Overview of Proposed Modifications for Exemptions to the Requirements for Transport of Fissile Material

C. Parks (ORNL, USA)
N. Barton (DfT, UK)
S. Darby (INS, UK)
B. Desnoyers (Areva, France)
M. Hirose (NFT, Japan)
L. Jutier (IRSN, France)
D. Mennerdahl (Consultant, Sweden)
I. Ortiz de Echevarrea Diez (IRSN, France)
I. Reiche (BfS, Germany)

IAEA
International Atomic Energy Agency

Introduction

- Currently, transport of fissile material using TS-R-1 performed consistent with one of two sets of provisions:

  Set 1: Fissile material in packagings subject to CA design approval and CSI control of accumulation (2009 paras 671-683)

  Set 3: Fissile material excepted from all requirements of Set I if specified characteristics and limits are met (2009 para 417). Traditional “fissile-excepted”

- Concerns expressed:
  - Safety: Insufficient control for accumulation of fissile material under Set 3
  - Accuracy: Some Set 3 material should be classified as UN FISSILE
  - Transport of low-risk material under Set 1 (regulatory burden)
- **Proposed Solution**:
  - Revise Set 3 criteria and limits
  - Add new “Set 2” criteria that provides control for mass accumulation but does not have package requirements of Set 1

IAEA

IAEA TS-R-1 2009 para 417 Set 3

Proposed para 417
Revised "Set 3"

- No requirements to be treated as fissile material (not classified as UN FISSILE)
  - Specified material
  - Very small masses per package
  - Unpackaged material mass limit
  - Specified material subject to CA approval

Proposed para 672
New "Set 2"

- Material classified as UN FISSILE
- Packages used for shipment excepted from CA approval
- Accumulation control by CSI* assures subcriticality
- Mass of fissile material per package is limited (maximum CSI = 10).

*CSI = 50/N

Summary of principles

- Assure identified safety concerns addressed
- Assure consistency in terms of safety margin for each of the “sets” of provisions
- Seek industry input to understand needs
  - Limited masses for low-enriched material
  - Small gram samples of material with high or unknown enrichment
  - Shipment of waste with low-concentrations of fissile material
- Minimize impact of transition
  - Sought to include provisions that would enable safe transport of packages previously loaded using existing “Set 3” exception criteria

IAEA

Graded approach summary

- Set 1 – no changes, require CA assessments
- Set 2 – proposed new para 672
  - Classified and controlled as UN FISSILE
  - Masses limited to assure subcritical margins consistent with CA assessments performed for Set 1: 2N under accident conditions of transport (ACT) and 5N normal conditions of transport" assured to be subcritical
  - Exception from Set 1 is on packaging requirements
- Set 3 – proposed para 417
  - Not classified or controlled as UN FISSILE
  - Exception from Set 1 is on packaging and operational requirements

IAEA

Technical basis of proposed changes (Set 1)

- Package designs approved by CA for shipment of fissile material and subject to CSI control: NO CHANGE

Safety basis of proposed changes (Set 2)

Set 2 = Package excepted from CA approval, control by CSI

- Material must maintain subcriticality during transport
  - Account for (not necessarily test for) routine, normal, and accident conditions of transport in the same way as packages approved by CAs. In other words, assume package does not pass tests for ACT nor tests for NCT unless specified.
  - 5 “groups of packages” under NCT
  - 2 “groups of packages” under ACT
  - Agreed to values of safe subcritical mass for U (1.5 wt% 235U to 100% 235U) and pure 239Pu.
    - Model: Optimum configuration and moderation, regulatory reflection, and accounting for typical packaging materials that could increase k-eff.
    - Values used to judge safety of proposed paras (Values provided in Table M of proposal)

IAEA

Safe subcritical masses

Fissile nuclide	Uranium enrichment in mass percent of U-235 not exceeding	General use	Limited use [iii]	For reference: Values for k=1. Value are with H20 moderation (compare with Limited Use column)
U-235 (Z)[i]	1.5	2000	2400	8000
	5	770	1000	1835
	10	550	810	1284
	20	470	700	1044
	100	360	540	800
Other fissile nuclides (Y)[ii]	Not Applicable	230	350	

Notes:

i) If a package contains uranium with varying enrichments of U-235, then the mass of corresponding to the highest enrichment value shall be used for Z.

ii) Plutonium may be of any isotopic composition provided that Pu-241 < Pu-240.

iii) Limited use is only allowed when there is no more than 20 grams of material with a hydrogen density greater than water in a package.

IAEA

Technical basis of proposed changes (Set 2)

Set 2 = Package excepted from CA approval, control by CSI

- Set 2: Limit masses of fissile nuclides in packages (new para 672)
  - Packages excepted from CA approval
  - Packages subject to CSI control and maximum package CSI = 10
- 672a: Fissile material mass per package limited such that 5 "groups of packages" < safe subcritical mass assuming packages do not meet NCT
  - Maximum mass per package (CSI = 10) = 14.4 g for pure 235U
- 672b: Fissile material mass limited such that
  - 5 "groups of packages" < safe subcritical mass under NCT (reason for 30-cm minimum external dimension)
  - 2 "groups of packages" < safe subcritcal mass (packages assumed not to meet ACT)
  - Package limited to max CSI = 10 (e.g., 36 g pure 235U)
- 672c: Same as 672b EXCEPT as follows:
  - Contents limit of 15 g (CSI = 4.2) allows array of packages with 10cm external dimension to be shown as subcritical under NCT
  - Enables larger mass in a "group of packages" as compared to 672a

IAEA

Set 2 : Implementation

- Limited quantities of fissile material in packages subject to CSI control (new para 672)
  - No pacakge assessment by CA
  - CSI label shall be used.
  - Packages labeled as FISSILE.
  - No F required in identification mark
  - New UN numbers needed to allow option for “fissile” with LSA-I material packages.
  - Industry indicates usefulness for all 3 subparas
- TS-R-1 Sections III, IV, V, and VIII reviewed and consequential changes proposed

IAEA

Set 2 : Outstanding Matters

Some Member States have expressed concern regarding:

- Reliance on self-assessment of package to meet NCT (672b-c)
  - Use of para requires adherence to management system and compliance assurance acceptable to CA
  - Consequences of inadequate self-assessment is unexpected failure under NCT
    - **Only 2 "groups of packages" needed to achieve safe subcritical mass**
    - **Screening and intervention by CA during shipment approval are potential mitigation for CSI > 50.**
  - Same "accident" scenario for non-fissile material could lead to many times Type B release limit
- Allowing mixing of CSI obtained from two different columns in Table M:
  - Two types of moderator
  - Footnote text added to significantly restrict use of values from "Limited Use" column – technical basis for future relaxation expected

IAEA

Technical basis of proposed changes (Set 3)

Set 3 = Package excepted from both CA approval AND control by CSI

- Fissile material not required to be classified as UN FISSILE and not subject to CSI control (new 417 a-b, no change)
  - 417a: U enriched to < 1 wt% 235U
  - 417b Uranyl Nitrate with U enriched to < 2 wt% 235U

Technical basis of proposed changes (Set 3)

Set 3 = Package excepted from both CA approval AND control by CSI

- (new 417 continued)
  - New para 417c: Up to 2 g ^{235}U per package, or up to 3.5 g ^{235}U per package if U enriched < 5 wt% with consignment limit of 45 g
    - Package limits based on expressed needs of industry for shipping UF6 and environment samples
    - 8 consignments required to accumulate safe subcritical mass of Table M, General Use
  - New para 417d: Up to 0.5 g Pu per package, with consignment limit of 15 g (allows A2 sample shipment in Type A package)
    - >15 consignments required to accumulate safe subcritical mass of Table M, General Use

IAEA

Technical basis of proposed changes (Set 3)

Set 3 = Package excepted from both CA approval AND control by CSI

- (new 417 continued)
  - New para 417e: 45g of fissile nuclides, unpackaged or packaged, shipped under exclusive use (8 conveyances to achieve safe subcritical mass)
  - New para 417f: Multilateral approval of material per requirements of 605bis
    - Infinite or “beyond credible” array of packages subcritical under normal and accident conditions of transport:
      - no need for accumulation control
      - with the conditions of para. 671(a) considered (water inleakage, temperature variation, geometry changes, etc.)

IAEA