.8	1.5	2.1

[1] for a proven compliance of a surface contamination of ≤ $5.2 \cdot 10^6$ Bq/cm^2 (33 GWd/Mg_U), ≤ $9.8 \cdot 10^6$ Bq/cm^2 (62 GWd/Mg_U), ≤ $1.9 \cdot 10^7$ Bq/cm^2 (120 GWd/Mg_U)

[2] surface contamination not measured or surface contamination limits according to footnote [1] not met

[3] for enclosure of the fuel in welded or brazed cans

Table 5.1b: Permissible heavy metal mass before irradiation

Burnup	U-235	U-total
GWd/Mg_U	g	g
33	15	468
62	15	333
120	15	210

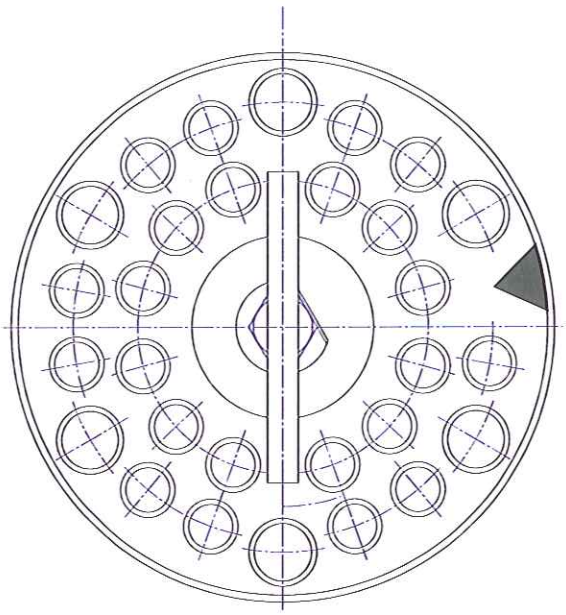


Fig. 1: Centering frame ZG-BSK-NA/SA
Drawing no. 0-090-108-00-00

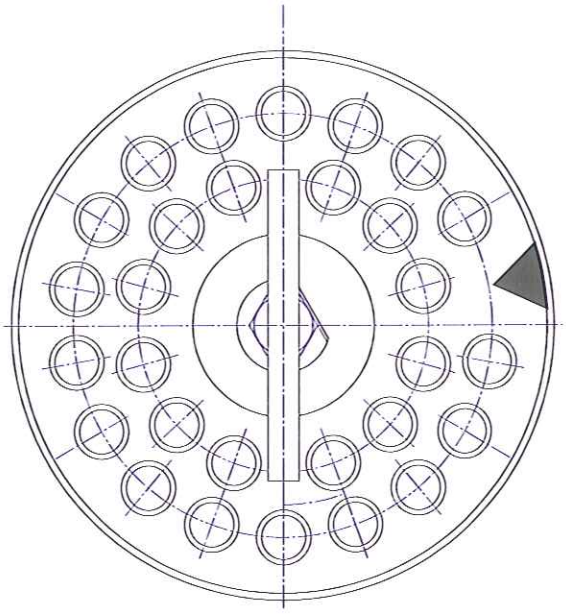
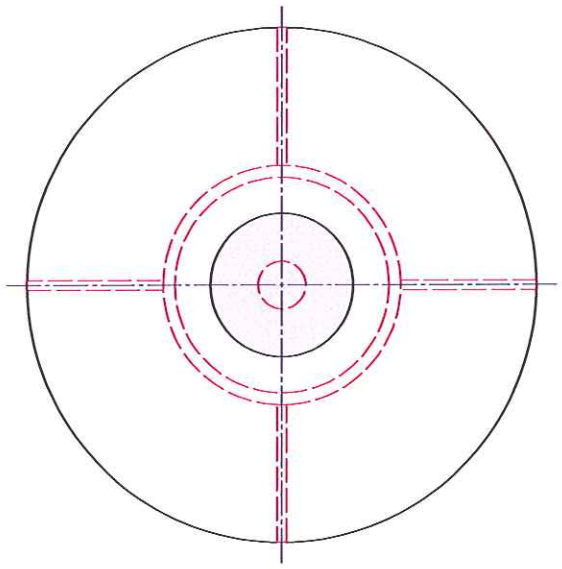


Fig. 2: Centering frame ZG-BS-NA/SA
Drawing no. 0-090-112-00-00

Design I



Design II
For outer diameter of Pos. 8 equal or greater 200 mm Pos. 4 is not used

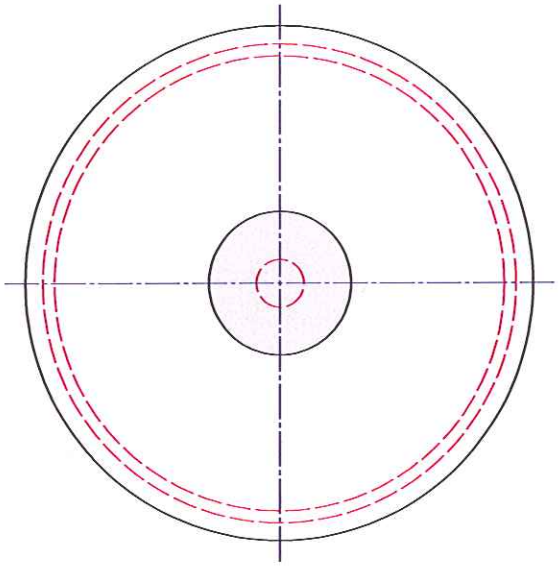


Fig. 3 and 4: Centering frame ZG-ZR-NA/SA (2 designs)
Drawing no. 1-090-109-00-00

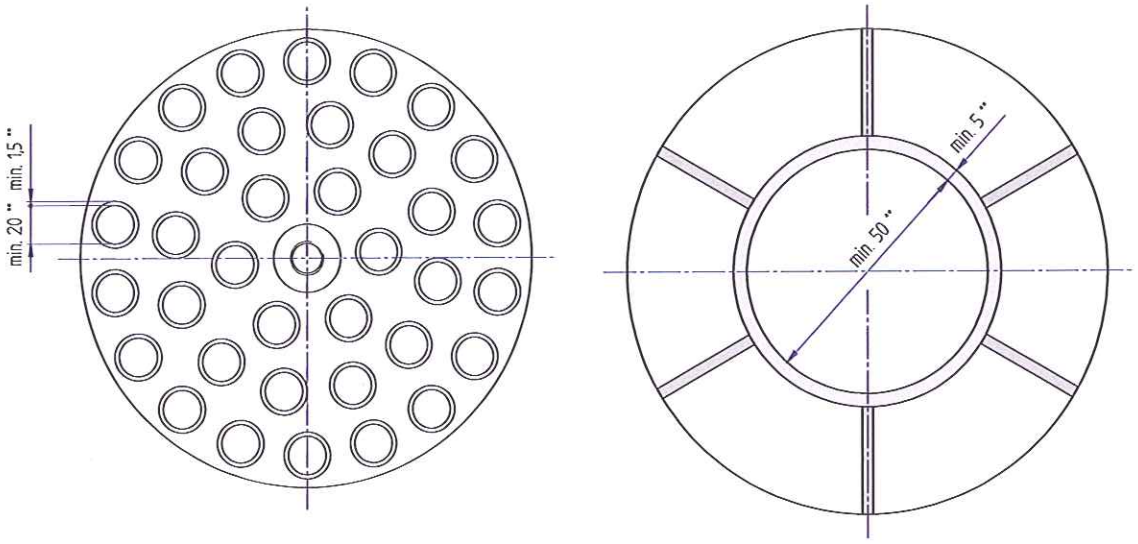


Fig. 5 and 6: Centering frame ZG-OA-NA/SA (different cross sections)
Drawing no. 1-090-110-00-00

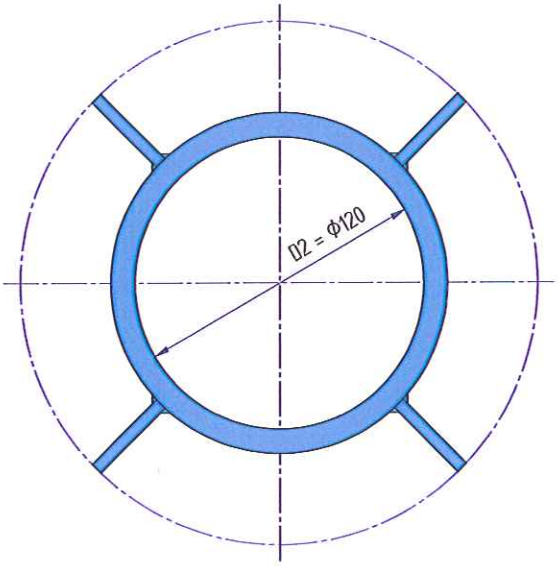


Fig. 7: Centering frame ZG-ZRS-NA/SA (diameter (D2) variable, maximal 18 cm)
Drawing no. 1-090-111-00-00

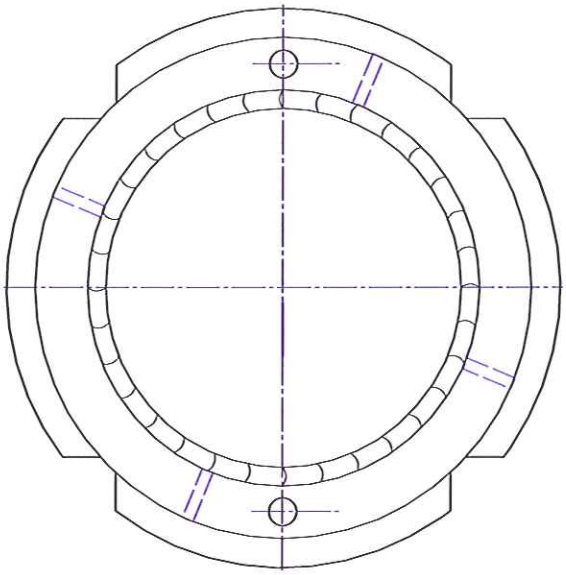
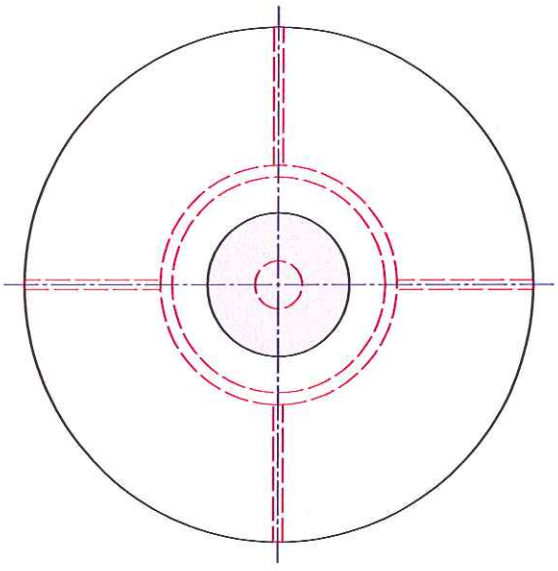


Fig. 8: Insert basket EK-OH-SA
Drawing no. 1-090-114-00-00

Design I



Design II
For outer diameter of Pos. 8 equal or greater 200 mm Pos. 4 is not used

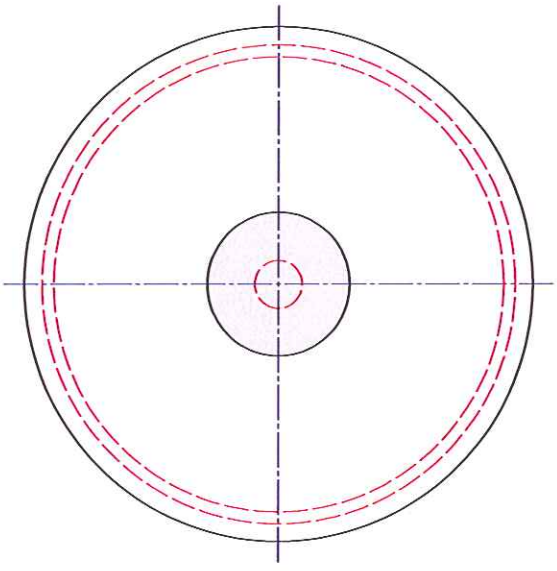


Fig. 9 and 10: Centering frame ZG-ZR100-NA/SA (2 designs)
Drawing no. 1-090-115-00-00

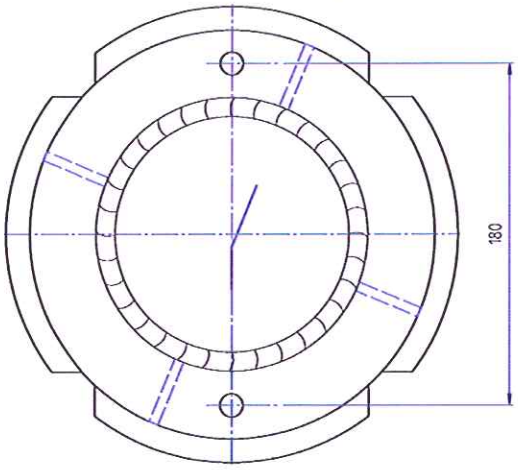
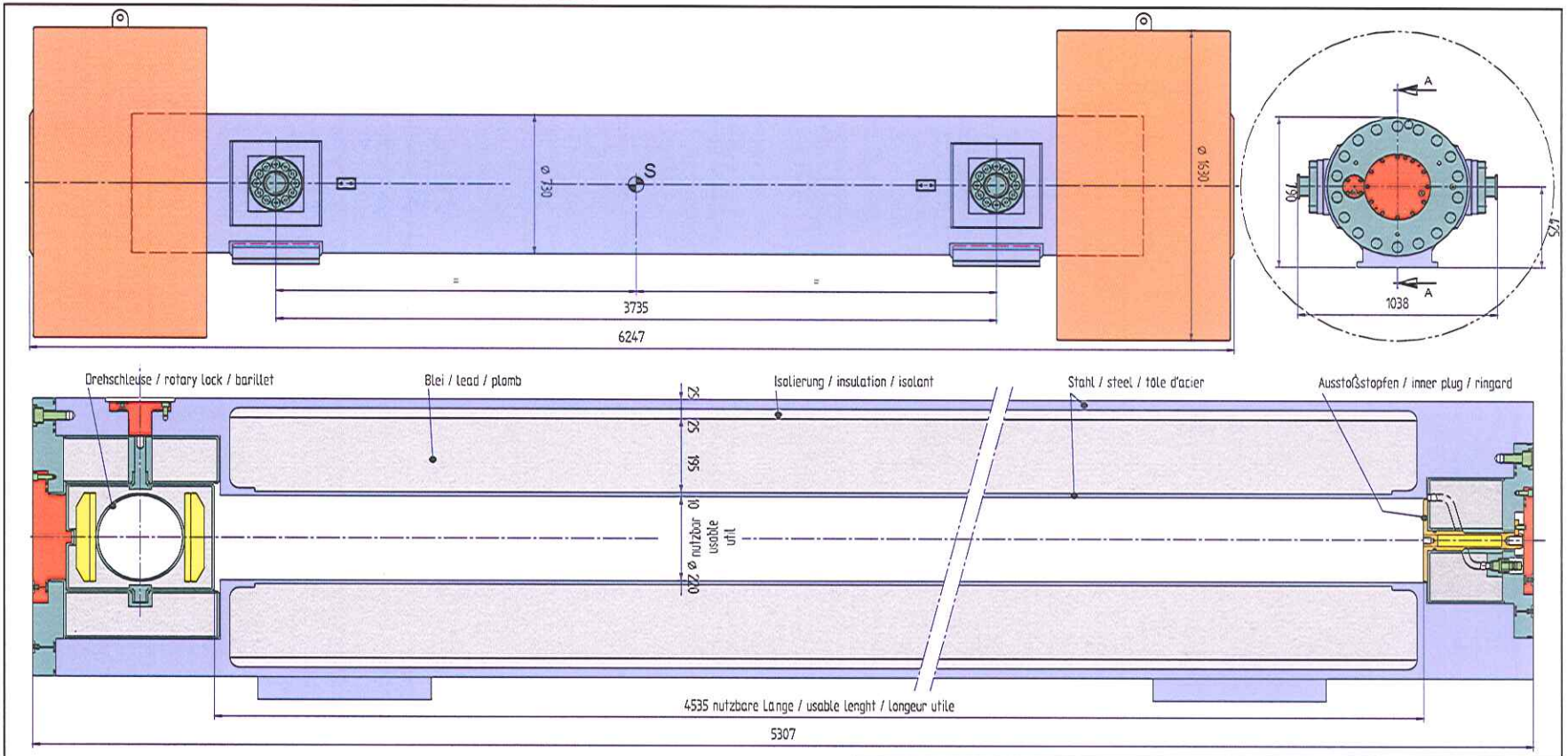


Fig. 11: Insert basket EK-CEA-SA
Drawing no. 1-090-113-00-00

NUR ZUR INFORMATION ! / ONLY FOR INFORMATION ! / POUR INFORMATION !



SCHNITT A - A
Section A - A
Coupe A - A

Massen / mass / Masse:

Behälter / body / Corps	: 19.650 kg
Deckelstoßdampfer / lid shock absorber / Capot avant	: 1.330 kg
Bodenstoßdampfer / bottom shock absorber / Capot arrière	: 1.330 kg
Tara / tare / Tare	: 22.310 kg
max. Zuladung / max. pay load / Charge utile max.	: 350 kg
max. Brutto / max. gross / Poids brut max.	: 22.660 kg

NCS NUCLEAR CARGO + SERVICE GMBH

DATENBLATT
DATASHEET

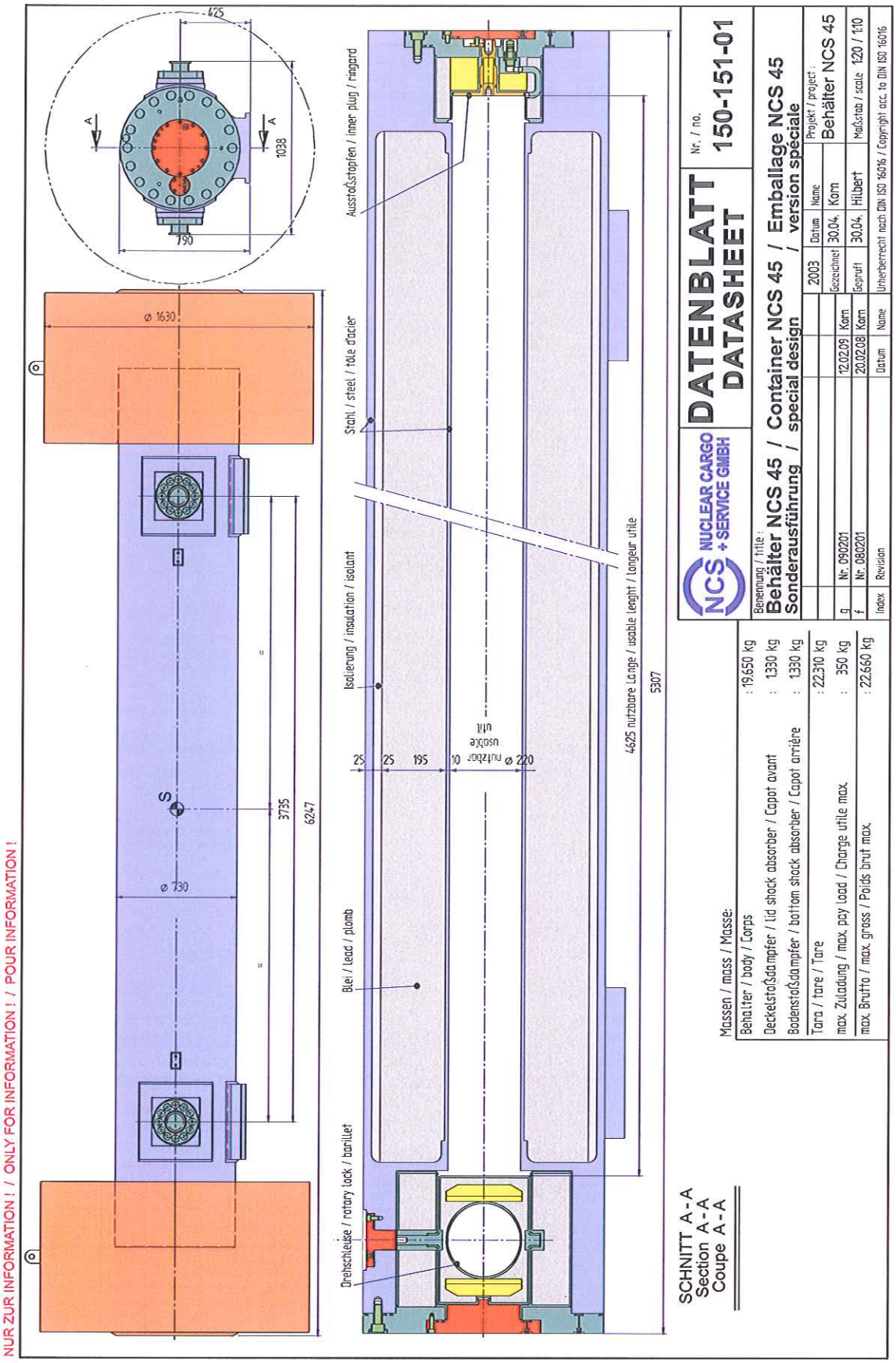
Nr. / no. **150-151-00**

Benennung / title :
Behälter NCS 45 / Container NCS 45 / Emballage NCS 45
Normalausführung / standard design / version normale

				2001	Datum	Name	Projekt / project : Behälter NCS 45
				Gezeichnet	31.07.	Korn	
i	Nr. 090201	12.02.09	Korn				
h	Nr. 080201	20.02.08	Korn	Geprüft	31.07.	Hilbert	Maßstab / scale 1:20 / 1:10
Index	Revision	Datum	Name	Urheberrecht nach DIN ISO 16016 / Copyright acc. to DIN ISO 16016			

- Attachment 3 Page 1 to Certificate of Approval D/4347/B(U)F-96 (Rev. 2) -

Translation


NUR ZUR INFORMATION ! / ONLY FOR INFORMATION ! / POUR INFORMATION !
SCHNITT A-A
Section A-A
Coupe A-A
Drehschieuse / rotary lock / barillet
Blei / lead / plomb
Isolierung / insulation / isolant
Stahl / steel / tôle d'acier
Ausstoßstopfen / inner plug / ringard
4625 nutzbare Länge / usable lenght / longeur utile
5307
6247
3735
ø 1630
ø 730
ø 220
790
1038
425
NUCLEAR CARGO + SERVICE GMBH
DATENBLATT
DATASHEET
Nr. / no.
150-151-01
Benennung / title:
Behälter NCS 45 / Container NCS 45 / Emballage NCS 45
Sonderausführung / special design / version spéciale
Projekt / project:
Behälter NCS 45
Maßstab / scale 1:20 / 1:10
Massen / mass / Masse:
Behälter / body / Corps : 19.650 kg
Deckelstoßdämpfer / lid shock absorber / Capot avant : 1330 kg
Bodenstoßdämpfer / bottom shock absorber / Capot arrière : 1330 kg
Tara / tare / Tare : 22.310 kg
max. Zuladung / max. pay load / Charge utile max. : 350 kg
max. Brutto / max. gross / Poids brut max. : 22.660 kg
Index Revision Datum Name
g Nr. 090201 12.02.09 Kern
f Nr. 080201 20.02.08 Kern
2003 Datum Name
Gezeichnet 30.04. Kern
Geprüft 30.04. Hilbert
Urheberrecht nach DIN ISO 16016 / Copyright acc. to DIN ISO 16016

Type List

for the transport packaging NCS 45

Packagings of type NCS 45 which were or are manufactured according to the parts lists listed in the following comply with the design certified in this certificate of package approval (see also collateral clauses 2, 3 and 7).

Parts list, Revision	Release by BAM
150-151, Rev. t	Design examination certificate of BAM of June 11, 2008 (Ref.: III.3/20837)
150-151, Rev. w	1st Amendment to the design examination report of BAM dated 22.03.2010 (Ref.: III.3/20837)
150-151, Rev. x	2nd Amendment to the design examination report of BAM dated 23.11.2011 (Ref.: III.3/20837) including the supplementary letter of BAM to the 2nd amendment dated July 17, 2012

Salzgitter, August 09, 2012

In representation

Thiele