

## RAJ-II AND NPC SHIPPING CONTAINERS DEVELOPMENT AND LICENSING STATUS

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### ABSTRACT

GNF has replaced its aging fuel bundle and drum type containers with the new generation RAJ-II and NPC packages. Both packages are constructed of stainless steel and engineered impact absorbing and fire insulating materials. The RAJ-II is currently licensed as a Type B(F) container for shipping BWR fuel bundles, mixed oxide, and channeled fuel bundles. The NPC is licensed as Type A(F) used to ship homogeneous or heterogeneous uranium bearing material that is enriched up to 5% U<sup>235</sup>. To meet the growing demands for shipping higher enrichments, NPC is currently being evaluated for Type B certification.

### RAJ-II SHIPPING CONTAINER

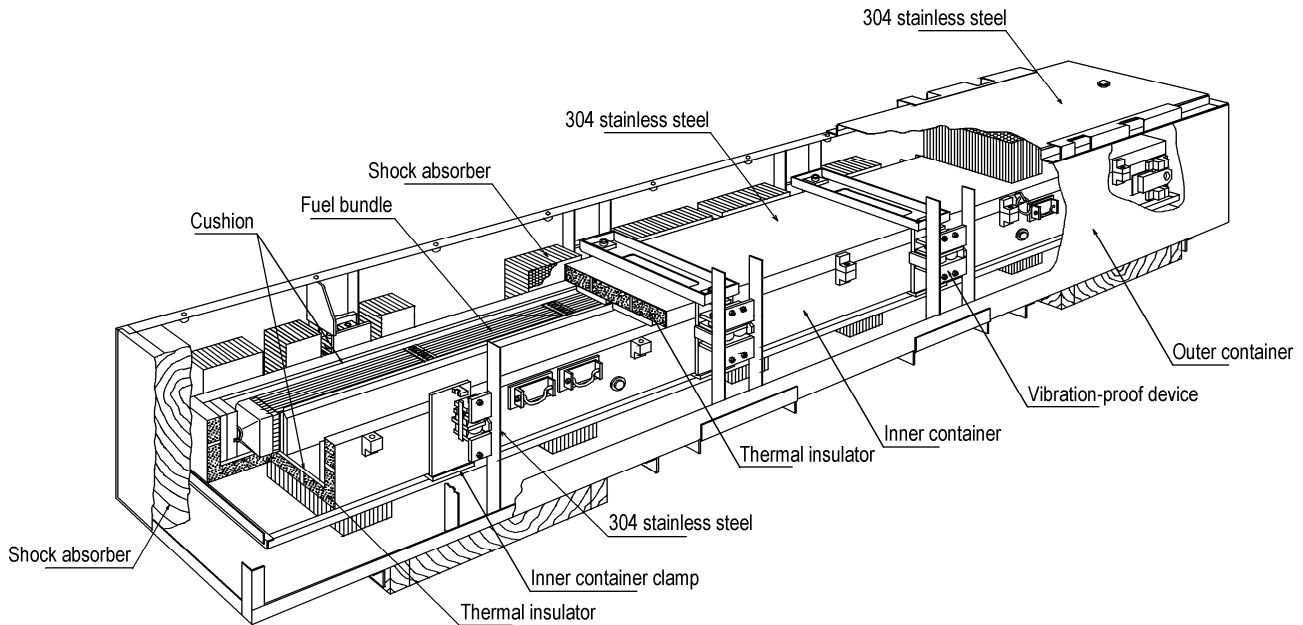
GNF has replaced its fleet of wood and carbon steel RA-3 and RA-3D fuel bundle shipping containers with the new stainless steel RAJ-II [Ref. 1]. The RAJ-II is used to transport Boiling Water Reactor (BWR) fuel assemblies containing both Type A and Type B fissile material and accommodates two bundles. The NRC Certificate of Compliance for the RAJ-II was received in November of 2004 and complies with the new “-96” IAEA regulations. Unlike the previous generation of container, the RAJ-II is licensed to ship mixed oxide fuel assemblies and pre-channeled fuel. The RAJ-II package is comprised of an inner container and an outer container both made of stainless steel.

#### Inner Container (IC)

The inner container is comprised of three parts: an inner container body, an inner container end lid (removable), and an inner container top lid (removable). These components are fastened together by bolts made of stainless steel through tightening blocks. The inner container body is fitted with six sling fittings and the inner container lid is fitted with four sling fittings.

The inner container is a double-wall stainless steel sheet structure with alumina silicate thermal insulation filling the gap between the two walls. Polyethylene foam cushioning material is placed on the inside of the inner container for protection of the fuel assembly.

The outer wall is made of a 1.5 mm (0.0591 in) thick stainless steel sheet formed to a U-shape that constitutes the bottom and sides of the inner container body. A total of 14 stainless steel tightening blocks are attached on the sides of the outer wall, seven per side, to fasten the inner container lid and the inner container end lid by bolts. Additionally, six stainless steel sling fittings are attached on the sides (three on each side) for handling.



**Figure 1. RAJ-II Shipping Container**

The inner wall of the inner packaging is formed into U-shape with 1.0 mm (0.0391 in) thick stainless steel sheet. The inner packaging is partitioned down the center with 2.0 mm (0.0787 in) thick stainless steel sheet welded to the bottom of the packaging. Foam polyethylene is placed on the inner surface of the inner wall where the fuel assemblies are seated.

#### Outer Container (OC)

The outer container is comprised of three parts: a container body, a container lid and inner container hold clamps made of stainless steel and fastened together using stainless steel bolts. Two tamper-indicating device attachment locations are provided, one on each end, of the outer container.

The outer container is made from a series of 50 mm (1.97 in) stainless steel angles that make the framework. Welded to the framework is a bottom plate and side plates made of 2 mm (0.079 inch) thick stainless steel. Sling holding angles for handling with a crane and protective plates for handling with a forklift are welded on the outside of the container body.

Eight sets of support plates are welded on the inside of the outer container body for installing the inner container hold clamps. Additionally, shock absorbers made of 146 mm (5.75 in) wood are attached to each end and paper honeycomb shock absorbers are attached to the bottom and sides for absorbing shock due to a drop. The shock absorbers are 157 mm (6.18 in) thick and 108 mm (4.25 in) thick.

The outer container lid is comprised of a lid flange and a lid plate made of stainless steel. Stainless steel lid sling fittings are welded four places on the top surface of the outer container lid. A paper honeycomb shock absorber, 157 mm (6.18 in) thick by 160 mm (6.30 in) wide and 380 mm (14.96 in) long is attached to the bottom side of the lid similar to the attachment at the bottom of the container. The outer container lid has holes for bolts in its flange so that it can be fastened to the outer container body by the stainless steel bolts.

The inner container hold clamp consists of an inner container receptacle and a vibro-isolating device. The inner container receptacle consists of an inner container support plate; a support frame, a bracket and an inner container hold clamp fastener made of stainless steel. The receptacle guides the inner container to the correct position. The inner container receptacle is fitted with the vibro-isolating device through the gusset attached to the bracket. The vibro-isolating material is attached on the upper and lower side of the gusset. Shock mount fastening bolts go through the center of each piece of vibro-isolating rubber. The bolts at both ends are tightened so that the vibro-isolating rubber pieces press the gusset. There are four sets (eight pieces) of the vibro-isolating devices mounted on the outer container.

### Gross Weight and Dimensions

The maximum gross shipping weight of a RAJ-II package is 1,614 kg (3,558 pounds). A summary of the major component weights and dimensions are given in Table 1.

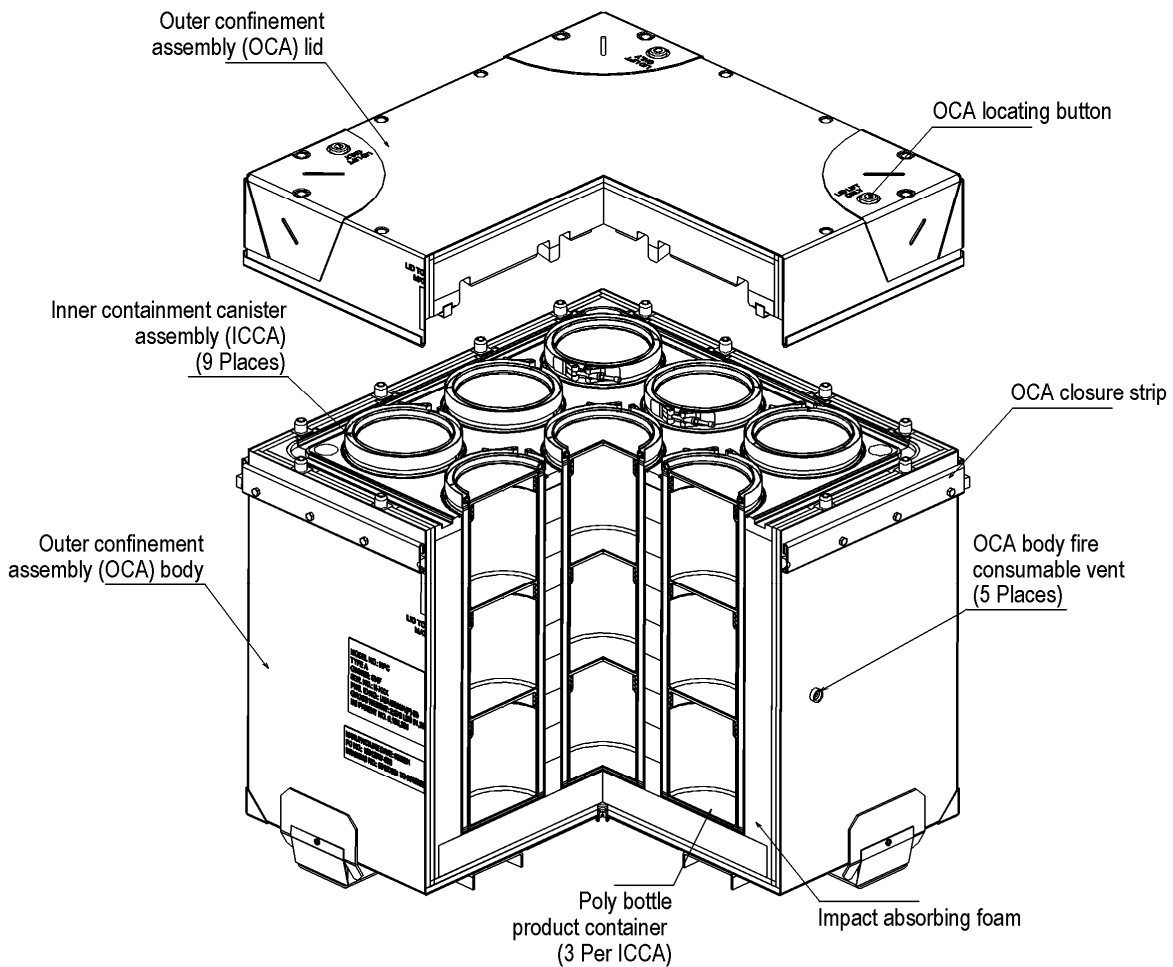
**Table 1. Summary of RAJ-II Weights and Dimensions**

COMPONENT	ITEM	RAJ-II
Contents	Number of assemblies per package	Maximum 2 Assemblies
	Number of fuel rods per package	See Table 6-2 RAJ-II Fuel Rod Loading Criteria (Reference 1)
	Maximum weight	684 kg (1,508 lb)
Inner Container	Body	200 kg (441 lb) <sup>1</sup>
	Lid	101 kg (223 lb)
	End lids	7 kg (15.4 lb)
	Dimension	Length: 4,686 mm (184.49 in) Width: 459 mm (18.07) Height: 286 mm (11.26)
	Maximum weight	308 kg (679 lb)
Outer Container	Body	485 kg (1,069 lb)
	Lid	137 kg (302 lb)
	Dimension	Length: 5,086 mm (199.53 in) Width: 720 mm (28.35) Height: 742 mm (29.21)
	Maximum weight	622 kg (1,371 lb)
Packaging	Maximum weight	930 kg (2,050 lb)
Package	Maximum weight	1,614 kg (3,558 lb)

### **NPC SHIPPING CONTAINER**

GNF has replaced its drum type containers with the new stainless steel New Powder Container (NPC) [Ref. 2]. The packaging consists of a stainless steel sheet metal Outer Confinement Assembly (OCA) body and lid that encases ceramic fiber insulation and rigid polyurethane foam, and nine equally spaced, individually sealed stainless steel Inner Containment Canister Assemblies (ICCA). The closure of each canister is provided by a closure lid with a silicone rubber gasket and a standard stainless steel bolted band clamp assembly.

The NPC packaging is a Type A(F) package designed for transportation of homogeneous or heterogeneous uranium bearing material that is enriched up to 5% U<sup>235</sup>. The maximum gross weight of the package is 2,870 pounds (1,302 kg).



**Figure 2. NPC Shipping Container**

### Outer Confinement Assembly

The Outer Confinement Assembly (OCA) consists of an OCA lid and OCA body, each primarily comprised of an outer stainless steel sheet structure, a layer of ceramic fiberboard, and a layer of rigid polyurethane foam. The polyurethane foam provides thermal insulation, energy absorption for the normal and hypothetical accident conditions of transport and neutronic isolation. Nine sealed individual canister assemblies, which provide containment of the uranium bearing material, are located within the interior of the OCA. The canisters are positioned such that their center-to-center spacing is fixed.

The OCA lid has nominal external dimensions of 1,099 mm × 1,099 mm × 2225 mm (43 1/4-in × 43 1/4-in × 8 7/8-in). The OCA body has nominal external dimensions of 1,118 mm × 1,118 mm × 981 mm (44-in × 44-in × 38 5/8-in). In its assembled configuration, the OCA has approximate nominal external dimensions of 1,140 mm × 1,140 mm × 1,122 mm (44 7/8-in × 44 7/8-in × 44 3/16-in).

The OCA lid is secured to the OCA body with (16) 1/2-13UNC socket head cap screws, with four bolts installed on each edge of the OCA lid. At the joint between the OCA lid and OCA body, a stainless steel closure strip is attached between the OCA lid and OCA body. The closure strip is secured with (24) 7/16-14UNC hex head bolts that are screwed into a 5/8-inch thick stainless steel bar, which is welded to the OCA body. The purpose of the closure strip is to provide additional structural strength to the OCA closure.

The outer skin of the OCA is fabricated using a 10-gauge (3 mm) thick Type 304L austenitic stainless steel sheet. Behind the outer skin, two layers of 12.7 mm (1/2-inch) thick ceramic fiberboard are positioned around the sides, bottom, and top of the OCA. Polyurethane foam is then installed between the ceramic fiberboard and the containment canisters. A 25.4 mm × 25.4 (1-in × 1-in) ceramic fiber braided rope is installed in the polyurethane foam around the circumference of the OCA body to provide additional thermal protection of the OCA lid/body joint. Nine individual canister silos, fabricated of 22-gauge (0.74 mm) thick Type 304L austenitic stainless steel sheet, are located within the OCA body interior. These canister silos provide the receptacle for the Inner Containment Canister Assemblies (ICCAs). A 1.6 mm × 229 mm diameter (1/16-in thick × 9-in diameter), silicon rubber pad is placed in the bottom of each canister silo to provide cushioning of ICCA during transport.

#### Inner Containment Canister Assembly

The Inner Containment Canister Assembly (ICCA) consists of a closure lid and body, which are fabricated with Type 304L austenitic stainless steel sheet. The closure lid and body are fabricated using 16-gauge (1.5 mm) and 18-gauge (1.2 mm) material respectively. An austenitic stainless steel band clamp assembly, which uses a 5/16-inch T-bolt, is utilized to secure the canister closure lid to the cylindrical canister body. The band clamp assembly includes a silicone rubber gasket between the canister closure lid and canister body. To provide criticality control, the outer cylindrical surface of each canister is wrapped with a minimum 0.5 mm (20-mil) cadmium sheet, and then a 0.4 mm (15-mil) High Density Polyethylene (HDPE) sheet wrapped to a thickness of 12.7 mm (1/2-in) minimum. A 24-gauge (0.6 mm) austenitic stainless steel sheet is wrapped around the cadmium/HDPE materials to secure these materials to the canister body.

The ICCA has a nominal external diameter of 248 mm (9 3/4-in) and a nominal overall length of 816 mm (32 1/8-in). The band clamp assembly has a nominal external diameter of 260 mm (10 1/4-in). The payload contents in an ICCA are limited to a maximum of 60 kg (132.2 lb), which is to include the weight of packing material (receptacles, etc.) in the ICCA.

#### Contents of Packaging

The NPC packaging is designed to transport a maximum of 540 kg (1,190 lb) of uranium bearing payload, including receptacles and packing material (e.g. bags, bottles, cans) in the ICCA in accordance with the Table 2 below. The radionuclide content is uranium from natural sources, which is commercially enriched. The payload within an NPC may be distributed in any ratio within the nine Inner Containment Canister Assemblies (ICCAs), if the content of any one ICCA never exceeds 60 kg (132.2 lb), and the maximum uranium payload of the following table are met.

#### Licensing Status

The RAJ-II is currently licensed in the United States as a Type B(F) container and Japan as Type A(F). Application for license is currently in review in Spain, France, Germany, Switzerland, Belgium, UK, Canada, Sweden, and Finland.

The NPC is currently licensed in the United States, Canada, Russia, and Japan as a Type A(F) container. Application for license is currently in review in Spain, France, Germany, Sweden, Belgium, and UK. To meet the growing demands for the NPC container, an expansion of current authorized contents is being evaluated.

**Table 2. Type, Form and Maximum Quantity of Material per NPC**

Material Form* (≤ 5.00 wt.% U-235)	Particle Size Restriction: Minimum OD (Inches)	Maximum Loading per ICCA (kg)		Maximum Loading per NPC (kg)	
		Net	Uranium	Net	Uranium
Homogeneous Uranium Oxides/Compounds	N/A	60.0	52.89	540.0	476.1
Heterogeneous UO <sub>2</sub> Pellets (BWR)	0.342	60.0	48.48	540.0	436.3
Heterogeneous UO <sub>2</sub> Pellets (PWR)	0.300	60.0	46.71	540.0	420.4
Heterogeneous Uranium Compounds	Unrestricted particle size	60.0	40.54	540.0	364.8

\*The Material Form within any NPC must be the same.

Note: Uranium-bearing contents may be moderated by water or carbon to any degree and may be mixed with other non-fissile materials with the exception of deuterium, tritium and beryllium. Materials such as uranium metal and uranium metal alloys are not covered by this analysis.

## REFERENCES

1. "Safety Analysis Report for the Model Number RAJ-II Package," USA/9309/B(U)F-96, Docket Number 71-9309, Rev. 6, Global Nuclear Fuel-Americas, Wilmington, April 2006.
2. Safety Analysis Report for the Model Number NPC Package," USA/9294/AF-85, Docket Number 71-9294, Rev. 4, Global Nuclear Fuel-Americas, Wilmington, October 2005.