The BG 18 Container: B(U)F Type Packaging for the Transport of Irradiated Fuel Rods or Materials Between Nuclear Power Plants and Research Laboratories

W. Claes

SCK•CEN, Boeretang 200, 2400 Mol, Belgium

J. Sperlich

Transnubel, Gravenstraat 73, 2480 Dessel, Belgium

Abstract

The BG 18 package was constructed in 1984 and has been approved according to the applicable IAEA safety regulations until 1995.

In 1998 the SCK•CEN and TNB (Transnubel) started with the upgrading of the container in order to make its use easier. The approval certificate in accordance to the IAEA safety regulations 1985 Edition (As amended 1990) has been delivered by the BfS in Germany (valid until end 2004).

The allowable contents cover most of the industrial or experimental irradiated fuel types: UO_2 or MOX, PWR or BWR, including high enrichment and burnup.

The design of the BG 18 package and the available auxiliary equipment make possible the handling and vertical loading/unloading under water as well as horizontal loading/unloading against a hot cell.

The physical capacity of the inner containment system allows the loading of up to 30 full-length fuel rods.

The SCK•CEN as owner of hot cell facilities and of the container is in a position to offer a complete service for examination of irradiated materials.

Transnubel as applicant of the BG 18 package can offer a complete transport service including all the transport formalities and the technical assistance for loading, transporting and unloading.

A first application of the modified package for full size irradiated fuel rods from a German power plant to the SCK•CEN hot laboratories is already planned for 2001.

1. Introduction

The BG 18 is a package designed and built by the German GOSLAR Company in 1984 at the request of the SCK.CEN. It was approved in accordance with the IAEA Safety Regulations until 1995. After a shipment of fuel rods between the Tihange 1 NPP and the SCK.CEN in 1985, it has been left unused but maintained in good condition.

In 1988 the SCK.CEN and TNB Companies started with the upgrading of the package in order to make it user friendly and to extend the allowable content.

A new Transport Safety Analysis Report (TSAR) has been presented to the German Licensing authorities in 1999. The approval certificate has been delivered by BfS (Bundesamt für Strahlenschutz) in August 2001 with a validity period of 3 years, in accordance with the Regulations for the Safe Transport of Radioactive Material, 1985 Edition (As Amended 1990).

2. Original configuration of the package

The BG 18 transport package is cylindrical and is equipped with a steel/lead/steel double envelope and with a 225 mm thick lead shielding in all directions. In the body cylindrical zone the package has a 15 mm thick thermal isolation layer embedded in a supplementary steel envelope.

The cavity is shielded and closed axially, in the front side by a turning lock and on the rear side by a massive plug equipped with an embedded draining spiral pipe. Each side is foreseen with a closure tight lid.

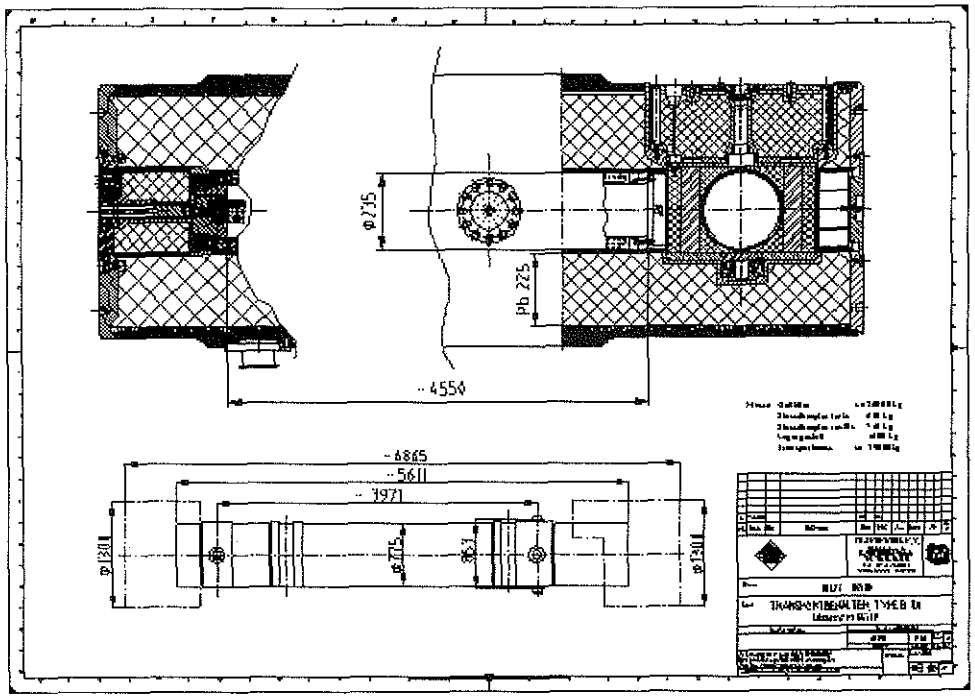


Figure 1 BG-18 package

The containment system is formed by a tube of large thickness with a welded bottom and closed with a tight bolted lid at the front side.

The transport package BG 18 is equipped with a rear side and a front side shock absorber, which belong to the package.

The package is shipped on a steel transport frame, which also serves for the tilting to the vertical position of the package around the pair of trunnions located on the rear side of the body. Two pairs of trunnions can be fixed on the front side of the body and used for the handling of the package with the help of lifting beams.

The main dimensions and masses are given on figure 1.

3. Modification of the package

3.1. Aim of the modifications

The modifications have been designed and performed in order to facilitate the draining, the drying and the control of leaktightness after a wet loading in a pool of a power station or research centre.

The modifications are essentially located on the rear side of the package body and of the inner containment system.

3.2. Description of the modifications

3.2.1. Rear side of the package

The closing system of the external part of the package, i.e. the closure lid at the rear side, has been slightly modified as a result of the modification of the inner containment system (see 3.2.2.).

3.2.2. Bottom of the inner containment

The inner containment bottom has been machined in order to be extended with a new stainless steel welded bottom piece. This bottom piece is equipped with a draining stop which keeps the inner containment tight and has draining apertures which make the draining of the vessel possible in vertical position through the draining stop opening. A special tooling has been developed which allows the mounting/dismounting of the draining stop.

The inner containment bottom side is equipped with an internal block locked with the help of a balls/springs system. This block can be unlocked with the help of the new developed tooling, making so possible to push the content (e.g. the basket with fuel rods) outside the package (case of the horizontal unloading in a hot cell)

3.2.3. Front side of the package

The minor modification at the front side is the insertion of a cylindrical volume between the turning lock and the front lid. The aim is only to reduce the interspace volume and so to increase the sensitivity of the leaktightness measurement.

3.2.4. Auxiliary equipment

3.2.4.1. Transport frame

The transport frame has been adapted in such a way that it can be easily split into two separate parts, after having fixed it on the carriage used for the introduction of the package inside the installation. This allows the lifting or tilting of the package from the horizontal to the vertical position in some specific configuration with insufficient stroke of the crane.

3.2.4.2. Tools for the operation of the package

Most of the tools remain unchanged such as:

- The shielding which is used for the mounting/dismounting of the lid of the inner containment;
- The key lock which allows the opening/closing of the turning lock.

A new orifice tooling has been developed and realised which allows all the operations related to the loading/unloading, to the draining, the drying and the controls of dryness and tightness.

4. Testing and qualification

The modification of the inner containment system and in particular the manufacturing of the new bottom piece and of the draining plug as well as the welding of the bottom piece have been performed according to a quality assurance programme approved by the licensing authorities.

This programme defined the manufacturing and control steps.

Regarding the sealing rings, EPDM rings have been foreseen for the inner vessel lid and draining plug as well as for the package upper and lower lids.

The sealing rings for the inner vessel have been supplied according to a specific quality programme involving testing by independent agreed laboratories.

4.1. Leaktightness testing

The tightness of the inner containment has been controlled with a Helium leak measuring system in following conditions. The inner containment is emptied with a vacuum pump and then filled with helium at ≥ 1 bar abs through the draining stop opening. The leak measuring device is connected to the cavity surrounding the inner containment. The cavity is put under vacuum and any He leakage is collected and measured by the system.

The measured leak rate fulfils the requirement of the safety analysis report. The helium leak testing is performed only for the maintenance inspection as required by the regulations. During transport operations the tightness of the package is controlled at the end of the loading and drying process, before shipment, by following method. The inner vessel is evacuated to an absolute pressure lower than 0,01 bar, then filled with dry air at 0,2 bar abs. and then closed. The surrounding cavity is filled with dry air to a pressure of 5 bar abs and the pressure drop measured after 1 hour. The criteria defined in the safety analysis report has been reached (satisfied) during preliminary testing at the CEN•SCK.

4.2. Trunnions testing

The trunnions used for the handling of the package fulfil the last edition of the rules KTA3905. They have undergone the overloading test as foreseen by the maintenance inspection programme.

5. Qualification and licensing

In the frame of the upgrading of the BG 18 transport package, a complete new TSAR – Transport Safety Analysis Report – has been elaborated and presented to the German Licensing Authorities, i.e. the BAM – Bundesanstalt für Materialforschung und –prüfung - and the BfS – Bundesamt für Strahlenschutz.

Among the chapters analysing the safety aspects such as namely the subcriticality, the dose rate or the thermal behaviour, the TSAR also includes the quality assurance programme related to the modification

works, the operating instructions and the periodical inspection programme for the package.

6. Technical specification

6.1. Package

The main features of the package are:

- overall length without shock absorbers : ca 5611 mm
- overall length with the shock absorbers : ca 6865 mm
- external diameter of the body : ca 775 mm
- overall distance between trunnions pair : ca 961 mm
- diameter of the shock absorbers : ca 1300 mm
- inner containment useful length : ca 4550 mm
- inner containment inner diameter : ca 162 mm
- mass of package without shock absorbers: ca 26000 kg
- mass in transport conditions (with transport frame and shock absorbers) : ca 29000 kg

The BG18 package is transported on its own dedicated trailer equipped with a tie-down system in accordance with the IAEA rules.

A basket in aluminium has been designed and supplied which allows the loading of rods up to 12 mm diameter. This basket fits the inner containment system and is provided with a removable handling grip. Alternative basket designs or geometry are possible for specific applications, as the basket is not part of the package approval.

6.2. Allowable contents

6.2.1. Fuel rods

The BG 18 package is approved to contain fresh or irradiated fuel rods or a combination of them. The fuel rods may be of the UO_2 or MOX type from PWR or BWR reactor plants.

These rods may be in one piece or cut, leaktight or leaking, have a length up to 4490 mm and a diameter up to 12 mm.

High burnup up to 80.000 MWd/t_M and high initial enrichment up to 10 % U-235 (UO_2 fuel) and 12 % fissile Pu (MOX fuel) are allowed within the limits fixed for the content.

These limits are:

- max. mass of the content : 86 kg
- max. thermal power : 2400 W
- min. cooling time for irradiated fuel : 6 months
- max. neutron source strength : 1.E+8 n/s

6.2.2. Irradiated non fissile materials

These materials may have any physical form; organic material inducing radiolysis effects are

excluded.

They may be loaded together with fuel rods if they don't include hydrogen as a component.

The same limits for the mass and residual thermal power are applicable as in 6.2.1.

The max. activity limit of irradiated non fissile material is:

Gamma radiation energy (MeV)	Max. activity (Bq)
0.575.	1.E+25
0.85	2.5.E+19
1.25	3.2.E+16
1.75	1.E+15
2.25	2.7.E+14

6.3. Operating instructions

Loading and unloading

- As general operation instruction exists document 10.120/53D part V. Specific operating instructions are available for the vertical loading or unloading of the package in a pool of nuclear power plants as well as for the horizontal unloading/loading against a hot cell.

6.3.1. Lifting device

A special lifting beam has been designed and constructed by SCK/TNB and approved by the German Authorities which allows the lifting and handling of the BG 18 package through a pair of upper trunnions. This lifting beam can fit the most crane hooks used in NPP for the lifting to the vertical position, for transportation and for dipping in the pool (submersible equipment).

6.3.2. Basket for fuel pins

The basket used for the transport of the fuel pins is a light aluminium structure, composed of tubes and spacing disks.

The grip of the basket is in stainless steel and fulfils the requirements of the KTA 3905 regulations applicable to the handling points used in the German nuclear power plants.

Within the dimensions of the inner vessel of the package other basket designs are possible and can be examined in order to meet specific client requirements.

7. Programmed application

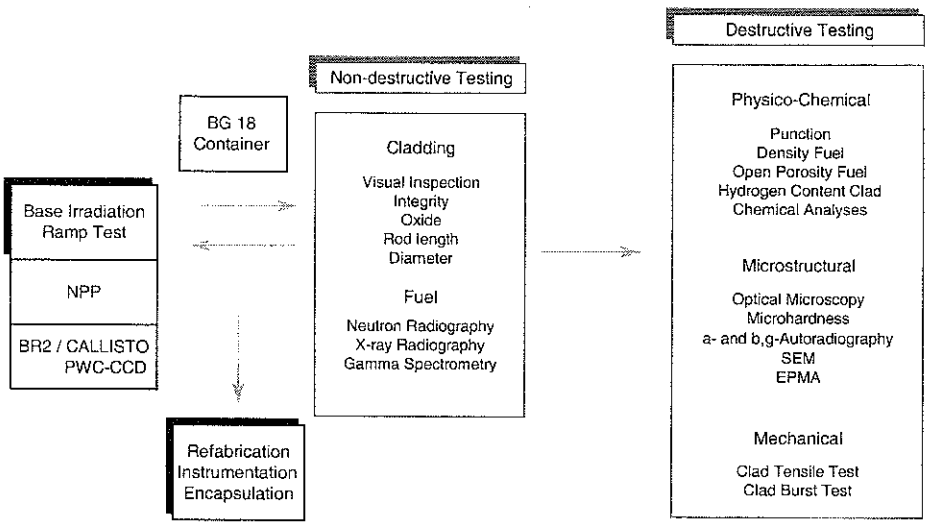
- KGB Gundremmingen
- GKN Neckarwestheim
- Tihange 1

8. Information on the transport and applicant company

TRANSNUBEL is a Belgian company, located in Dessel near Mol, active on the field of the transport of radioactive fuel, radioactive materials or wastes, in particular fresh MOX fuel pins.

They also can offer engineering support for equipment and technical assistance in the field of the operation and the maintenance of the packages used for the conditioning and transport of those products.

9. Information on the SCK.CEN hot cell operations



10. Contact persons

- TRANSNUBEL
  Gravenstraat, 73
  B-2480 Belgium
  Phone: +32 14 33 11 11
  Fax: +32 14 31 89 48
  e-mail: tnb.secr@glo.be
- Equipment and Technical Assistance Department :
  - M. Jean-Pierre Lahaye (phone +32 14 33 11 57) Department Manager
  - M. Jürgen Sperlich (phone +32 14 33 11 52) Project Manager
- Transport Department Manager : M. Guy Merckaert (phone +32 14 33 11 20)

11. Conclusions

With the upgrading of the BG 18 container the SCK-CEN and TRANSNUBEL have the opportunity to arrange nuclear transports between NPP and their own hot cells. These transport facilities are available as well to serve other companies.