

## **Transportation of Spent Research Reactor Fuel to USA - 11110**

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### **ABSTRACT**

Under the umbrella of the “Global Threat Reduction Initiative” (GTRI) which expands the “Reduced Enrichment for Research and Test Reactors” (RERTR) and the “Russian Research Reactor Fuel Return” (RRRFR) Programs spent fuel of research reactors containing high enriched Uranium (HEU) was transported from all over the world to the USA and to Russia. The presentation will concentrate on transportation to the USA.

For this kind of transportation the following main challenges have to be met:

- Availability of casks designed for the respective material and fulfilling the boundary conditions of the reactors (e.g. size, weight);
- Availability of a certificate of package approval or validations, respectively, in the country of origin of the shipment, and any other country through or into which the consignment is transported;
- Availability of transport means, especially a vessel suitable for this kind of transport;
- Physical protection;
- And last but not least economic restrictions.

Nuclear Cargo + Service GmbH (NCS) operates two types of casks suitable for HEU spent research reactor fuel. The cask type TN7-2 has a shipping gross weight of approx. 25 to and can accommodate up to 64 fuel elements with an enrichment of up to 94 wt.% U-235 in uranium. The cask type GNS 16 has a shipping gross weight of approx. 15 to and can accommodate up to 33 fuel elements with an enrichment of up to 94 wt.% U-235 in uranium.

The presentation will give a short overview about the design of the two cask types and a summary of the permissible contents. The licensing and validation status will be described including a short discussion of new requirements during periodic reviews of the certificate of package approval. Finally, a recently completed shipment will be used to highlight the schedule for planning and carrying out such a transport.

### **INTRODUCTION**

The “Reduced Enrichment for Research and Test Reactors” (RERTR) Program was initiated by the U.S. Department of Energy in 1978. During the Program’s existence, over 40 research reactors have been converted from HEU (20% or more U-235 enrichment) to LEU (less than 20% U-235 enrichment). The “Russian Research Reactor Fuel Return” (RRRFR) Program was launched by the USA, the Russian Federation and the IAEA in 1999. By mid of 2010, over

1.3 Mg of HEU has been returned to Russia under this Program. The “Global Threat Reduction Initiative” (GTRI) announced by the U.S. in 2004 continued and extended the RERTR and RRRFR Programs.

### **CASKS FOR THE TRANSPORT OF RESEARCH REACTOR FUEL**

For the transport of research reactor fuel Nuclear Cargo + Service GmbH (NCS) operates two casks of design type TN7-2 and two casks of design type GNS 16. The main data are given in Table I.

Table I: Main Data of the Casks of Design Types TN7-2 and GNS 16

<b>Item</b>	<b>Unit</b>	<b>TN7-2</b>	<b>GNS 16</b>
Diameter (without shock absorbers)	mm	1 030	1 200
Diameter (with shock absorbers)	mm	1 660	1 800
Height (without shock absorbers)	mm	3 136	1 535
Height (with shock absorbers)	mm	3 936	2 075
Mass (as presented for transport)	kg	24 650	15 250
Thermal capacity	W	3 000	1 320
Max. allowable radioactivity	PBq	39	63
Max. enrichment in U-235	wt. %	94	94
Capacity box shaped fuel elements	-	64	33
Capacity tubular fuel elements	-	60	28
Capacity TRIGA fuel elements	-	-	90
License type	-	B(U)F-96	B(U)F-85
License expiry date	-	08/2012	04/2013
Number of available casks	-	2	2

#### **Design Type TN7-2**

The transport cask TN 7-2 consists of a cylindrical stainless steel exterior container, a centric integrated cylindrical stainless steel inner container, each with welded on bottom, between which a lead shielding is positioned (185 mm in the wall region, 170 mm in the bottom region) which is

surrounded by a thermal insulation made of humid cement. The cask is closed with a stainless steel lid with an integrated lead shielding (165 mm).

In the bottom of the cask body and in the lid are connections for draining, flushing and drying of the inner cavity which are closed by protective lids. In the cask inner cavity there are located up to four insert baskets for the accommodation of the fuel elements or capsules. In the upper and lower region of the cask mantle are two trunnions fixed with bolts for handling and transport of the cask. The transport cask is equipped with lid and bottom shock absorber which are part of the package. The transport cask is transported horizontally in a transport frame.

The “containment system” consists of the inner container, the screwed on lid with EPDM-O-ring-gaskets and the screwed on protective lids with EPDM-O-ring-gaskets in the cask bottom and cask lid.

The “confinement system” consists of the cask body with lids including the screws and gaskets, the respective baskets and the fuel elements respectively fuel plates.

Fig. 1 shows the TN7-2 in horizontal position in the transport frame and Fig. 2 contains the data sheet of the design type TN7-2.

### **Design Type GNS 16**

The design type GNS 16 is similar to the design TN7-2. It consists of a cylindrical body with an upper primary lid which is fixed to the cask body by bolts and sealed by an EPDM-O-ring-gasket. Above the primary lid there is a protective plate bolted to the cask body. The cask body consists of an inner liner with welded bottom plate made from stainless steel, the outer shell with welded bottom plate made of stainless steel and the head ring which is welded to inner liner and outer shell. The space between inner liner and outer shell is filled with lead. A protective sheet protects the outer shell in the area between the two shock absorbers. The lid has an opening to insert a draining device; this opening is closed by a screwed on protective lid sealed with EPDM-O-ring-gaskets. In the upper part there are two trunnions fixed to the outer shell for vertical handling.

The containment consists of the inner liner with bottom plate, the head ring, the primary lid with the protective lid and the respective bolts and EPDM-O-ring-gaskets.

The cavity of the cask accommodates the basket which consists either of rectangular or circular shafts made of stainless steel or cast aluminum to accommodate the fuel elements. Depending on reactivity of the fuel elements borated steel plates might be used to control reactivity of the basket. The maximum capacity of a basket is 33 fuel elements.

The cask is equipped with a lid and bottom shock absorber to reduce impact forces onto the cask during a hypothetical transport accident. The transport is carried out in a 20' ISO container which is considered to be the easily accessible surface on which dose rate limits are to be observed.

Fig. 3 shows the loading situation of the GNS 16 cask in a pool. The lid has been removed and the basket is exposed. Fuel elements have already been loaded into the basket. Fig. 4 shows a sketch of the GNS 16 with the main dimensions.



Fig. 1: Cask of design type TN7-2 on transport frame

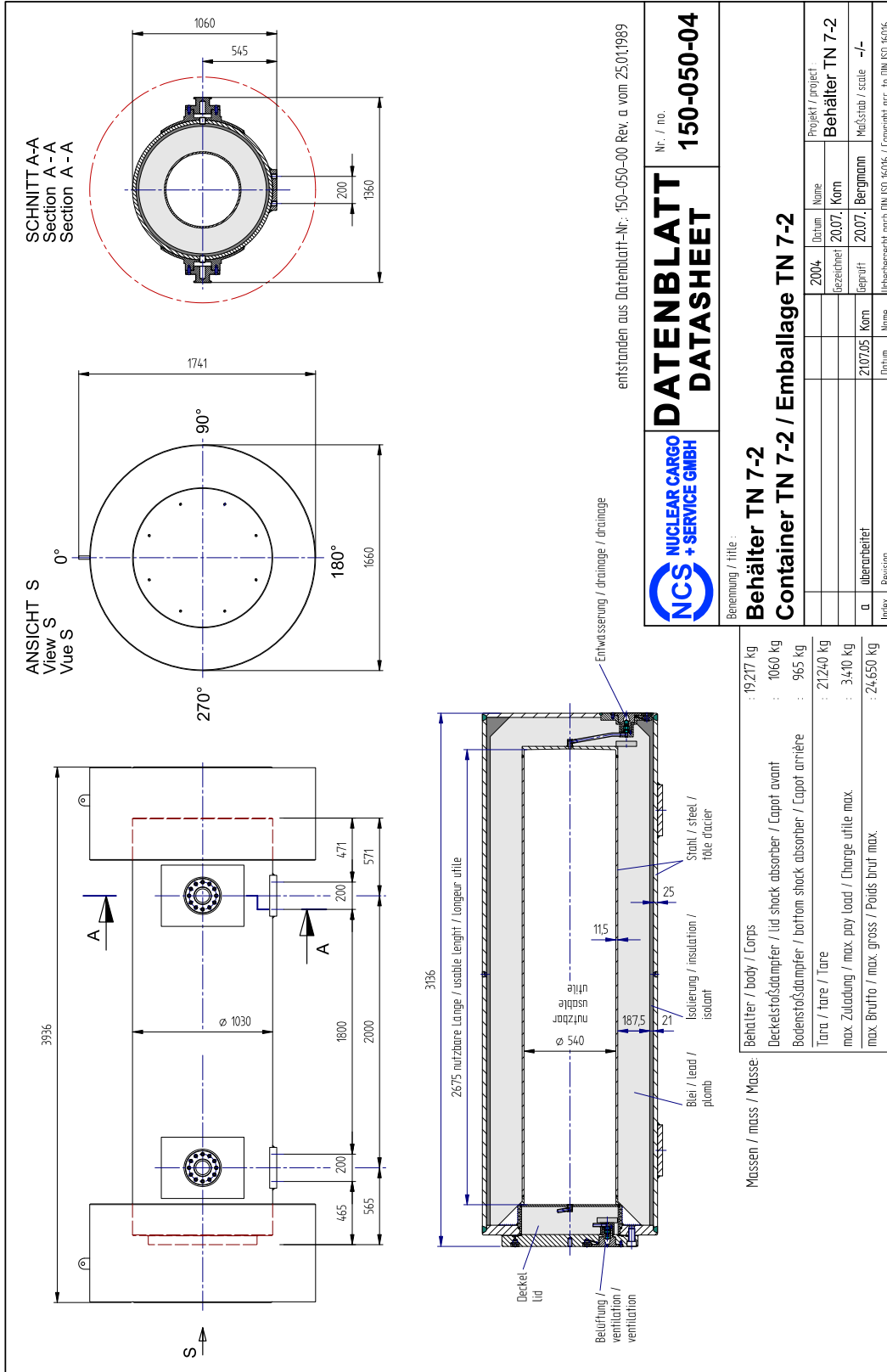


Fig. 2: Data sheet of design type TN7-2

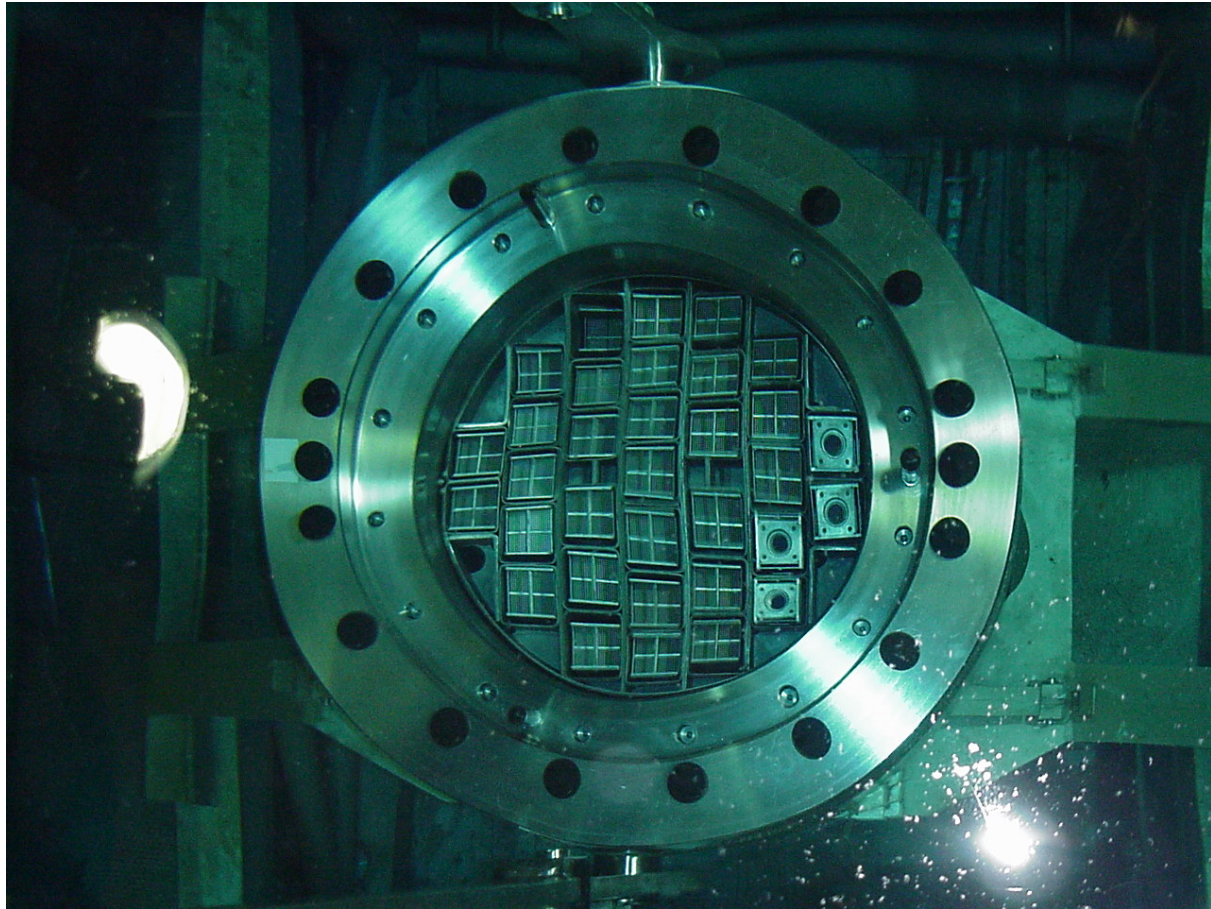


Fig. 3: Body and partially loaded basket of cask of design type GNS 16 (lid removed, view from above)

## LICENSING ISSUES

The cask of design type TN7-2 received its first license in 1985 under the “Regulations for the Safe Transport of Radioactive Material, 1985 Edition”. In 2007 the license was upgraded to the “Regulations for the Safe Transport of Radioactive Material, 1996 Edition”. This upgrade required considerable effort concerning the documentation but no physical changes on the cask itself.

- Revision of the complete safety analysis report based on the new Regulations
- New handling, maintenance and testing instructions
- Full safety assessment by the German Competent Authority

The upgrade was successfully completed in a period of approx. 2 years.

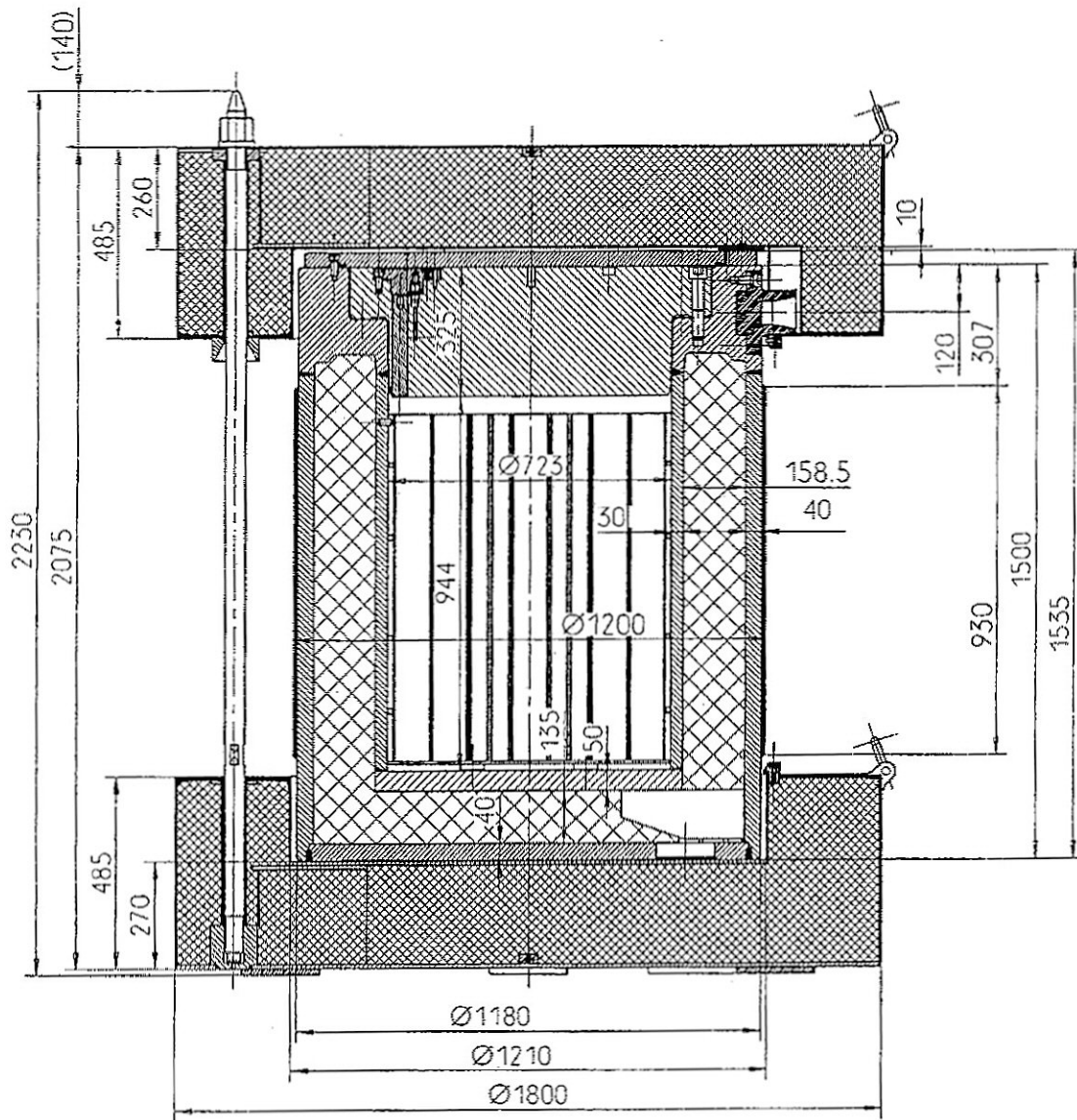


Fig. 4: Data sheet of design type GNS 16

The cask of design type GNS 16 received its first license in 1998 under the “Regulations for the Safe Transport of Radioactive Material, 1985 Edition”. In the last prolongation procedure, which started in 2009, requirements were raised by the German Competent Authority to revise the complete set of handling, maintenance and testing instruction and upgrade the instruction to the same level than previously asked for the TN7-2. The work on this revision process and the

subsequent assessment by the Competent Authority was successfully completed after about 1.5 years.

## TRANSPORT EXPERIENCE

Under the RERTR Program NCS carried out transports of research reactor fuel from all over the world to the USA. In total 52 transports carrying 2554 fuel elements were carried out between 1994 and 2010. Table II contains a summary of the transports with the casks types GNS 11 (license expired), GNS 16 and TN7-2.

Table II: List of Transports of Research Reactor Fuel to U.S.A Carried out since 1978

Type of cask	Transport from	No of casks shipped	No of fuel elements shipped	Period
GNS 11 a	Brazil	2	66	1999
GNS 11 a	Germany	24	718	1987-2000
GNS 11 a	Netherlands	1	33	1994
GNS 16	Brazil	2	61	1999
GNS 16	Germany	15	552	1999-2010
GNS 16	Sweden	4	115	2007-2008
TN7-2	Australia	4	240	1998-2006
TN7-2	Germany	6	458	2000-2008
TN7-2	Italy	1	12	2000
TN7-2	Sweden	15	940	1994-2008
TN7-2	Switzerland	3	176	1995-1997

a The license of design type GNS11 expired in 2000



## **TRANSPORT OF 45 FUEL ELEMENTS FROM GERMANY TO USA**

In the following the major issues of a recent transport of fuel elements with 2 GNS 16 casks from Germany to USA are described.

T0: Inquiry to carry out the transport of fuel assemblies from Germany to USA

Questions to be answered:

- Is a suitable cask available?  
Both cask types, the TN7-2 and the GNS 16 were able to carry the fuel type foreseen for the transport. However, the crane capacity at the place of loading was not sufficient for the TN7-2 cask. Hence, only the GNS 16 was considered suitable for the transport. For the 45 fuel assemblies two casks must be used which were then blocked for the foreseen transport period.
- Is the certificate of package approval valid for the foreseen transport date and validated in the countries through or into which the cask is transported?  
The certificate of package expired before the foreseen transport date. Therefore a prolongation was applied for immediately.
- Are there suitable transport means available?  
Inquiries were sent out to qualified companies to assure the availability of road transportation in Germany and USA
- Is there a vessel of INF 2 category available licensed to carry spent nuclear fuel?
- Many other questions – duties, nuclear liability, import/export licenses, etc.

T0 + 4 months: All questions answered, technical offer sent to customer.

The prolongation of the certificate of package approval took considerable time and effort, because the German Competent Authority requested a complete revision of the handling, maintenance and testing procedures.

T0 + 14 months: New certificate of package approval issued; this triggered:

- Immediate application for validation of the certificate of package approval in the USA
- Fixed booking of the vessel
- Full activity on preparation work – road transportation in Germany and USA, liabilities, import/export licenses, etc.

T0 + 16 months: Validation of the certificate of package approval in USA issued

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The validation of the certificate in USA took only about 2 months because the former revision has been also validated and there were no relevant changes in the prolonged certificate.

T0 + 18 months: Loading of two GNS 16 casks at the place of loading and departure by truck, transport to the port and transfer of the casks to the vessel; sea transport to U.S.A port and subsequent road transport to destination

The vessel carried only the two loaded GNS 16 casks!

T0 + 19 months: arrival at destination and unloading of the two GNS 16 casks

## **CONCLUSION**

19 months from inquiry to arrival at the destination may seem for people transporting “normal” goods rather long; for experts in the transport of radioactive material this period might be even considered rather short.

The basic issue is the availability of a cask suitable to be handled at the reactor and at the destination. The design, licensing and manufacturing of a new cask is no realistic option as this task might take 5 years or more to be completed and would usually be quite above any reasonable budget.

The next issue is the validity of the certificate of package approval for the content to be transported and for the date foreseen for the transport. An application for extension and/or prolongation must be filed with the Competent Authority of the country of origin of the cask design and additional safety analyses might be required to substantiate this application.

The time required for the licensing procedure for the certificate of package approval will usually dominate the transport planning by far. Only after the certificate was issued in the country of origin preparation work for the transport can start in full. The time required for the validation of the certificate in the other countries affected by the transport is vaguely predictable, if the design is already known in these countries.

Compared to the preparation and planning phase the time required for the real transport is considerable small, provided that preparation and planning are carried out with extensive subject matter expertise and dedication.

The transport of spent research reactor fuel is a challenging task. NCS has the experience, personnel and equipment to meet this challenge in full!