

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

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Item 4 (c) of the provisional agenda

Listing, classification and packing: miscellaneous

WNTI Information Position Paper on UF6 Subsidiary Hazards (Results of extended/continued literature search)

Transmitted by the World Nuclear Transport Institute (WNTI)

WNTI Position paper on UF6 subsidiary hazards (May 2014)

(Results of extended/continued literature search)

Introduction

1. Labelling of UF6 packages with a radioactive label and a corrosive label has been practised for decades, based on decisions taken in UN meetings in 1980 and re-confirmed in 1994 (see Ref. 1).
2. IAEA TECDOC-423 (Ref. 2) cites the practice, summarised as follows:
“Uranium hexafluoride (UF6) is both radioactive and corrosive. The uranium itself is also toxic (UN Class 6). The UN Recommendations do not denote UF6 as being a toxic substance since its most significant secondary hazard is corrosive”.
3. During 2011, preparations for the allocation of a new UN number for small (< 100 gr) quantities of UF6, initiated discussions on subsidiary hazards, especially the need for additional labelling for toxicity.
4. The UN Data sheet (Ref. 3) to be appended to a request for a new UN number, has been provisionally completed with available information. Some data listed, were marked with “under investigation”, because the history of the data was not precisely known at the time. The toxicity data had been taken from documents as:
 - EC IUCLID Dataset UF6 (Ref. 4)
 - US NRC NUREG-1391 (Ref. 5)
 - IAEA TECDOC-423 (Ref. 2)
 - IAEA TECDOC-608 (Ref. 6)
 - NIOSH-ICSC: 1250 (Ref. 8)
 - NIOSH-RTECS #: YR4720000 (Ref. 9)
5. Later investigations revealed that the toxicity data in the documents listed above, all originate from the same research project in the early 1980s.

6. The toxicity experiments were carried out on rats and guinea pigs and the results were used to predict exposure levels for soluble uranium (U) and hydrogen fluoride (HF) for humans. This work has been presented by Just in a conference paper in 1988 (Ref. 7).

7. The EC IUCLID Dataset notes on the first page: "*The data have not undergone any evaluation by the EC*". A similar note is in NIOSH-RTECS #: YR4720000.

Continued literature search

8. Further search learned that much more documents on toxicity of U and of HF have been published. Most information available describes exposure experiments with animals, such as rats, guinea pigs, mice, dogs, etc. Extrapolations from animal data have however large and unknown uncertainties.

9. There are also data from medical treatment of human patients with exposure to uranium compounds (e.g. diabetes) and from experiments with human volunteers being exposed to lower concentrations of HF. Other documents describe effects from the use of depleted uranium armour and ammunition in battle field situations.

10. There are a number of well documented reports on exposures directly connected with accidental release of UF₆ (2 events) and accidental exposure to HF (4 events).

11. Most documentation reports on the outcome of experimental work or describes what has happened in the accident. Only few documents discuss and evaluate the outcome and results of earlier work and do put these in perspective and/or do make recommendations for practical use.

12. In this context, important and rather recent information is contained in:

- Acute Exposure Guideline Levels (AEGL) for Selected Airborne Chemicals: Volume 4 – 2004 Appendix 5 Uranium Hexafluoride (Ref. 10)
- Acute Exposure Guideline Levels (AEGL) for Selected Airborne Chemicals: Volume 4 – 2004 Appendix 3 Hydrogen Fluoride (Ref. 11)
- Acute toxicity of uranium – Article in Health Physics 2008 (Ref. 12)
- PPT Presentation 12 November 2011 (Ref. 13)

13. The AEGL for UF₆ (Ref. 10) writes the following in the summary:

Uranium hexafluoride (UF₆) is a volatile solid. It is one of the most highly soluble industrial uranium compounds and, when airborne, hydrolyses immediately on contact with water to form hydrofluoric acid (HF) and uranyl fluoride (UO₂F₂) as follows: UF₆ + 2H₂O > UO₂F₂ + 4HF.

Thus, an inhalation exposure to UF₆ is actually an inhalation exposure to a mixture of fluorides. The HF component may produce pulmonary irritation, corrosion, or oedema, and the uranium component may produce renal injury. If death does not occur as a result of HF exposure, renal effects from the uranium moiety might occur.

14. The AEGL for HF (Ref. 11) writes the following in the summary:

Hydrogen fluoride (HF) is a colourless, highly irritating, corrosive gas.

Reaction with water is rapid, producing heat and hydrofluoric acid.

HF is severe irritant to the eyes, skin and nasal passage; high concentrations may penetrate the lungs, resulting in oedema and haemorrhage.

15. Both these AEGL documents do evaluate available data from accidents and experimental work extensively.
16. The article from Health Physics (Ref. 12) and the PPT Presentation (Ref. 13) on that article, also analyse and evaluate previous work.
17. The authors conclude that:

There has never been a death attributed to uranium poisoning in humans, and humans seem to be less sensitive to both acute and chronic toxic effects than other mammalian species studied.
18. They also signal an overestimation in NUREG-1361, as the kinetics of absorption from the lung and excretion via the kidneys has been ignored. The authors propose an acute oral LD50 value for soluble compounds of uranium of over 8 times more than resulting from the early 1980s work.

Conclusions

19. The weighted information from the more recent documentation supports the earlier decisions taken by the UN in 1980/1994 (Ref.1).
20. The highly irritating and corrosive properties of HF have to be primarily and most urgently considered in emergency response operations following a transport accident involving UF6 packages.

Recommendation

21. It is recommended that the more recent documentation and information identified is taken into consideration and valued before any changes to the current labelling practise are decided upon.

References

1. UN/SCETDG/40/INF.18 (18 November 2011)
2. IAEA TECDOC-423: Recommendations for Providing Protection during the Transport of Uranium Hexafluoride - 1987
3. Annex to UN ST/SG/AC.10/C.3/2011-46e: "Data sheet to be submitted to the United Nations for new or amended classification of substances" – Provisional information dated 9 September 2011
4. IUCLID Dataset Uranium Hexafluoride EC/European Chemicals Bureau (2000)
5. NUREG-1391 Chemical Toxicity of Uranium Hexafluoride Compared to Acute Effect of Radiation (1991)
6. IAEA TECDOC-608: Interim Guidance on the Safe Transport of Uranium Hexafluoride - 1991
7. Conference paper Acute Toxicity of Uranium Hexafluoride, Uranyl Fluoride and Hydrogen Fluoride – Conf880558pages 7-10 Robert A. Just 1988
8. NIOSH International Chemical Safety Cards – ICSC: 1250 Uranium Hexafluoride

9. NIOSH The Registry of Toxic Effects of Chemical Substances – RTECS #: YR4720000 Uranium fluoride
 10. Acute Exposure Guideline Levels for Selected Airborne Chemicals: Volume 4 – 2004 Appendix 5 Uranium Hexafluoride
 11. Acute Exposure Guideline Levels for Selected Airborne Chemicals: Volume 4 – 2004 Appendix 3 Hydrogen Fluoride
 12. Acute toxicity of uranium, R.L. Kathren/R.K. Burklin – Health Physics 94(2):170-179;2008
 13. PPT - Acute Toxicity of Uranium: A Brief Review with Special Reference to Man, R.K. Burklin/R.L. Kathren – 12 November 2011
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