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**Committee of Experts on the Transport of Dangerous Goods  
and on the Globally Harmonized System of Classification  
and Labelling of Chemicals****Sub-Committee of Experts on the Transport of Dangerous Goods****Fortieth session**

Geneva, 28 November – 7 December 2011

Item 6 of the provisional agenda

**Cooperation with the International Atomic Energy Agency (IAEA)****Provisions for uranium hexafluoride with less than 0.1 kg per  
package****Transmitted by the International Atomic Energy Agency (IAEA)<sup>1</sup>****Introduction**

1. A proposal for a new UN number was approved by the IAEA Transport Safety Standards Committee at its twenty-second session (TRANSSC 22) (June 2011). It was recommended to establish a fifth UN number for “Radioactive material, excepted package” for uranium hexafluoride (UF<sub>6</sub>) with less than 0.1 kg per package. At the thirty-ninth session of the Sub-Committee (20 to 24 June 2011) (ST/SG/AC.10/C.3/78, para 86), it was recalled that the issue had been discussed at the thirty-eighth session of the Sub-Committee but the decision had been postponed at the request of IAEA since the transport conditions had not yet been approved by IAEA. The IAEA was therefore invited to submit a proposal for the fortieth session covering transport conditions in the light of the comments made by the Sub-Committee at the thirty-eight session.

2. The current logic of the IAEA Regulations for the Safe Transport of Radioactive Material (TS-R-I) and of the United Nations Recommendations on the Transport of Dangerous Goods, Model Regulations, is that uranium hexafluoride (UF<sub>6</sub>) shall always be transported as a Class 7 material under UN Nos. 2977 or 2978, as appropriate (see 2.7.2.4.5 of the Model Regulations). Nevertheless, this has led to divergent interpretations when this material is transported in packagings meeting the requirements for excepted packages, notably because this material is highly corrosive. The view of the IAEA in this respect is

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<sup>1</sup> In accordance with the programme of work of the Sub-Committee for 2011-2012 approved by the Committee at its fifth session (refer to ST/SG/AC.10/C.3/76, para. 116 and ST/SG/AC.10/38, para. 16).

that UF6 should always remain classified in Class 7 as this allows it to be kept under control of IAEA which has more transport experience with this material.

For any quantity "large or small" UF6 "prepared for transport", the predominant hazard is "corrosive". The justification for the new UN number is simply to bring it in line with the existing UN number 2977 and 2978 and to clarify the transport conditions when UF6 is transported in excepted packages.

3. In the course of discussions, attention was drawn to the fact that the United Nations Recommendations on the Transport of Dangerous Goods, Model Regulations, contains provisions for classification of dangerous goods possessing different hazards on the basis of a system of precedence of hazard as described in section 2.0.3 of the Model Regulations.

4. According to this system, the Class 7 hazard takes precedence over other hazards, except for radioactive material in excepted packages where the other hazards take precedence over the Class 7 hazard. In such a case, the UN number to be assigned is the UN number to be determined according to the other hazard properties, rather than one of the generic Class 7 UN numbers for excepted packages which do not convey information on the other hazardous properties. Although radioactive material possessing other hazards in excepted packages remain subject to all relevant IAEA requirements for excepted packages, the hazard communication elements concerning the radioactive hazard are different from those required for excepted packages of radioactive material without any other hazard.

<i>Radioactive material in excepted package</i>		
	Without other hazard	With other hazard
Marking of the package (outside)	Excepted package UN number only, e.g UN 2910	Other hazard UN number and proper shipping name, e.g UN 1993, flammable liquid n.o.s (ethanol and toluene mixture), radioactive material, excepted package – limited quantity of material  Marking "UN 2910" not required
Labelling	No label	Other hazard label(s) No Class 7 label
Document	Excepted package UN number only, e.g UN 2910  (No other information required)	Other hazard UN number and proper shipping name, supplement by Class 7 name, other hazard class number and packing group if any  No indication of UN 2910  e.g "UN 1993, flammable liquid n.o.s (ethanol and toluene mixture), radioactive material, excepted package – limited quantity of material, Class 3, PG II.

5. When considering this UF<sub>6</sub> issue, TRANSSC noted the legitimate concern of the United Nations Sub-Committee to properly address the other hazards presented by radioactive material in excepted packages, but felt that the current solution was not optimal and that there would be merit to pursue work in cooperation with the United Nations Sub-Committee on radioactive material possessing other hazards in general. Furthermore, in this specific case, the material UF<sub>6</sub> would be assigned to a specific UN number with specific transport conditions and this could not lead to misunderstandings or uncertainty in emergency response situations. Therefore the TRANSSC view was that the entry should be in Class 7 and the provisions which have been elaborated for inclusion in the next edition of the IAEA Regulations have been conceived on the assumption that UF<sub>6</sub> in excepted packages would remain classified in Class 7.

6. In case the IAEA proposal would not be acceptable to the UN Sub-Committee despite the above arguments and because of the principles laid down in 2.0.3.2 and special provision 290, the IAEA has prepared an alternative proposal for an entry in Class 8.

7. None of these two proposals contain an exhaustive list of consequential amendments that may need to be made to the UN Model Regulations. These, if any, would be submitted at the July session depending on the decision made at this session.

8. In the discussions, it was mentioned that UF<sub>6</sub> possesses other hazardous properties, notably toxicity and oxidizing properties. This is not an issue which concerns this new entry only, it is an issue which concerns also UN Nos 2977 and 2978. But at this time, it might be better to consider that only the hazards identified for UN Nos 2977 and 2978 should be taken into account for this new entry (i.e. class 8 only). But it should be borne in mind for action before the end of the biennium (end 2012) if there is evidence of additional subsidiary risks to be taken into account. As an annex to this working paper, provisional information (data sheet) is provided.

9. A separate information paper will be submitted to the Sub-Committee when additional reliable data are available for classification.

### **IAEA Proposal: UF<sub>6</sub> < 100 g classified as Class 7 with subsidiary risk of Class 8**

10. In table 2.7.2.1.1 add the following entry under "Excepted packages" and "Uranium hexafluoride":

UN3XYZ RADIOACTIVE MATERIAL, EXCEPTED PACKAGE – URANIUM HEXAFLUORIDE, less than 0.1 kg per package, non-fissile or fissile-excepted

11. Amend paragraph 2.7.2.4.1.1 to read as follows:

“2.7.2.4.1.1 Packages may be classified as excepted packages if:

- (a) They are empty packages having contained radioactive material;
- (b) They contain instruments or articles in limited quantities as specified in Table 2.7.2.4.1.2;
- (c) They contain articles manufactured of natural uranium, depleted uranium or natural thorium;
- (d) They contain radioactive material in limited quantities as specified in Table 2.7.2.4.1.2; or
- (e) They contain less than 0.1 kg of uranium hexafluoride not exceeding the activity limits specified in column 4 of Table 2.7.2.4.1.2.”

12. Add a new paragraph 2.7.2.4.1.4bis:  
 “2.7.2.4.1.4bis Uranium hexafluoride not exceeding the limits specified in column 4 of Table 2.7.2.4.1.2 may be classified under UN 3XYZ RADIOACTIVE MATERIAL, EXCEPTED PACKAGE – URANIUM HEXAFLUORIDE, less than 0.1 kg per package, non-fissile or fissile-excepted, provided that the conditions of 2.7.2.4.1.4 (a)–(b) are met.”
13. Amend paragraph 2.7.2.4.5 to read as follows:  
 “2.7.2.4.5 Classification of uranium hexafluoride  
 2.7.2.4.5.1 Uranium hexafluoride shall only be classified as:  
 (a) UN No 2977, RADIOACTIVE MATERIAL, URANIUM HEXAFLUORIDE, FISSILE; or  
 (b) UN No 2978, RADIOACTIVE MATERIAL, URANIUM HEXAFLUORIDE, non-fissile or fissile-excepted; or  
 (c) UN No 3XYZ, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE – URANIUM HEXAFLUORIDE, less than 0.1 kg per package, non-fissile or fissile-excepted, in the case of uranium hexafluoride in quantities of less than 0.1 kg packaged and in an excepted package.  
 2.7.2.4.5.2 The contents of a package containing uranium hexafluoride shall comply with the following requirements:  
 (a) The mass of uranium hexafluoride shall not be different from that allowed for the package design;  
 (b) The mass of uranium hexafluoride shall not be greater than a value that would lead to an ullage of less than 5% at the maximum temperature of the package as specified for the plant systems where the package may be used; and  
 (c) The uranium hexafluoride shall be in solid form and at the internal pressure shall not be above atmospheric pressure when presented for transport.”
14. Add the following entry in Chapter 3.2, List of Dangerous Goods:

UN No.	Name and description	Class	Subsidiary risk	PG	SP	Limited Quantity	Excepted Quantity	Packing Instruction
3XYZ	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE - URANIUM HEXAFLUORIDE, less than 0.1 kg per package, non-fissile or fissile-excepted	7	8		317 37X	0	E0	P701

*N.B. In the above table Packing Group is not indicated, but requirements for Packaging Group I in Special Provision XXY should apply.*

15. Delete Special Provision 325 in column 6 against the entry for UN 2910 in the List of Dangerous Goods

16. Add a new special provision 37Y in the column 6 against the entry for UN 2910 in the list of Dangerous Goods and a corresponding text in Chapter 3.3 to read as follows:

"37Y In the case of non-fissile or fissile-excepted uranium hexafluoride, the material shall be classified under UN3XYZ or UN 2978."

17. Chapter 3.3, add the following special provision:

"37X Packing Group I is assigned to this entry due to the Class 8 subsidiary risk. For labelling, only a label of model No. 8 is required. The package shall be marked in accordance with 5.1.5.4.1. Notwithstanding the provisions of 1.5.1.5 and 5.1.5.4.2, the following documentation requirements of Chapter 5.4 apply: 5.4.1.1 to 5.4.1.4; 5.4.1.5.1; 5.4.1.6; 5.4.2 to 5.4.4.

The description in the transport document according to 5.4.1.4.1 shall be UN 3XYZ radioactive material, excepted package, uranium hexafluoride, 7(8)I."

18. Add the following Packing Instruction P701

P701	PACKING INSTRUCTION	P701
This instruction applies to UN No. 3XYZ		
<p>The following packagings are authorized provided that the general provisions of 4.1.1 and 4.1.3 and the special packing provision of 4.1.9 applicable to excepted package for radioactive material are met:</p> <p>Constitution of the package:</p> <p>(a) Inner packagings comprising:</p> <p>(i) leakproof rigid primary receptacle(s) limited to less than 15 g of uranium hexafluoride of capacity, made of metal and or plastic not reacting with uranium hexafluoride;</p> <p>(ii) leakproof rigid secondary packaging (s) to contain primary receptacles;</p> <p>(iii) cushioning material in sufficient quantity placed between the primary receptacle(s) and the secondary packaging; if multiple primary receptacles are placed in a single secondary packaging, they shall be either individually wrapped or separated so as to prevent contact between them;</p> <p>(iv) the secondary packaging(s) (inner packaging(s)) shall be placed in an outer packaging and cushioning material shall be placed between the secondary packaging(s) and the outer packaging to prevent movement.</p> <p>(b) A rigid outer packaging:</p> <p>Drums (1A2, 1B2, 1N2, 1H2, 1D, 1G);</p> <p>Boxes (4A, 4B, 4C1, 4C2, 4D, 4F, 4G, 4H1, 4H2);</p> <p>Jerricans (3A2, 3B2, 3H2).</p> <p>(c) The total quantity of uranium hexafluoride per package shall be less than 100g.</p> <p>(e) In case of fissile material, limits specified in (417 (a) or (c) or (d) or (e) of TS-R-1 20XX edition) for fissile excepted material shall be complied with.</p> <p>Packagings shall fully comply with the requirements of Chapter 6.1 for combination packagings and those of 6.4.4 (for the entire package and its contents). In addition, packages containing fissile excepted material shall comply with the requirements of 6.4.7.2.</p>		

**Alternative proposal: UF6 < 100 g classified as Class 8 with subsidiary risk of Class 7:**

19. In table 2.7.2.1.1 add the following entry under "Uranium hexafluoride" and "Excepted packages":

UN 3XYZ URANIUM HEXAFLUORIDE, RADIOACTIVE MATERIAL IN EXCEPTED PACKAGE, less than 0.1 kg per package, non-fissile or fissile-excepted

20. Amend paragraph 2.7.2.4.1.1 to read as follows:

“2.7.2.4.1.1 Packages may be classified as excepted packages if:

- (a) They are empty packages having contained radioactive material;
- (b) They contain instruments or articles in limited quantities as specified in Table 2.7.2.4.1.2;
- (c) They contain articles manufactured of natural uranium, depleted uranium or natural thorium;
- (d) They contain radioactive material in limited quantities as specified in Table 2.7.2.4.1.2; or
- (e) They are designed to contain less than 0.1 kg of uranium hexafluoride not exceeding the activity limits specified in column 4 of Table 2.7.2.4.1.2.”

21. Add a new paragraph 2.7.2.4.1.4bis:

“2.7.2.4.1.4bis Uranium hexafluoride not exceeding the limits specified in column 4 of Table 2.7.2.4.1.2 may be classified under UN 3XYZ **URANIUM HEXAFLUORIDE, RADIOACTIVE MATERIAL IN EXCEPTED PACKAGE, less than 0.1 kg per package**, non-fissile or fissile-excepted provided that the conditions of 2.7.2.4.1.4 (a)–(b) are met.”

22. Amend paragraph 2.7.2.4.5 to read as follows:

“2.7.2.4.5 Classification of uranium hexafluoride

2.7.2.4.5.1 Uranium hexafluoride shall only be classified as:

- (a) UN No 2977, RADIOACTIVE MATERIAL, URANIUM HEXAFLUORIDE, FISSILE; or
- (b) UN No 2978, RADIOACTIVE MATERIAL, URANIUM HEXAFLUORIDE, non-fissile or fissile-excepted; or
- (c) UN No 3XYZ **URANIUM HEXAFLUORIDE, RADIOACTIVE MATERIAL IN EXCEPTED PACKAGE, less than 0.1 kg per package**, non-fissile or fissile-excepted in the case of uranium hexafluoride in quantities of less than 0.1 kg packaged and in an excepted package.

2.7.2.4.5.2 The contents of a package containing uranium hexafluoride shall comply with the following requirements:

- (a) The mass of uranium hexafluoride shall not be different from that allowed for the package design;

- (b) The mass of uranium hexafluoride shall not be greater than a value that would lead to an ullage of less than 5% at the maximum temperature of the package as specified for the plant systems where the package may be used; and
- (c) The uranium hexafluoride shall be in solid form and at the internal pressure shall not be above atmospheric pressure when presented for transport.”

## 23. Chapter 3.2, List of Dangerous Goods

UN No.	Name and description	Class	Subsidiary risk	PG	SP	Limited Quantity	Excepted Quantity	Packing Instruction
3XYZ	URANIUM HEXAFLUORIDE, RADIOACTIVE MATERIAL IN EXCEPTED PACKAGE, less than 0.1 kg per package, non-fissile or fissile-excepted	8	7	I	317 37X	0	E0	P8XY

24. Delete Special Provision 325 in column 6 against the entry for UN 2910 in the list of Dangerous Goods

25. Add a new special provision 37Y in column 6 against the entry for UN 2910 in the List of Dangerous Goods and a corresponding text in Chapter 3.3 as follows:

"37Y In the case of non-fissile or fissile excepted uranium hexafluoride, the material shall be classified under UN3XYZ or UN 2978."

26. Chapter 3.3, add the following special provision:

"37X This entry may be used only if the conditions of 2.7.2.4.1.1 (d), 2.7.2.4.1.2, and 2.7.2.4.1.4bis are met. In addition to the requirements applicable to Class 8 substances, the following requirements shall apply: 1.1.1.6; 1.5.1.1 to 1.5.1.4, as relevant; 1.5.1.5.1(c); 1.5.2; 1.5.3; 1.5.6; 5.1.3.2; 5.1.5.4.1 (b) and (c); 6.4.4; 7.1.8.5.2, 6.4.4; 7.1.8.5.2 (all these paragraphs as modified by IAEA DS437 Draft 2.5)."

In the case where the material contains fissile material and where conditions of (paragraphs 417(a), (c) or (d) from IAEA DS437 Draft 2.5) are not met, the classification shall be UN2978 or UN2977 as appropriate.

Fissile exceptions under [417 (b) and (e)] are not applicable to that entry.

In the case where the quantity of uranium hexafluoride per package reaches or exceeds 0.1 kg, the classification shall be UN2978 or UN2977 as appropriate.

In the case where the radiation level at contact of the loaded package exceeds 5  $\mu$ Sv/h, the classification shall be UN2978 or UN2977 as appropriate.

For documentation, in accordance with 5.4.1.4.1 and notwithstanding the provisions of 5.4.1.5.7, the description in the transport document shall be as followed:

“UN 3XYZ URANIUM HEXAFLUORIDE, RADIOACTIVE MATERIAL IN EXCEPTED PACKAGE, 8 (7)I”.

No Class 7 label is required for the subsidiary risk.

27. SP 37Z (to be introduced for UN2978 and UN2977 in column (6) of the dangerous goods list)

"37Z: In case of quantity of UF6 less than 0.1 kg per package the material may be classified under UN3XYZ provided all requirements applicable to UN3XYZ are met."

28. Packing instruction P8XY

P8XY	PACKING INSTRUCTION	P8XY
This instruction applies to UN No.3XYZ		
<p>The following packagings are authorized provided that the general packing provisions of 4.1.1 and 4.1.3 and the special packing provision 4.1.9 applicable to excepted package for radioactive material are met:</p> <p>Constitution of the package:</p> <ul style="list-style-type: none"> <li>(a) Inner packagings comprising:                             <ul style="list-style-type: none"> <li>(i) leakproof rigid primary receptacle(s) limited to less than 15 g of UF6 of capacity, made of metal and or plastic not reacting with UF6;</li> <li>(ii) leakproof rigid secondary packaging (s) to contain primary receptacles;</li> <li>(iii) cushioning material in sufficient quantity placed between the primary receptacle(s) and the secondary packaging; if multiple primary receptacles are placed in a single secondary packaging, they shall be either individually wrapped or separated so as to prevent contact between them;</li> <li>(iv) the secondary packaging(s) (inner packaging(s)) shall be placed in an outer packaging and cushioning material shall be placed between the secondary packaging(s) and the outer packaging to prevent movement.</li> </ul> </li> <li>(b) A rigid outer packaging:                             <ul style="list-style-type: none"> <li>Drums (1A2, 1B2, 1N2, 1H2, 1D, 1G);</li> <li>Boxes (4A, 4B, 4C1, 4C2, 4D, 4F, 4G, 4H1, 4H2);</li> <li>Jerricans (3A2, 3B2, 3H2).</li> </ul> </li> <li>(c) The total quantity of uranium hexafluoride per package shall be less than 100g.</li> <li>(e) In case of fissile material, limits specified in [(417 (a) or (c) or (d) or (e) of TS-R-1 20XX edition)] for fissile excepted material shall be complied with.</li> </ul> <p>Packagings shall fully comply with the requirements of Chapter 6.1 for combination packagings and those of 6.4.4 (for the entire package with its contents). In addition, packages containing fissile excepted material shall comply with the requirements of 6.4.7.2.</p>		



## Annex

### Provisional information dated 9 September 2011

#### Data sheet to be submitted to the United Nations for new or amended classification of substances

Submitted by.....IAEA.....Date .....blank.....

Supply all relevant information including sources of basic classification data. Data should relate to the product in the form to be transported. State test methods. Answer all questions - if necessary state "not known" or "not applicable" - If data is not available in the form requested, provide what is available with details. Delete inappropriate words.

#### Section 1 Substance identity

- 1.1 Chemical name: Uranium hexafluoride
- 1.2 Chemical formula: UF<sub>6</sub>
- 1.3 Other names/synonyms
- 1.4.1 UN number:.....left blank. 1.4.2 CAS number: ..left blank....
- 1.5 Proposed classification for the Recommendations: left blank
- 1.5.1 Proper shipping name (3.1.2<sup>[a]</sup>)... left blank
- 1.5.2 Class/division: left blank  
Packing group: left blank

Subsidiary risks .5.1 (oxidizing), 6.1 (toxic) are under investigation

- 1.5.3 Proposed special provisions, if any see left blank
- 1.5.4 Proposed packing instruction(s)..... see left blank

#### Section 2 Physical properties

- 2.1 Melting point or range..... 64.05 °C (triple point)
- 2.2 Boiling point or range ..... 56.5 °C (sublimes)
- 2.3 Relative density at :
- 2.3.1 15 °C ...5.12 g/cm<sup>3</sup>.....
- 2.3.2 20 °C ..5.09 g/cm<sup>3</sup>.....
- 2.3.3 50 °C ...4.92. g/cm<sup>3</sup>.....
- 2.4 Vapour pressure at : (20 °C is 10.58 kPa<sup>[b]</sup>)
- 2.4.1 50 °C .....70.2.. kPa<sup>[h]</sup>
- 2.4.2 65 °C .....156.56.. kPa<sup>[h]</sup>
- 2.5 Viscosity at 20 °C<sup>[c]</sup>.....NA..... m<sup>2</sup>/s
- 2.6 Solubility in water at 20 °C ....NA.... g/100 ml (reacts with water)
- 2.7 Physical state at 20°C (2.2.1.1<sup>[a]</sup>) solid<sup>[c]</sup>

- 2.8 Appearance at normal transport temperatures, including colour and odour: Colourless to white deliquescent crystals.
- 2.9 Other relevant physical properties.....

**Section 3 Flammability**

- 3.1 Flammable vapour
  - 3.1.1 Flash point (2.3.3<sup>[a]</sup>) ..... °C oc/cc, NA.
  - 3.1.2 Is combustion sustained? (2.3.1.3<sup>[a]</sup>) NA
- 3.2 Autoignition temperature .....°C, NA
- 3.3 Flammability range (LEL/UEL) .....%, NA
- 3.4 Is the substance a flammable solid? (2.4.2<sup>[a]</sup>) no
- 3.4.1 If yes, give details .....

**Section 4 Chemical properties**

- 4.1 Does the substance require inhibition/stabilization or other treatment such as nitrogen blanket to prevent hazardous reactivity ? no
  - If yes, state:
    - 4.1.1 Inhibitor/stabilizer used . .....
    - 4.1.2 Alternative method .....
    - 4.1.3 Time effective at 55 °C .....
    - 4.1.4 Conditions rendering it ineffective .....
- 4.2 Is the substance an explosive according to paragraph 2.1.1.1? (2.11) no
  - 4.2.1 If yes, give details .....
- 4.3 Is the substance a desensitized explosive? (2.4.2.4[a]) no
  - 4.3.1 If yes, give details .....
- 4.4 Is the substance a self-reactive substance? (2.4.11) no
  - If yes, state:
    - 4.4.1 Exit box of flow chart .....
    - What is the self-accelerating decomposition temperature (SADT) for a 50 kg package? ..... °C
    - Is the temperature control required? (2.4.2.3.4<sup>[a]</sup>) no
    - 4.4.2 Proposed control temperature for a 50 kg package ..... °C
    - 4.4.3 Proposed emergency temperature for a 50 kg package..... °C
- 4.5 Is the substance pyrophoric? (2.4.31) no
  - 4.5.1 If yes, give details .....
- 4.6 Is the substance liable to self-heating? (2.4.3<sup>[a]</sup>) no
  - 4.6.1 If yes, give details .....

- 4.7 Is the substance an organic peroxide (2.5.1<sup>[a]</sup>) no  
 If yes state:  
 4.7.1 exit box of flow chart .....  
 What is the self accelerating decomposition temperature (SADT) for a 50 kg package?..... °C  
 Is temperature control required? (2.5.3.4.1<sup>[a]</sup>) yes/no  
 4.7.2 proposed control temperature for a 50 kg package ..... °C  
 4.7.3 proposed emergency temperature for a 50 kg package..... °C  
 4.8 Does the substance in contact with water emit flammable gases? (2.4.4<sup>[a]</sup>) no  
 4.8.1 If yes, give details .....  
 4.9 Does the substance have oxidizing properties (2.5.11) : under investigation  
 4.9.1 If yes, give details: UF<sub>6</sub> readily oxidates organic compounds.  
 4.10 Corrosivity (2.8<sup>[a]</sup>) to: No data available, (the test 37)  
 4.10.1 Mild steel .....mm/year at ..... °C  
 4.10.2 Aluminium.....mm/year at.....°C  
 4.10.3 Other packaging materials (specify)  
 .....mm/year at..... °C  
 .....mm/year at..... °C  
 4.11 Other relevant chemical properties:.

Uranium hexafluoride (UF<sub>6</sub>) combines with water to form the soluble reaction products UO<sub>2</sub>F<sub>2</sub> and HF. UF<sub>6</sub> is (essentially) inert to most metals and fluorinated plastics and rubbers. Teflon is used in the valve packing and cap gasket of UF<sub>6</sub> cylinders. The use of glass is not advised because the presence of trace amounts of HF in UF<sub>6</sub> and residual moisture on the glass can result in rapid attack of the material.

### Section 5 Harmful biological effects

- 5.1 LD50, oral (Human) (2.6.2.1.1<sup>[a]</sup>): 1.63 mg/kg<sup>[bl],[cl]</sup> (under investigation)  
 5.2 LD50, dermal (2.6.2.1.2<sup>[a]</sup>) .....mg/kg Animal species .....  
 5.3 LC50, inhalation (2.6.2.1.3<sup>[a]</sup>) .. 942 mg/m<sup>3</sup> Exposure time 10 minutes  
 Animal species: rat<sup>[dl]</sup>... (under investigation)  
 5.4 Saturated vapour concentration at 20 °C (2.6.2.2.4.3<sup>[a]</sup>): 104436 ml/m<sup>3</sup><sup>[bl]</sup>  
 5.5 Skin exposure (2.8<sup>[a]</sup>) results: Highly corrosive (causes severe burns), effect based on the corrosivity of HF produced by the hydrolysis of UF<sub>6</sub><sup>[bl]</sup>  
 Exposure time ..... hours/minutes  
 Animal species.....  
 5.6 Other data: Radiological toxicity, mainly emit alpha particles that have little penetrating ability, the main radiation hazard from uranium occurs when uranium compounds are ingested or inhaled.

Specific activity of UF<sub>6</sub>: 1.2x10<sup>4</sup> ~ 2.3x10<sup>6</sup> Bq/g (0.5% ~ 95% U-235)[e].

Acute toxicity to aquatic organisms: Likely to be high[b] , N[f]..(Not relevant to small quantity)

5.7 Human experience: Accidents in facilities.

LC50 (Human): 0.276 mg/litre Exposure time 1 hour<sup>[b]</sup>. (under investigation)

**Section 6 Supplementary information**

6.1 Recommended emergency action

6.1.1 Fire (include suitable and unsuitable extinguishing agents)

6.1.2 Spillage .....

6.2 Is it proposed to transport the substance in:

6.2.1 Bulk Containers (6.8<sup>[a]</sup>)

6.2.2 Intermediate Bulk Containers (6.5<sup>[a]</sup>)?

6.2.3 Portable tanks (6.7<sup>[a]</sup>)?

If yes, give details in Sections 7, 8 and/or 9.

**Section 7 Bulk containers (only complete if yes in 6.2.1)**

7.1 Proposed type(s)

**Section 8. Intermediate bulk containers (IBCs) (only complete if yes in 6.2.2)**

8.1 Proposed type(s).....

**Section 9. Multimodal tank transport (only complete if yes in 6.2.3)**

9.1 Description of proposed tank (including IMO tank type if known).....

9.2 Minimum test pressure

9.3 Minimum shell thickness

9.4 Details of bottom openings, if any

9.5 Pressure relief arrangements

9.6 Degree of filling

9.7 Unsuitable construction materials .

## Endnote:

- [a] This and similar references are to chapters and paragraphs in the Model Regulations on the Transport of Dangerous Goods.
  - [b] IUCLID: EUROPEAN COMMISSION – European Chemicals Bureau, [http://esis.jrc.ec.europa.eu/doc/existing-chemicals/IUCLID/data\\_sheets/7783815.pdf](http://esis.jrc.ec.europa.eu/doc/existing-chemicals/IUCLID/data_sheets/7783815.pdf)
  - [c] See definition of "liquid" in 1.2.1 of the Model Regulations on the Transport of Dangerous Goods.
  - [d] The Registry of Toxic Effects of Chemical Substances (RETCS), <http://www.cdc.gov/niosh-rtecs/yr480580.html>
  - [e] IAEA TECDOC – 423: RECOMMENDATIONS FOR PROVIDING PROTECTION DURING THE TRANSPORT OF URANIUM HEXAFLUORIDE, <http://nelib-w1/lib/Tecdods/0423.pdf>
  - [f] International Chemical Safety Cards 1250, <http://www.cdc.gov/niosh/ipcsneng/neng1250.html>
  - [g] Uranium hexafluoride: a survey of the physico-chemical properties, R. DeWitt, GAT-280, the GOODYEAR atomic cooperation, Portsmouth Ohio, 1960.
  - [h] Oliver, G. D., Milton, H.T. and Grisard, J.W., The Vapor Pressure and Critical Constants of Uranium Hexafluoride, J. Am. Chem. Soc., 75, 2827-9 (1953)
  - [i] IAEA – TECDOC- 608: Interim guidance on the safe transport of uranium hexafluoride  
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