



# **New transport regulations on fissile materials following the Regulations for the Safe Transport of Radioactive Material 2012 Edition**

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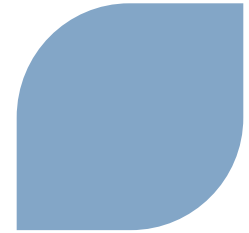
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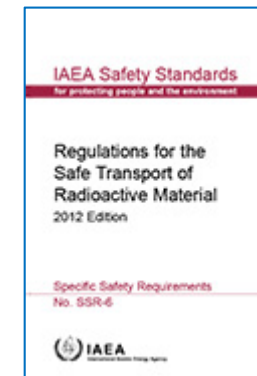


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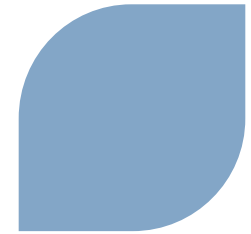
# Introduction



- ▶ **For the transport of radioactive material, the International Atomic Energy Agency (IAEA) establishes safety standards**
  - ◆ → Acceptable level of control of the radiation, criticality and thermal hazards to persons, property and the environment
- ▶ **In 2012**
  - ◆ Revision to the IAEA Regulations for the Safe Transport of Radioactive Material, Specific Safety Requirement No. 6 (SSR-6)
  - ◆ Many changes in the provisions that allow exceptions to the use of competent authority approved package designs for transport of fissile material



# Background



## ▶ IAEA fundamental safety principles

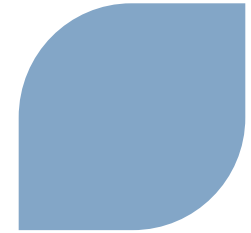
- ◆ Established in order to protect persons, property and the environment from the effects of radiation
- ◆ In transport regulations, this protection is achieved by requiring
  - Containment of the radioactive content
  - Control of external radiation levels
  - Prevention of criticality
  - Prevention of damage caused by heat
- ◆ These requirements can be satisfied by
  - Applying a graded approach to content limits and to performance of the package design
  - Imposing conditions on the design and use of the packages
  - Requiring administrative controls



## ▶ To prevent criticality

- ◆ Graded approach to fissile material quantity limits (for packages and conveyances)
- ◆ Certain quantities and configurations of fissile material cannot become critical in any circumstances → this modulation of the content allows the transport of fissile material without the need of a package design approved by a competent authority

# History overview



## ▶ Since 1961

- ◆ The IAEA transport regulations have provided criteria whereby package designs approved by a competent authority to contain fissile material were not required to transport fissile nuclides

## ▶ In 1996

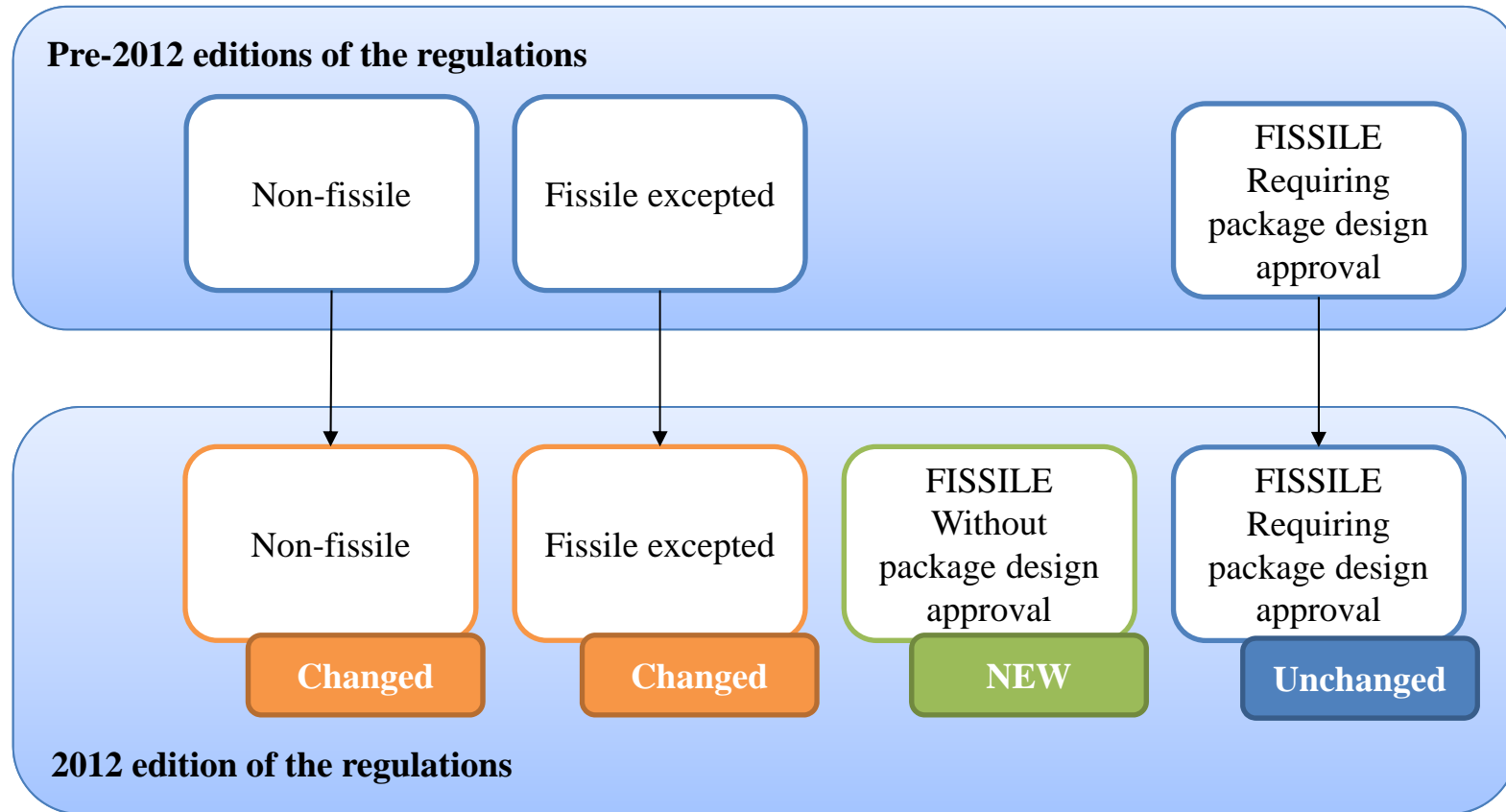
- ◆ As none of these criteria required control of accumulation of packages, the 1996 edition of the regulations added limits on the total mass of fissile nuclides that could be shipped in a consignment

## ▶ In 2012

- ◆ This remained unchanged until the 2012 edition of the regulations

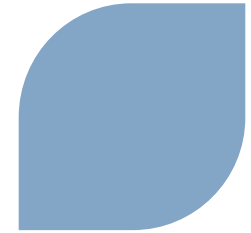


# Options for transporting material containing fissile nuclides



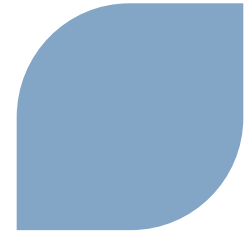
- ▶ “without approval of the package design by a competent authority” only applies to the fissile material requirements; Package designs could require competent authority approval according to the type of package (for instance type B(U) or B(M) package designs)

# Exclusion from definition as fissile material



- ▶ **Fissile material is defined in the transport regulations as material containing the following fissile nuclides**
  - ◆ Uranium-233, uranium-235, plutonium-239 and plutonium-241
- ▶ **Prior to the 2012 edition of the transport regulations**
  - ◆ Only natural uranium or depleted uranium (unirradiated or irradiated in thermal reactors only) were excluded from the definition of fissile material
- ▶ **In the 2012 edition of the transport regulations**
  - ◆ New exclusion, for materials with less than a total of 0.25 g of fissile nuclides
  - ◆ This low limit can be useful for materials having trace quantities of fissile nuclides, for which provisions applicable to fissile material would be irrelevant

# Exception from classification as FISSILE (1/2)



## ▶ Material called “fissile-excepted”

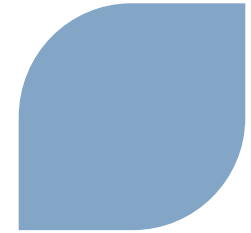
- ◆ Shipment of small quantities of fissile material, or larger masses in forms inducing very low risks of criticality
- ◆ Without the need of a FISSILE classification
- ◆ No need for competent authority package design approval
- ◆ No need for CSI accumulation control

## ▶ Note:

- ◆ CSI stands for “Criticality Safety Index”
- ◆ Number providing control over the accumulation of packages containing fissile material, to prevent criticality



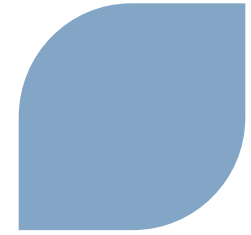
## Exception from classification as FISSILE (2/2)



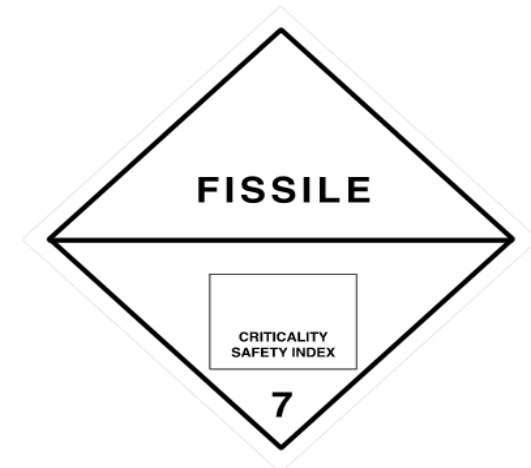
- ▶ **Part of the previous exceptions remained unchanged**
  - ◆ Uranium enriched in U-235 to a maximum of 1% by mass
  - ◆ Liquid solutions of uranyl nitrate enriched in U-235 to a maximum of 2% by mass
- ▶ **The previously widely used exceptions related to mass limit per consignment (15 g per package limit or 5 g in any 10 L limit, with conveyance limits between 180 and 400 g) have been replaced**
  - ◆ Either 2 g per package, and a consignment up to 15 g, of fissile material
  - ◆ A consignment up to 45 g of fissile material, under exclusive use shipment
- ▶ **And also**
  - ◆ Previous exception about plutonium (with up to 20% of fissile material) has been removed
  - ◆ A new exception was created, for fissile material requiring competent authority approval of the “fissile material design”



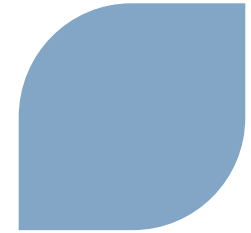
# Exception from competent authority approval of FISSILE packages (1/3)



- ▶ **The 2012 edition of the transport regulations introduces a new type of exception for fissile material**
  - ◆ The package is classified as FISSILE
  - ◆ CSI accumulation is controlled
  - ◆ No competent authority package design approval is required
  
- ▶ **4 types of new exceptions**
  - ◆ Three for packages containing fissile material in any form
  - ◆ One for packages containing not more than 1 kg of plutonium (*not described hereunder*)



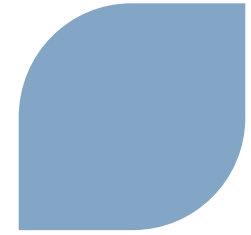
# Exception from competent authority approval of FISSILE packages (2/3)



	Exception (a)	Exception (b)	Exception (c)
Smallest external dimension of package	10 cm	30 cm	10 cm
Ability to withstand normal conditions of transport <sup>[1]</sup>	Not required	Required	Required
CSI calculation (CSI =) <sup>[2]</sup>	$50 \times 5 \times (M_{U-235} / Z + M_{OFN} / 280)$	$50 \times 2 \times (M_{U-235} / Z + M_{OFN} / 280)$	$50 \times 2 \times (M_{U-235} / 450 + M_{OFN} / 280)$
CSI limit of any package <sup>[3]</sup>	10	10	-
Maximum mass of fissile nuclides in any package	-	-	15 g

1. The tests used to demonstrate the ability of a package to withstand normal conditions of transport are: water spray test, free drop test, stacking test, penetration test. After the tests, the package must retain its fissile material contents, preserve its minimum external dimension and prevent the entry of a 10 cm cube.
2.  $M_{U-235}$  is the mass of uranium-235 in grams;  $M_{OFN}$  is the mass of the other fissile nuclides in grams; Z is a value varying with the enrichment of uranium-235 (going from Z = 2200 for uranium enriched up to 1.5% to Z = 450 for uranium enriched up to 100%).
3. Additional limits are given in the regulations. For instance the limit on sum of CSIs abroad a vehicle is 50 (not under exclusive use) or 100 (under exclusive use).

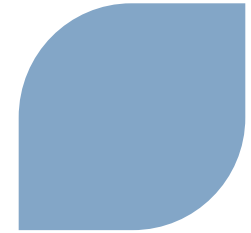
# Exception from competent authority approval of FISSILE packages (3/3)



- ▶ **Exception (b) is the most capacitive in terms of transportable fissile material quantity**
  - ◆ **Maximum transportable material masses per package, for the transport of enriched uranium (considering no other fissile nuclides):**

Uranium enrichment	Maximum mass of fissile isotope (g)	Equivalent uranium mass (heavy metal) (g)
Up to 1.5%	220	14,666
Up to 5%	85	1,700
Up to 10%	66	660
Up to 20%	58	290
Up to 100%	45	45

# Example of consequences for a specific package



## ▶ Package “Flying Pig”

- ◆ International transport of various materials (irradiated pellets, fuel rod sections, fuel plates sections, metal samples, ...), by terrestrial and air means
- ◆ Package model shall be type B(U)
  - “unilateral” package design approval by a competent authority
  - Approval of the design is required to be given by the competent authority of the country of origin only



## ▶ Prior to the 2012 edition of the transport regulations

- ◆ Limited in the maximum transportable mass of fissile material
- ◆ The commonly used limit of 15 g of fissile material per package would have often been the limiting factor

## ▶ With the 2012 edition of the transport regulations

- ◆ Type B(U) package designs already require a demonstration of their ability to withstand normal conditions of transport → eases the use of the (b) or (c) exceptions from competent authority approval of FISSILE packages
- ◆ Possible to transport a package such as the “Flying Pig” as a type B(U)F package design, with enriched uranium quantities reaching limits given before
- ◆ No other required approval of package design, except the one of the competent authority of the country of origin