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Representative sampling of plutonium nitrate solutions for determination of plutonium concentration

*Échantillonnage représentatif de solutions de nitrate de plutonium en vue de
déterminer la concentration du plutonium*

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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Representative sampling of plutonium nitrate solutions for determination of plutonium concentration

1 Scope

This International Standard describes the basic precautions necessary to ensure that installed tank mixing and sampling systems achieve representative samples from a batch of pure final-product plutonium nitrate solution free from organic compounds and suspended solids, and that the samples remain representative until used.

NOTE — When this International Standard is applied, it can be shown that the difference between the plutonium concentration of the samples, taken from the batch, and the average concentration of plutonium in the solution is less than 0,2 %.

2 Rationale

Plutonium processing plants vary in design, process and installation. Therefore standard procedures for sampling of plutonium nitrate storage tanks cannot be established. However, the necessity for representative samples of the tank contents is absolutely fundamental for accurate plutonium measurement.

The chemical and physical properties of plutonium nitrate solutions introduce many factors which can hinder representative sampling. These include:

- a) storage in shielded tanks for radiation protection, with consequently long sample lines;
- b) storage in tanks of very complex geometry for criticality control purposes, with a consequent need for prolonged mixing to avoid stagnant zones;
- c) high density and viscosity, particularly at the highest plutonium concentrations, leading to prolonged mixing to avoid significant density differences within a single tank;
- d) the possible presence of a second phase, either precipitated plutonium species or organic liquids, which would make totally representative sampling essentially impossible;
- e) the tendency for plutonium(IV) nitrate to undergo hydrolysis and polymerization at low acidity, high concentration and high temperature;
- f) high yields of radiolytic off-gases, particularly at high plutonium-238 or high plutonium(VI) content, leading to the build-up of gas mixtures under pressure, and the possibility of incorrect volume measurements;
- g) high evaporation rates, due to both self-heating and self-radiolysis, especially if mixing is by gas sparging;
- h) temperatures above ambient, leading to thermal expansion of solution and the tank and the possibility of incorrect volume measurements.

Many of the problems mentioned can be avoided or controlled by appropriate engineering at the design stage. However, it is essential that for each storage tank installation a mixing and sampling procedure is drawn up and is experimentally verified as yielding truly representative samples. After any plant modification, the mixing and sampling procedures shall be revalidated. Finally, the tank shall be equipped with a means of accurately measuring the total quantity of solution present or transferred at the time of sampling.